Metrical and Tonal Phonology of Compounds in Two Chinese Dialects

San Duanmu

University of Michigan

This study argues that both Shanghai and Taiwanese have a metrical system, that compound stress is left-headed in Shanghai and right-headed in Taiwanese and that a tonal domain is a metrical domain. It predicts tonal domains better than previous studies and explains some asymmetries between Shanghai and Taiwanese. It also supports the view that metrical structure can be determined in languages that lack data on phonetic stress. In addition, it shows that compound stress is not universal, contrary to the proposal of Cinque 1993. Finally, this study has implications for the theory of prosodic structure.[*]

1. Introduction

This study examines the interaction between the metrical system and the tonal system in two Chinese dialects (or languages), Shanghai and Taiwanese. I argue that a tonal domain is a metrical domain. Descriptively, this study resolves several problems, such as the correct prediction of tonal domains and the tonal asymmetry between Shanghai and Taiwanese with regard to word-length sensitivity and contrastive stress. Theoretically, this study has the following implications. First, a metrical head need not be realized as greater intensity and/or duration phonetically; formal metrical properties, such as the location of the head, stress clash, stress reduction, and the avoidance of a degenerate foot, may be manifested through other means, in the present case the

formation of tonal domains. This idea has been proposed for African languages (e.g. Goldsmith 1984, Kenstowicz 1987, Sietsema 1989, Kenstowicz and Kisseberth 1990, Kisseberth 1993). The fact that it is also true in Chinese suggests that metrical systems may exist in other languages in which phonetic stress is not obvious. Second, both Shanghai and Taiwanese have a metrical system, contrary to the view that Chinese lacks stress. Third, compound stress is not universal, but can vary from language to language, contrary to Cinque 1993; for example, it is left-headed in Shanghai and right-headed in Taiwanese, even though the two languages have the same morphological structures. Fourth, the present study shows once again that a metrical system and a tonal system can exist in the same language. Finally, a tonal domain is not just a 'prosodic constituent', in which a head is not a necessary element, but a metrical domain, in which a head is.

I focus on nominal compounds, which are the majority of all compounds. Chinese has two nominal structures, [M de N] and [M N], where N is a nominal, M the modifier of N, and *de* a particle. M or N can in turn be made of [M N]. I follow Zhu 1956, Fan 1958, Huang 1984, Dai 1992, and Duanmu 1994 in assuming that [M de N] is always a phrase (XP) and [M N] is always a compound (X^0).

2. Metrical Phonology

I will assume a few elements of metrical phonology that are not controversial (e.g. Halle and Vergnaud 1987, Hayes 1994).

First, a metrical constituent has boundaries. The boundaries can be created over a multisyllabic morpheme, as when one constructs iambic or trochaic feet. An example is given in (1), where metrical boundaries are represented by parentheses and S = syllable

(1)   S-S-S-S-S-... --> (S-S)(-S-S)(-S-...

Metrical boundaries can also be projected from morphosyntactic boundaries, so that morpheme, word and phrase boundaries become metrical boundaries. Consider a two-word compound, shown in (2), where W = word.

(2)   Compound: (   )
       Word: (   ) (   )
                    [[W] [W]]

The syntactic boundaries (shown by brackets) project three pairs of metrical boundaries (shown by parentheses), one from each word and one from the compound.[1]

Second, every metrical domain has one and only one head, or stress. A stress is usually located either on the left or on the right. When a new stress is added, a new domain is created. Similarly, when a stress is deleted, the domain it heads will also be eliminated. Consider the examples in (3), where x = stress[2]

(3)   a.   x   b.   x   c.   d.   x x   e.   x   x
             (S S)   (S S)   *(S S)   *(S S S S) -->   (S S)(S S)

(3a) is left-headed and (3b) right-headed. (3c) is ill-formed, since there is no head. (3d) is also ill-formed, since the domain has two heads. However, (3d) can be converted into (3e), which is well-formed.

Third, there is a constraint against stress clash, shown in (4).

(4)   x   x
        (S)(S S)

When clash occurs, several things can happen. Usually, one of the stresses will be deleted. Alternatively, an extra mora can be introduced between the two stresses, such as by lengthening the vowel, so that the stresses are no longer adjacent.

Fourth, a monosyllabic domain, or a 'degenerate foot', is not preferred, though not necessarily forbidden. This is shown in (5).

(5)   x   x   x
        (S S)(S)   or   (S S S)

The structure in (5) can form either one or two metrical domains depending on whether

one keeps the monosyllabic foot. In general, one tends not to build a monosyllabic foot, unless there is a reason, such as when it carries a contrastive stress, or when one is speaking very carefully, possibly with a lengthening of the monosyllabic foot.

Finally, it is possible to reduce the number of stress contrasts in a structure by deleting a stress line, or 'conflation' (Halle and Vergnaud 1987). (6) is an example.

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(6)    Line 2:    a.   x                  b.    x                 c.
       Line 1:         ( x     x )             (         )              x
       Line 0:         (S S)(S S)  ---->        S S S S   -- -->      (S S S S)
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In (6a) the first and third syllables have stress. After deleting stresses on Line 1, their corresponding domains on Line 0 are lost, as shown in (6b). The Line 2 stress is now the only stress, and its domain the only domain, as shown in (6c).[3]

3. Shanghai

Shanghai is a Wu dialect of Chinese. The variety I discuss is called New Shanghai or Mainstream Shanghai by Xu et al 1988, spoken in Shanghai City.

In Chinese phonetic stress is rarely contrastive lexically; exceptions are few and will be ignored. Gao and Shi (1963:68) represent a popular belief: 'Chinese has no word stress.' In what follows I examine stress from a different perspective, namely, its effect on the domain of tone sandhi. I will show that tonal domains in Shanghai are stress domains. Then I will show that compound stress in Shanghai is uniformly left-headed.

Shanghai tone has been studied in several works (e.g. Zee and Maddieson 1979, Yip 1980, Jin 1986, Selkirk and Shen 1990, Duanmu 1992). Basically, every syllable has a tone pattern. An expression of two or more syllables may break into two or more domains. The tonal pattern of each domain is determined by the initial syllable; underlying tones from noninitial syllables are all deleted. Following Selkirk and Shen

1990, I assume that the underlying tones of a Shanghai syllable is either LH or HL. According to Duanmu 1993 all Shanghai syllables are underlyingly light; when a syllable forms a domain by itself it is lengthened to bimoraic (cf. the minimal word effect, McCarthy and Prince 1990) and can carry both of its tones.[4] In a polysyllabic domain there are three patterns. When the initial syllable is underlyingly HL, the first syllable is H, the second L, and the rest L (or perhaps toneless). When the initial syllable is underlyingly LH with either a voiceless onset or a non-glottal vowel, the first syllable is L, the second H, and the rest L (or perhaps toneless). When the initial syllable is underlyingly LH with both a voiced onset and a glottal vowel, the first syllable is L, the last H, and the rest L (or perhaps toneless). The three patterns are shown in (7), along with the monosyllabic cases in (8) (Shanghai has syllabic C, such as [z] in [tsz]; [V'] is a glottal vowel; underlying tones are shown above surface tones).

(7)   HL LH LH   LH LH LH   LH LH LH
       H L L   L H L   L L H
       ko vã- tsz   wã vã- tsz   lo' vã- tsz

       tall house   yellow house   green house

       'tall house'   'yellow house'   'green house'

(8)   HL   LH
       koo 'tall'   wãã 'yellow'

For simplicity, I will omit vowel length in the following discussion.

In multitiered phonology the analysis of (7) and (8) is fairly straightforward. One can assume that the tone bearing units (TBUs) are moras, and the steps in (9).

(9)   a. Delete underlying tones from noninitial syllables.

       b. Associate tones to TBUs one-to-one, left-to-right.

       c. Assign default L to extra TBUs.

For the pattern [L...L H], one can assume 'edge-in' association (Yip 1988), instead of (9b). It will be noted that the [L...L H] pattern is optional for domains longer than three

syllables. This is shown in (10).

(10)   LH LH HL LH -->   a.   L H L L
        ba' ço' kõ- tsz b.   L L L H

        white snow princess   'Snow White'

The [L...L H] pattern is of particular interest because it shows where the domain boundaries are. For example, in (7) the domain must contain all the three syllables, even though spreading does not reach the third syllable in [H L L] and [L H L]. Similarly, the domain in (10) contains all the four syllables, although in (10a) H only moves to the second syllable. In other words, the third syllable in [H L L] and [L H L] is not unparsed, nor are the last two syllables in (10a).

Although there is general consensus on the tonal behavior within a domain, there is some disagreement on how a domain is determined. For example, Selkirk and Shen (1990) suggest that a tonal domain in Shanghai is a 'prosodic word' (PWd), which starts from the left edge of every lexical word or compound. Zhang (1992:224) proposes that tonal domains are determined by syntactic c-command and thematic relations. And Duanmu (1992) proposes that tonal domains are metrical constituents. In what follows I argue for the metrical analysis. I discuss three aspects: multisyllabic morphemes, the effect of contrastive stress, and the phenomenon of word-length sensitivity.

Consider multisyllabic morphemes first. Since Shanghai is a monosyllabic language, multisyllabic morphemes are mostly borrowed names. The underlying tones of a foreign name come from the Chinese syllables that the translator chooses to represent the foreign word. Consider the words below, in fairly broad phonetic transcription, where tonal domains are shown by parentheses:

(11)   HL LH   LH LH
        H L   L   H
        (pa-li)   (zã- he)

        'Paris'   'Shanghai'

(12)   HL HL HL   LH HL HL
         H L L   L L H
       (tsz-ka-ku)   (lo'- se- tçi)

       'Chicago'   'Los Angeles'

(13)   HL LH HL LH   LH LH   HL HL
         H L   H L   L H   H L
       (ya-lu)(-sa- lã)   (de'-k^{h}e')(-sa- sz)

       'Jerusalem'   'Texas'

(14)   HL LH HL LH HL   HL LH LH LH LH
         H L H L L   H L   L H L
       (ku- r)(-pa- tço- fu)   (ka- li)(-fo'-ˆi- ya)

       'Gorbachev'   'California'

(15)   LH LH   HL LH LH LH
        L H   H L   L H
       (je'-k^{h}a')(-sz- lu)(-va'-k^{h}a')

       'Czechoslovakia'

In general a multisyllabic morpheme splits into disyllabic domains, from left to right, and if there is an odd syllable left, it merges with the preceding domain. This cannot be done by appealing to the PWd, since all the above expressions are single morphemes, hence single PWds, and all of them should form just one domain. Similarly, the data cannot be accounted for by c-command, since there is just one word, and hence there is no c-command relation to speak of.[5]

In the metrical approach, the data can be analyzed by forming bimoraic feet from left to right, ignoring a degenerate foot. Thus, an odd numbered morpheme will contain a trisyllabic final domain.

Next consider contrastive stress. If tonal domains are stress domains, one expects contrastive stress to have an effect. But if tonal domains are not stress domains, one does not expect such an effect. Consider the data in (16).

(16) a.   HL LH LH   b.   HL LH LH
              H L   L   H L   LH
              (so-fa' tsʰ ã̃)   (so-fa')(tsʰ ã̃)

              'sofa factory'   'sofa FACTORY'

Such compounds usually form one domain, as in (16a). When a contrastive stress is put

on [tsʰ ã̃] (indicated by small caps in the gloss), the compound breaks into two domains.

In the metrical approach, this is expected. In (16a) [tsʰ ã̃] 'factory' is monomoraic and is

not preferred to form a domain. In (16b), the contrastive stress on [tsʰ ã̃] 'factory' prompts

it to form a domain by itself (accompanied by vowel lengthening); this is because in

metrical theory every stress heads a metrical constituent. If tonal domains are not

metrical domains, there is no reason for a contrastive stress to start a new domain. (I

return later to the case where a contrastive stress cannot start a new domain.)

Next consider word-length sensitivity. It has been noted that tonal domains are

sensitive to word length (syllable counts). For example, a two-word compound [W1 W2]

can form either one or two domains depending on the length of W1 and W2. If W1 is

monosyllabic and W2 is disyllabic, there can be only one domain, as in (17). If both W1

and W2 are disyllabic, there can be two domains, as in (18).

(17) a.   LH LH LH   b.   HL LH LH
           L H L   LH L H   H L L   HL L H
           (du ve- ti)   *(du)(ve-ti)   (sã Ho'-yü)   *(sã)(Ho'-yü)

           'large restaurant'   'business school'

(18) a.   LH HL LH LH   b.   LH LH LH LH
           L H L H   L H L H
           (he- çi)(ve- ti)   (kø- li)(Ho'- yü)

           'seafood restaurant'   'management school'

(17) and (18) are both [M N]; their difference in tonal domains solely depends on the

syllable count of W1. If tonal domains are determined by PWds or by c-command, the

contrast between (17) and (18) is hard to explain. But if tonal domains are metrical

domains, an explanation is available. In (18) W1 and W2 each forms a binary foot, giving two domains. In (17) W1 cannot form a binary foot, hence there is just one domain. It will be noted that, unlike W2 in (16b), W1 in (17) cannot be lengthened to a bimoraic foot, either because lengthening is not a preferred solution, or because lengthening can only occur at a phrase boundary.

Now, if tonal domains are metrical domains, one should show that each domain has a head. Since native Shanghai speakers cannot feel stress in their language (Selkirk and Shen 1990:315), evidence must be sought elsewhere. Consider (19).

(19) a.　HL LH　LH　　　　　　　　b.　LH HL HL
　　　　 H　L　L　　　HL　L　H　　　　L　H　L　　　　L　H　HL
　　　　(tçi tsʰz-pã)　*(tçi)(tsʰz-pã)　　　(lu- sõ　tʰã)　or　(lu-sõ)(tʰã)

　　　　 chicken wing　　　　　　　　　　Russian soup

　　　　 'chicken wing'　　　　　　　　　'Russian soup'

In general, if W1 is monosyllabic and W2 disyllabic, there is just one domain, as in (19a). If W1 is disyllabic and W2 monosyllabic, there can be either one or two domains, as in (19b). The contrast between (19a) and (19b) provides evidence for left-headed stress.

If domains have no heads, the contrast between (19a) and (19b) is unexpected. In particular, if a monosyllabic domain is tolerable, both (19a) and (19b) should allow it, and if it is not tolerable, neither (19a) or (19b) should allow it.

If a domain has a head, there is the question of whether it is left-headed or right-headed. If it is left-headed, the metrical structures of (19a) and (19b) will be (20) and (21), respectively (S = syllable).

(20)　a.　　x　x　　　　b.　　x　　　　c.　　x
　　　　 *(S)(S-S)　　　　　S (S-S)　　　　　(S　S-S)

(21)　a.　x　x　　　　b.　　x
　　　　(S-S)(S)　　　　　(S-S S)

Following a common assumption in metrical phonology, word boundaries are

projected as metrical boundaries. In (20a), there are two resulting domains, with stresses on the first and the second syllables, which leads to stress clash. To resolve stress clash, one can delete one of the stresses. If one deletes the first, the first foot is lost and the first syllable becomes free, as in (20b). The free syllable cannot join the following foot; if it does, the domain will no longer be left-headed.[6] Thus, the first syllable will either remain unmetrified or join a preceding domain, but neither actually happens. Thus (20b) is incorrect. Now consider deleting the second stress from (20a). First, the second domain will be lost, but then the free syllables can merge into the first domain without affecting the direction of the head. This gives (20c) = (19a), which is correct.

Next consider (21). The word boundaries provide two domains, as in (21a). This structure does not violate stress clash, therefore it is a possible output (the second foot will ultimately be lengthened to bimoraic). Alternatively, one can merge the monosyllabic second foot with the first, since a short foot is not preferred. This gives (21b), which is the other correct output.

I have shown that left-headed stress correctly accounts for the contrast between (19a) and (19b). Let us now consider right-headed stress. The metrical structures of (19a) and (19b) are shown in (22) and (23), respectively.

(22)   a.   x   x   b.   x
            (S)(S-S)   (S S-S)

(23)   a.   x x   b.   x   c.   x
            *(S-S)(S)   (S-S S)   (S-S) S

In (22) word boundaries provide two initial domains, as in (22a). Since there is no stress clash, (22a) should be a possible output. Alternatively, if one merges the monosyllabic first domain with the second, one gets an additional output (22b). Thus, right-headed stress predicts two patterns for (19a), which in fact has just one. Next consider (23). (23a) shows the initial domains from word boundaries; it is ill-formed due to a clash between

the second and third syllables. If one deletes the stress from the second syllable, one gets

(23b). But if one deletes stress from the third syllable, it becomes free, as in (23c). In

other words, right-headed stress can only predict one of the two good patterns for (19b).

Thus, right-headed stress makes wrong predictions for both (19a) and (19b).

I conclude that a tonal domain in Shanghai is a left-headed metrical domain. This

conclusion explains another phenomenon. Recall that in Shanghai, tones from noninitial

syllables are deleted. In the present analysis this is not an accident but follows from the

fact that only the initial syllable has stress (a point also made by Yip 1980 and Wright

1983). This correlatiob between tone and stress agrees with a general tendency in

Chinese that all toneless syllables are unstressed and that syllables that originally have

tones tend to lose them when they lose stress.[7]

The metrical approach also explains some data which may otherwise seem quite

surprising. Consider (24).

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(24)   LH HL LH  LH LH LH          HL HL LH  LH LH LH
       L  H  L   L  H  L           H  L  L   L  H  L
       (nø ka- li)(-fo'- ˆi- ya)   (çi  ka- li)(- fo'- ˆi- ya)

       south California            west California

       'southern California'       'western California'
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Each compound is made of two words and each forms two domains. But the domain

boundaries do not fall on word boundaries. Instead, the first word forms a domain with

part of the second word, and the remaining part of the second word forms another

domain. In the metrical analysis, the explanation is simple, as shown in (25).

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(25)   a.   x   x    x                b.   x          x
            (nø)(ka-li)(-fo'-ˆi-ya)   ---->   (nø ka-li)(-fo'-ˆi-ya)
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First, W1 [nø] projects a domain, and W2 forms two domains (se (14)). This gives (25a).

But (25a) contains a stress clash between the first two syllables and the one on the second

has to be removed (see discussion on (20)). The result then is (25b), which is correct.

It is interesting to see the interaction between contrastive stress and stress clash. I showed earlier that contrastive stress can start a new domain. This is, however, not always so. Consider [W1 W2] compounds where W1 is monosyllabic, shown in (26).

(26)   a.   HL LH LH
           H L   L   H   L   L HL L   H
           (tçi ts^{h}z-pã)   (tçi ts^{h}z-pã)   *(tçi)(ts^{h}z-pã)

           chicken wing   chicken WING

           'chicken wing'   'chicken WING'

      b.   HL LH
           H   L   H L   HL LH
           (tçi mo)   (tçi mo)   *(tçi)(mo)

           chicken feather   chicken FEATHER

           'chicken feather'   'chicken FEATHER'

Whether there is contrastive stress or not, such compounds can only form one domain. In the metrical analysis, this is again expected. The contrastive stress on the second syllable clashes with that on the first , therefore the contrastive stress will be removed. As a result, no new domain is created.

I have shown that a tonal domain is a left-headed metrical domain. Let us now see what compound stress is in Shanghai. I will argue that it is also left-headed. Evidence comes from three areas: stress clash, optional domain patterns, and contrastive stress.

First, consider stress clash. I have shown that when W1 is monosyllabic there is stress clash between the first two syllables, which leads to the removal of the stress on the right. An example is repeated in (27).

(27)   x x   x
        (S)(S-S)   -->   (S S-S)

But why is it the second stress, instead of the first, that is deleted? One may suggest that this is a language particular choice. But there is a further problem. Consider (28) (for typographic reasons, stresses are shown below segments in (28)).

(28)   a.   LH LH
                    LH LH   L   H
                    (ma)(dã)   *(ma   dã)
                      x   x   x

                    buy candy

                    'buy candy'

        b.   LH   HL HL
                    LH   H   L   L   H   L
                    (ma)(çã- tço)   *(ma   çã-tço)
                      x   x   x

                    buy banana

                    'buy bananas'

Although there is clash between the first two syllables, one cannot delete the second

stress in this case. Instead, both stresses remain (and a monosyllabic foot will be

lengthened). One notes, thought, that (28a) and (28b) are not compounds, since there is a

phrase boundary between the two words. Perhaps a tonal domain cannot cross a phrase

boundary? But this is not the case. Consider (29) (from Selkirk and Shen 1990, (6e) and

(17a)):[8]

(29)   a.   LH LH LH   b.   LH LH HL LH
              L   H LH   L   H   L   LH
             (p´˙ nõ)(tsʰe)   (to   ?i' pe)(zo)

                give you vegetable   pour a cup tea

                'give you vegetables'   'pour a cup of tea'

        In (29a) [p´˙] 'give' and [nõ] 'you' form a domain, although there is a phrase

boundary between them. Similarly, in (29b) [to] 'pour' and [?i' pe] 'a cup (of)' form a

domain, although there is a phrase boundary in between. Such examples show that phrase

boundaries need not be barriers to tonal domains. A further example is shown in (30)

(cited in Zhang 1992:266)

(30)   LH LH LH LH
　　 LH LH L   H　　　　 L H   L H
　　(kP)(No)(lo- pe)　　or　　(kP No)(lo-pe)

　　dog bite boss

　　'The dog bit the boss'

Here, [kP] 'dog' and [No] 'bit' may form either two domains or just one, even though there is a phrase boundary between them.

Why then, do (28a) and (28b) remain two domains? The reason, I suggest, is again metrical. When there is a stress clash, one does not delete the stress 'on the right' or 'on the left', but the stress that is 'weaker' (Hammond 1984, Nespor & Vogel 1989:81). Let us see how.

Following Cinque 1993, I assume that phrasal stress in [V O] (verb-object) is on O. The metrical analysis of (28a) and (28b) is shown below:

(31)   Phrasal stress: x
        Word stress: x   x
                             (ma)(dã)

                              buy candy   'buy candy'

(32)   Phrasal stress: x
        Word stress: x   x
                             (ma)(çã-tço)

                              buy banana   'buy bananas'

In both cases there is a clash. Since the stress on O is primary, it cannot be deleted. If one deletes the stress on V, V will be either unmetrified or merge with a preceding domain, as in the second pattern of (30). Alternatively, one can add a mora to V so as to separate the two stresses; this is seen in the first pattern of (30). (Adding a mora to the verb is possible probably because it lies at a phrase boundary. Cf. (26), where one cannot add a mora inside a compound.)

Let us now return to compounds. If every metrical domain has a head and if all

morphosyntactic boundaries are projected as metrical boundaries, every compound level should be a stress domain. The question then is, what is the direction of compound stress in Shanghai? I argue that it is left-headed. Consider (33).

(33)　　 x　 x　　　　　 x
　　　 (tçi)(ts^{h}z-pã)　-->　　(tçi ts^{h}z-pã)

　　　 'chicken wing'

In (33), only word stresses are shown. I have argued that due to stress clash, the stress on W2 is removed. Let us now see why is the second stress, instead of the first, that is deleted. I have shown that in phrasal structures, it is the weaker stress that is removed. If compound stress is left-headed, then the result follows. This is shown in (34).

(34)　Compound stress:　　 x　　　　　　 x
　　　 Word stress:　　　 x　 x　　　　 x
　　　　　　　　　 (tçi)(ts^{h}z-pã)　-->　　(tçi ts^{h}z-pã)

　　　　　　　　　 'chicken wing'

Here, the second stress is removed because it is weaker. If there is no compound stress, or if compound stress is right-headed, additional assumptions must be made.

　　　It is interesting at this point to note Kennedy's 1953 study of Tangsic. Like Shanghai, Tangsic is a Wu dialect of Chinese. As in Shanghai, [M N] in Tangsic forms one tonal domain and [V O] forms two. Kennedy (p. 372) reports that 'the louder stress' in Tangsic falls on M in [M N] and on O in [V O]. While Kennedy's judgment is based on his intuition as a native speaker, it agrees with the stress pattern proposed here for Shanghai, which is arrived at on purely formal evidence.

　　　Although the present analysis and Kennedy 1953 agree on where stresses fall, they differ on why stress fall on those places. For Kennedy (p. 373), the tonal difference between [M N] and [V O] is functional: 'The function of tone in Tangsic is essentially not to distinguish otherwise homophonous syllables, but to express syntactic relationships.' For the present study, the tonal patterns follow from phonological reasons alone, namely,

Shanghai and Tangsic have left-headed compound stress. Phrasal stress assignment is
determined by a general principle cross linguistically (Cinque 1993), and need not be
separately stated for Shanghai.

Let us now consider optional domain patterns. In general, when both W1 and W2
of a compound are disyllabic, there can be either one or two domains, as shown in (35).

(35)   a.   LH LH LH HL
              L H L H   L H L L
           (lo- ˆi)(tço- sz)   or   (lo-ˆi tço-sz)

           old   teacher

           'old teachers'

     b.   LH LH HL LH
            L H   H L   L L L H   L H L L
           (ba'-ço')(kõ- tsz) or (ba'-ço' kõ- tsz) or   (ba'-ço' kõ- tsz)

           white-snow princess

           'Snow White'

The single domain pattern usually occurs in faster speech, and the two-domain pattern in
slower speech. (As discussed earlier, (35b) has a voiced onset and a glottal coda, so it has
two optional patterns when there is one domain.) It is easy to understand why there can
be two domains, given that each disyllabic word forms a domain. It is less clear why a
single domain is also possible. But if compound stress is left-headed, then an answer is
available. Consider the metrical structure in (36).

(36)   a.   x   b.
           x   x   x
          (S-S)(S-S)   ---->   (S-S S-S)

In (36a) the lower stress line shows word stresses and the upper stress line shows
compound stress. Since there is no stress clash, (36a) is a good output. Suppose in faster
speech stress reduction (or 'line conflation') is applied, by which the lower stress line is
deleted, the result is (36b), in which there is one domain.[9] This is the other good pattern.

Now if there is no compound stress, or if compound stress is right-headed, there is no obvious way of deriving (36b).

There seems to be some overlap between stress reduction and clash resolution. A reviewer asks if the latter is derivable from the former. (34) is no problem, shown in (37).

```
(37)    x
       ( x   x  )        x
       (S)(S-S)  -->   (S S-S)
```

After stress reduction deletes the lower stress line, there is one domain, as there is in (34), which used clash resolution. There are, however, two reasons for separating stress reduction and clash resolution. First, stress reduction is optional, but clash resolution is often obligatory (see below). Second, stress reduction affects an entire stress line, whereas clash resolution affects just one column. (24) suggests that stress clash only affects one stress column, as shown in (38) (surface tones below segments; cf. (24)).

```
(38)   x                        x
      (x    x            )       x
       x ( x        x    )       x       x            x
      (nø)(ka-li)(-fo'-ˆi-ya)    (nø ka-li)(-fo'-ˆi-ya)   (nø ka-li-fo'-ˆi-ya)
      'southern California'       L  H  L   L  H  L        L  H  L  L  L  L

                a.                      b.                      c.
```

First, [ka-li-fo'-ˆi-ya] forms two feet. Then word stress adds another mark on [ka]. Finally, compound stress falls on [nø], giving (38a). Now there is a clash between the first two syllables. If the stress column on [ka] is removed, there will be two domains, as in (38b), which is correct. If stress clash is resolved by stress reduction, then one needs to delete the two lower stress lines; this removes stress from both [ka] and [fo'], giving (38c). Although (38c) is a possible pattern (the result of both clash resolution and stress reduction), stress reduction alone cannot derive (38b).

Next consider contrastive stress. I have shown that it can affect tonal domains. Let us look at more cases where both W1 and W2 are disyllabic. Consider (39)-(41).

(39) No contrastive stress

   LH LH LH HL
   L H L   H   L H L   L
   (lo- ˆi)(tço- sz)   or   (lo- ˆi tço- sz)

   old teacher

(40) Contrastive stress on W1

   LH LH LH HL
   L H L   L   L   H L   H
   (lo- ˆi tço- sz)   ??(lo- ˆi)(tço- sz)

   OLD teacher

(41) Contrastive stress on W2

   LH LH LH HL
   L H L   H   L H L   L
   (lo- ˆi)(tço- sz)   *(lo- ˆi tço- sz)

   old TEACHER

Without contrastive stress there can be one or two domains. When contrastive stress is on W1, there tends to be just one domain. When contrastive stress is on W2, there must be two domains. The challenge is to explain the variation.

Before I proceed, I will make two assumptions. First, one does not delete a contrastive stress unless one is forced to. Second, a contrastive stress may prompt the deletion of another stress if the latter is optional. I submit that both assumptions are intuitive and I will not offer further explanations.

Now consider the case where compound stress is left-headed. First, consider the case where contrastive stress is on W1, shown in (42).

(42)   x
    x   x   x
   (lo-ˆi)(tço-sz) --> (lo-ˆi tço-sz)

   OLD teacher

When contrastive stress is on W1, it coincides with the primary stress. Since the weaker

stress on W2 is optionally subject to deletion (by reduction), the presence of a contrastive stress makes the deletion more likely. Thus, there tends to be just one domain.

Next, consider the case in which contrastive stress is on W2, shown in (43).

(43)   x
     x   x
    (lo-ˆi)(tço-sz)

    old TEACHER

Here, the stress on the first syllable is the primary stress and cannot be deleted. In addition, there is no motivation for deleting the contrastive stress either, since it does not clash with the primary stress. Thus, both domains remain.

(43) is to be contrasted with (26b), repeated in (44), where the contrastive stress is also on W2 but W1 is monosyllabic.

(44)   x   x
     x   x   x
    (tçi)(ts^{h}z-pã) ---->   (tçi ts^{h}z-pã)   *(tçi)(ts^{h}z-pã)

    chicken WING

Here the contrastive stress clashes with the primary stress on W1 and so must be deleted.

I have shown that left-headed compound stress correctly predicts all domain patterns. Let us now examine whether right-headed compound stress can give the correct results. First, consider the case where contrastive stress is on W2, shown in (45).

(45)   x
     x   x
    (lo-ˆi)(tço-sz)

    old TEACHER

Here the contrastive stress coincides with the primary stress. One predicts that it is possible for both domains to stay, which is correct. But one also predicts that the stress on W1 can be deleted by reduction, as a result of which W1 can merge with a preceding domain. This, however, does not happen. Thus, right-headed stress predicts only one of

the two patterns.

Next, consider the case where contrastive stress is on W1, shown in (46).

(46)   x
        x   x
      (lo-ˆi)(tço-sz)

      OLD teacher

The primary stress on W2 cannot be deleted. The contrastive stress on W1 will not be

deleted either, since it does not clash with the primary stress. Thus one predicts there to

be two domains, which is incorrect.

I conclude that in Shanghai, there is a metrical system, both word stress and

compound stress are left-headed, and a tonal domain is a metrical domain.

4. Taiwanese

Taiwanese, also called Xiamen or Amoy, is a Min dialect of Chinese. It is also spoken in

Xiamen, Fujian Province, from where many people emigrated to Taiwan.

Tone sandhi in Taiwanese has attracted much attention. It has been proposed that

Taiwanese has right-headed stress (R. Cheng 1973, Wright 1983, Yue-Hashimoto 1986),

but little work has been done on its metrical system. I will leave it open whether

Taiwanese speakers have intuitions on stress in their language. Nevertheless, I will show

that as in Shanghai there is a metrical system in Taiwanese, which influences tonal

domains.

In Shanghai the tonal pattern of a domain is determined by the initial syllable. In

Taiwanese, however, no single syllable determines the domain pattern. Instead, every full

syllable has two lexically determined tone patterns: a final pattern, which is used when

the syllable occurs in isolation or in the domain final position, and a nonfinal pattern,

which is used when the syllable occurs in a nonfinal position.[10] There are seven pairs of syllable tones. The exact value of each tone may vary for different transcribers. According to Chen 1987, they are as in (47) (in Chao digits, where 1 is the lowest pitch and 5 the highest).

(47)

Tone type	A	B	C	D	E	F	G
Final tone	44	24	53	21	22	32	4
Nonfinal tone	22	22	44	53	21	4/53	21

Unlike Shanghai, where tone sandhi can be seen as deletion and (re)association, the nature of tone sandhi in Taiwanese is not so clear, nor is it clear how Taiwanese tones can be converted to level tones (see Wang 1967 for an early analysis and Tsay 1991 for a recent one). In the following I will only focus on how tonal domains are determined.

For typographic convenience, I will mark final tones as A, B, C, D, E, F, and G, and nonfinal tones as A', B', C', D', E', F', and G'. The reader can refer to (47) for their approximate pitch values.

Since the pioneering work of R. Cheng 1968, tonal domains in Taiwanese have been studied quite extensively (e.g. R. Cheng 1973, Chen 1987, 1992, Hsiao 1991, Hsu 1992). But no work has taken a metrical approach. In fact, there is some skepticism whether tonal domains have anything to do with stress (Chen 1987:114). However, it has been noted that tonal domains are subject to the 'rhythmic effect', which favors disyllabic domains and disfavors monosyllabic domains (Hsiao 1991, Chen 1992, Hsu 1992, among others). For example, consider the data in (48) and (49), where domains are indicated by parentheses (Chung 1989, Chen 1992, Ku 1993).[11]

(48) a. D' C   b. E' C
         (tua hai)   (tian ts^{h}iun)

         big ocean   electricity station

         'big ocean'   'power station'

(49) a.   C' F' C' C
          (bi-kok sio-tsia)

          America Miss

          'Miss America'

b.   A'   B   B' F
          (tiong-hua)(bin-kok)

          China   republic

          'The Chinese Republic'

c.   A' B D' C   A' B' D' C
          (sin-bun)(ki-tsia)   or   (sin-bun ki-tsia)

          news journalist

          'news journalist'

According to Chen 1987, all [M N] nominals should form one domain. This is true for (48) but not for (49). In general, when both M and N are disyllabic, the situation is flexible. Some expressions form one domain, some two, and some either one or two, as shown in (49a-c); the choice between one or two domains seems to depend on the familiarity of the expression and the speed of speech (as well as personal or dialectal preferences). With familiar expressions and in faster speech, one domain occurs more often. Otherwise two domains are used. Such flexibility is often contributed to the rhythmic effect.

The rhythmic effect is an indication of metrical structure. If so, one expects to find other metrical effects, such as word-length sensitivity and the influence of contrastive stress. I show that this is indeed the case.

Consider word-length sensitivity first. As in Shanghai, a Taiwanese compound can form either one or two domains depending on the length of W1 and W2. When W1 is monosyllabic and W2 disyllabic, there can be either one or two domains. When W2 is monosyllabic, there can be just one domain. This is shown in (50) (examples from Chen

1992 and Ku 1993).[12]

(50)   Word length sensitivity in Taiwanese

a.   D' C' A   D   C' A
         (ts^{h}u ting-bin)   or   (ts^{h}u)(ting-bin)

         house top

         'top of the house'

b.   A'   C' C   A'   C   C
         (ts^{h}ing-li be)   *(ts^{h}ing-li)(be)

         thousand-li horse

         'winged steed' (Lit.: a horse that travels 1000 li (500 km) a day)

         Although both Shanghai and Taiwanese show word-length sensitivity, there is an

interesting difference between them, namely, their sensitivities seem to be mirror images.

Compare the Taiwanese data in (50) with the Shanghai data in (51).

(51)   Word length sensitivity in Shanghai

a.   LH LH LH
          L   H   L   LH L   H
         (?o' tĩ - lã)   *(?o')(tĩ - lã)

         house top

         'top of the house'

b.   HL LH LH
          H   L   L   H   L   LH
         (tɕ^{h}i-li mo)   or   (tɕ^{h}i-li) (mo)

         thousand-li horse

         'winged steed'

When W1 is monosyllabic and W2 disyllabic, there can be two domains in Taiwanese but

one in Shanghai. When W1 is disyllabic and W2 monosyllabic, there can be two domains

in Shanghai but one in Taiwanese. This asymmetry is a puzzle for previous analyses. In

particular, if the rhythmic effect is due to a preference for disyllabic domains, why should

the same structures be treated in opposite ways in the two languages?

In the metrical approach, the asymmetry indicates that Taiwanese and Shanghai have different directions of the metrical head. Whereas word stress and compound stress are both left-headed in Shanghai, they must both be right-headed in Taiwanese. This is shown in (52) and (53) (assuming, as in Shanghai, that morphosyntactic boundaries are projected as metrical boundaries in Taiwanese).

(52) Taiwanese: right-headed

```
a.              x                      x
           x      x                    x
         (S)(S-S)      or      (S S-S)
```

```
b.              x                      x
            x  x                       x
        *(S-S)(S)      -->      (S-S  S)
```

(53) Shanghai: left-headed stress

```
a.         x                      x
         x   x                    x
       *(S)(S-S)      -->      (S S-S)
```

```
b.     x                      x
      x    x                   x
     (S-S)(S)      or      (S-S S)
```

When W1 is monosyllabic and W2 disyllabic, there is stress clash in Shanghai but not in Taiwanese. Thus, Shanghai must resolve the clash by removing the weaker stress, giving one domain, whereas the optionality of a monosyllabic foot allows Taiwanese to have either one or two domains. When W1 is disyllabic and W2 monosyllabic, the reverse happens; there is stress clash in Taiwanese but not in Shanghai. Thus, Taiwanese has one domain, whereas Shanghai can have either one or two domains.

Taiwanese tone sandhi is also sensitive to contrastive stress, as the metrical approach expects. Consider the examples in (54) (from Ku 1993), where contrastive stress is indicated by small caps in the gloss.

(54)　a.　　　C' F' C' C　　　　b.　　　C' F　　C' C
　　　　　　　(bi-kok sio-tsia)　　　　　　　　　(bi-kok)(sio-tsia)

　　　　　　　America Miss　　　　　　　　AMERICA Miss

　　　　　　　'Miss America'　　　　　　　　'Miss AMERICA'

[bi-kok sio-tsia] 'Miss America' usually forms one domain. When a contrastive stress

falls on [bi-kok] 'America', the compound can break into two domains. In the metrical

analysis, this is expected. Since a tonal domain is a metrical domain, and since every

metrical domain has just one head, adding a new stress is adding a new domain. If tonal

domains are not metrical domains, it is unclear why contrastive stress can create a new

domain.

　　　　　Let us consider two further pieces of evidence for a metrical system in Taiwanese.

The first comes from the interaction between contrastive stress and stress clash. As seen

in (44), a contrastive stress in Shanghai cannot start a new domain if it clashes with a

stronger stress. This is also true in Taiwanese, shown in (55) (from Ku 1993).

(55)　a.　E' A' F　　　　　　　b.　E' A' F　　　　E' A F
　　　　　(hu-ts^{h}in tsiet)　　　　　　　(hu-ts^{h}in tsiet)　 *(hu-ts^{h}in)(tsiet)

　　　　　father festival　　　　　　　　FATHER festival

　　　　　'Father's Day'　　　　　　　　'FATHER's Day'

Without contrastive stress there is one domain. With a contrastive stress on W1, there is

still one domain; the contrastive stress cannot start a new domain here. The metrical

analysis is shown in (56) (s = syllable, S = syllable with contrastive stress)

(56)　a.　　　　　　x　　　　　b.　　　　　x
　　　　　　　x x　　　　　　　　　　x
　　　　　*(S-S)(s)　　　-->　　　　(S-S s)

Since Taiwanese has right-headed stress, the word stress of W1, as well as its contrastive

stress, falls on the second syllable. This stress clashes with the compound stress on W2.

As a result, the contrastive stress must be removed, and no new domain is created.

As a final argument, consider another asymmetry between Taiwanese and Shanghai with regard to contrastive stress. First, consider compounds in which W1 is monosyllabic and W2 disyllabic. Relevant patterns are shown in (57) and (58).

(57) Taiwanese

     a.   D C' A   D' C' A
          (ts^{h}u)(ting-bin)   *(ts^{h}u ting-bin)

          HOUSE top

     b.   D' C' A   D   C' A
          (ts^{h}u ting-bin)   ??(ts^{h}u)(ting-bin)

          house TOP

(58) Shanghai

     a.   LH LH LH   LH LH LH
          L H L   LH L H
          (ʔo' tĩ - lã)   *ʔ(ʔo')(tĩ - lã)

          HOUSE top

     b.   LH LH LH   LH LH LH
          L H L   LH L H
          (ʔo' tĩ - lã)   *(ʔo')(tĩ - lã)

          house TOP

When contrastive stress is on W1, there are two domains in Taiwanese but only one in Shanghai. When contrastive stress is on W2, there is one domain in Shanghai and preferably one in Taiwanese. Once again, the metrical analysis is straightforward. Consider Taiwanese first, shown in (59).

(59) Taiwanese

                   x
             x   x
     a.   (ts^{h}u)(ting-bin)

          HOUSE top

```
                x
        x       x                   x
b.      (tsʰu)(ting-bin)  -->  (tsʰu ting-bin)
```

house TOP

When contrastive stress is on W1, it does not clash with the compound stress. So both can stay, giving two domains. When contrastive stress is on W2, it coincides with compound stress; here the weaker stress on W1 is optionally subject to reduction, and the presence of a contrastive stress makes the reduction more likely to apply, leading to one domain.

Now consider Shanghai. The metrical representations are given in (60).

(60)   Shanghai

```
          x               x
        x   x   x
a.      (ʔoʼ)(tĩ -lã) -->  (ʔoʼ tĩ -lã)
```

HOUSE top

```
        x               x
        x   x   x
b.      (ʔoʼ)(tĩ -lã) -->  (ʔoʼ tĩ -lã)
```

house TOP

Since compound stress in Shanghai is on W1, whether contrastive stress is on W1 or W2, there is always a clash, and the stress on W2 will always be deleted. Thus, there is just one domain in both cases.

When W1 is disyllabic and W2 monosyllabic, the opposite asymmetry happens. Consider (61) and (62).

(61)   Taiwanese

```
a.       A'  C'  C              A'   C   C
        (tsʰing-li  be)       *(tsʰing-li)(be)
```

THOUSAND-LI horse

b.   A' C' C   A' C C

(ts^{h}ing-li be)   *(ts^{h}ing-li)(be)

thousand-li HORSE

(62)   Shanghai

a.   HL LH LH   HL LH LH

       H L L   H L LH

(tɕ^{h}i-li mo)   ??(tɕ^{h}i-li) (mo)

THOUSAND-LI horse

b.   HL LH LH   HL LH LH

       H L LH   H L L

(tɕ^{h}i-li) (mo)   *?(tɕ^{h}i- li mo)

thousand-li HORSE

In Taiwanese there is just one domain no matter where the contrastive stress is, but in Shanghai there can be one or two domains depending on where the contrastive stress is. This contrast again has no explanation in previous analyses. In the metrical approach, the answer is again straightforward. Consider the structures in (63) and (64).

(63)   Taiwanese

                 x   x

             x x   x

a.   *(ts^{h}ing-li)(be) --> (ts^{h}ing-li be)

THOUSAND-LI horse

                x   x

            x x   x

b.   *(ts^{h}ing-li)(be) --> (ts^{h}ing-li be)

thousand-li HORSE

(64)   Shanghai

         x

       x   x   x

a.   (tɕ^{h}i-li)(mo) --> (tɕ^{h}i-li mo)

THOUSAND-LI horse

```
         x
         x        x
b.      (tɕʰi-li)(mo)
```

thousand-li HORSE

In Taiwanese, compound stress is on W2, and there is always stress clash whether contrastive stress is on W1 or W2, so the weaker stress on W1 must always be deleted. Thus, there is one domain in both cases. In Shanghai, compound stress is on W1, and there is no stress clash in either case. The stress on W2 stays if it is a contrastive stress, giving two domains. Otherwise, the stress on W2 tends to be deleted, giving one domain.

Let us now consider a final case, where both W1 and W2 are disyllabic. I have shown that in the normal case, there can be either one or two domains in Shanghai. The same is true in Taiwanese. Relevant examples are shown in (65) and (66).

(65)   Shanghai

```
 HL LH  LH LH
 H  L   L  H          H  L   L  L
(çĩ -wẽ )(tçi- tse')     or     (çĩ -wẽ   tçi-tse')
```

news journalist

'news journalist'

(66)   Taiwanese

```
  A'  B  D'  C                 A'  B'  D'  C
(sin-bun)(ki-tsia)     or     (sin-bun ki-tsia)
```

news journalist

'news journalist'

One already understands why there can be two domains, since each disyllabic word can form a domain. One also understands why there can be just one domain, since stress reduction can delete the weaker stress, along with its domain. At this point, Shanghai and Taiwanese seem parallel. But the similarity breaks down when contrastive stress is applied, shown in (67) and (68).

(67)   Shanghai

    a.   HL LH LH LH
          H L L L   H L   L H
          (çĩ - wẽ tçi- tse')   ??(çĩ -wẽ)(tçi-tse')

          NEWS journalist

    b.   HL LH LH LH
          H L   L H   H L L L
          (çĩ - wẽ)(tçi- tse')   *(çĩ -wẽ   tçi-tse')

          news JOURNALIST

(68)   Taiwanese

    a.   A' B   D' C   A'   B' D' C
          (sin-bun)(ki-tsia)   ??(sin-bun ki-tsia)

          NEWS journalist

    b.   A' B' D' C   A' B   D' C
          (sin-bun ki-chia)   ??(sin-bun)(ki-chia)

          news JOURNALIST

When the contrastive stress is on W1, one normally uses one domain in Shanghai but two in Taiwanese. On the other hand, when contrastive stress is on W2, one prefers two domains in Shanghai but one in Taiwanese. This asymmetry is again unexpected in non-metrical approaches. But in a metrical approach, the analysis is again straightforward. Consider the analysis in (69) and (70) (s = syllable, S = syllable with contrastive stress).

(69)   Shanghai

    a.   x
         x   x   x
        (S-S)(s-s)   -->   (S-S s-s)

    b.   x
         x   x
        (s-s)(S-S)

(70) Taiwanese

     a.   x
             x   x
       (S-S)(s-s)

     b.   x
             x   x   x
       (s-s)(S-S)   -->   (s-s S-S)

When contrastive stress is on W1, it coincides with compound stress in Shanghai but not in Taiwanese. The stress on W2 is secondary in Shanghai and tends to be deleted, but it is primary in Taiwanese and cannot be deleted. Thus, there tends to be one domain in Shanghai but two in Taiwanese. When contrastive stress is on W2, the reverse happens. The stress on W1 is primary in Shanghai and cannot be deleted, but it is secondary in Taiwanese and tends to be deleted. Thus, there tends be two domains in Shanghai but one in Taiwanese.

       To conclude, I have shown that in Taiwanese, there is a metrical system, both word stress and compound stress are right-headed, and a tonal domain is a metrical domain.[13]

5. Implications

       The present study has implications for some theoretical issues: the universality of compound stress, the theory of prosodic structure, the distinction between a tone language and a pitch-accent language, and Optimality Theory. For space limitations, only the first to are discussed below.

5.1. Cinque's universal stress rule.   Cinque 1993 proposed a rule for assigning both phrasal and compound stress in all human languages. The rule makes three assumptions.

First, syntactic and morphological structures are both projected in accordance with the X-bar theory. Second, the Spec(ifier) of an X-bar projection is not favored for primary stress, so its internal structure is ignored. Third, the element that is embedded the deepest gets the primary stress. Consider the phrase structures in (71).

(71)   a.   XP   b.   XP
              /\   /\
          YP   X'   YP   X'
         (Spec) /\   (Spec) |
                ZP   X   X
            (Comp) (Head)   (Head)
                  |
                 Z'
                  |
                 Z
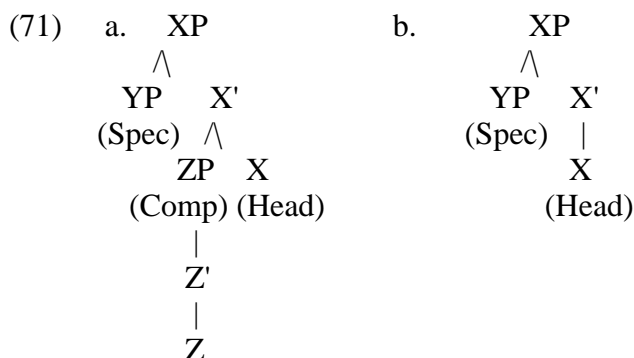
In (71) the internal structure of the Spec YP is ignored. In (71a), the deepest element is Z, which receives the primary stress. In (71b), which lacks the Comp(lementizer), the deepest element is X, which receives the primary stress. In general, this mechanism gives the following order of preference for primary stress: Comp>Head>Spec.

Cinque's proposal assumes some new syntactic analyses. For example, *red cars* is not analyzed as the traditional [NP AP N] but as [FP AP [F' F NP]], which is a projection of a functional element F, in which *red* is in the Spec (= AP) and *cars* in the Comp (= NP). In this analysis, *cars* correctly receives the primary stress.

Compound stress is treated similarly. Consider (72) (from Cinque's (96) and (97)).

(72) a.   N^0 b.   N^0 c.   N^0
             / \   / \ |
         N^0 N^{-1} N^0 N^{-1} N^{-1}
        (Spec)   / \   (Spec) | / \
           | N^0 N^{-2} | N^{-2} N^0 N^{-2}
        N^{-1} (Comp) (Head)   N^{-1} (Head)   (Comp)   (Head)
         | | | | | | |
        N^{-2} N^{-1} rack   N^{-2} RACK   N^{-1} rack
         | | | |
      kitchen N^{-2} kitchen   N^{-2}
              | |
           TOWEL   TOWEL
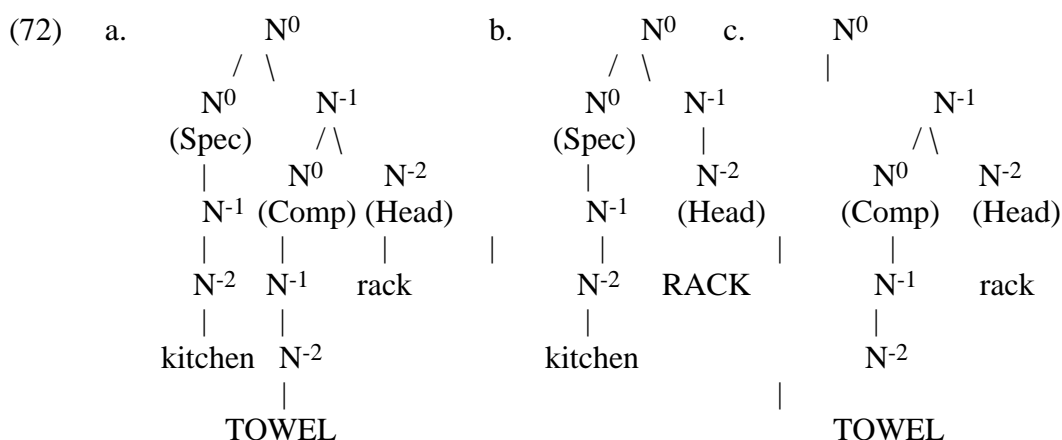
Cinque assumes that the maximal projection in a compound is X^0 and the minimal projection is X^{-2}. Ignoring the internal structure of the Spec, the deepest element is *towel* in (72a), *rack* in (72b), and *towel* in (72c), all of which receive primary stress (indicated by small caps).

The contrast between (72b) and (72c) is crucial. It has been noted that in [W1 W2] compounds the primary stress sometimes falls on W1, as in (72c), and sometimes on W2, as in (72b). Further examples are shown in (73) (Cinque's (92)).

(73) a.   FROST bitten   b.   lily WHITE

            DISEASE prone   waist HIGH

            BLOOD thirsty   dirt CHEAP

            GERM resistant   crystal CLEAR

As Selkirk (1984:245) points out, in English, whether W1 gets primary stress or not depends on whether W1 is an argument of W2. If it is, W1 gets the primary stress, otherwise W2 gets the primary stress. Extending Selkirk's insight, Cinque suggests that when W1 is an argument of W2, it is in the Comp, as in (72c), and when W1 is not an argument of W2, it is in the Spec, as in (72b). The stress pattern thus follows from the location of W1 in the X-bar projection.

As Cinque notes, there are some apparent exceptions. Notably, in many [A N]

(adjective-noun) expressions which are traditionally thought to be compounds, the primary stress is on A even though A is not an argument of N. Some examples are given in (74).

(74)   BLACKbird   BLUEfish   WHITE House   BLACKmail

Adopting an idea from Liberman and Sproat (1992:148ff.), Cinque (1993, footnote 52) suggests that such expressions are not compounds but single words. Similarly, Cinque (1993, footnote 52) notes the following variations:

(75)   APPLE cake   MADISON Street

(76)   apple PIE   Madison AVENUE

Expressions in (75) and (76) have the same structure but different stress patterns. Those in (76) appear to be compounds, since their stress pattern is regular, namely, W1 is not an argument of W2, so stress falls on W2. But what are those in (75)? Cinque suggests that they are neither compounds nor phrases but simple words, since their stress pattern does not follow from the proposed rule. In addition, whether [W1 W2] is a simple word or a compound can vary among speakers. Expressions in (75) are simple words for those who put stress on W1 but compounds for those who put stress on W2. Similarly, as noted by a reviewer, *weekend* and *icecream* are pronounced with initial stress by American English speakers and final stress by British English speakers, indicating that they are considered single words in America and compounds in the UK.

Cinque's analysis covers a large amount of data in English and German. However, the present study shows that it is not universally correct. I have argued that compound stress is left-headed in Shanghai and right-headed in Taiwanese, whether or not W1 is an argument of W2. Consider the Shanghai data in (77) (stress is shown below segments).

(77)   a.   M is an argument of N   b.   M is not an argument of N

```
        LH LH                          LH LH
         L   H                          L   H        LH LH
        (de   pu)                      (Hõ  pu)    *(Hõ)(pu)
          x                              x            x

        table cloth                    red cloth

        'table cloth'                  'red cloth'
```

W1 is an argument of W2 in (77a) but not in (77b).[14] According to Cinque, compound

stress should be on W1 in (77a) and W2 in (77b), but in both cases it is on W1. In

particular, the compound stress in (77b) is not on W2; if it were, W2 should keep its

underlying stress and form a domain by itself. (This is because W2 has primary stress and

so is not subject to clash deletion. See section 3.) Similarly, consider (78) and (79).

(78)
```
      LH LH LH
       L   H   L                 LH  L H
      (du   de   pu)           *(du)(de pu)
        x                          x

      large table cloth

      'large table-cloth'
```

(79)
```
      LH LH LH
       L   H   L              L   H   LH              LH  L H
      (du   Hõ   pu)        *(du Hõ)(pu)           *(du)(Hõ pu)
        x                        x                      x

      large red cloth

      'large red cloth'
```

According to Cinque, compound stress should be on *de* 'table' in (78) and *pu* 'cloth' in

(79), but it is on *du* 'large' in both cases. If Cinque is right, *de* 'table' should start a domain

in (78) and *pu* 'cloth' should start a domain in (79), but neither does. Let us consider two

more examples, shown in (80) and (81).

(80)   HL LH HL LH

      H   L   H   L   H L   L L

     (ko- tçe')(pĩ - kø)   or   (ko-tçe' pĩ -kø)

      x   x   x

      x

     luxury hotel

     'luxury hotel'

(81)   LH LH LH HL

      L   H   L   H   L H   L   L

     (tçĩ -kʰP)(tçʰi-tsʰo) or   (tçĩ -kʰP tçʰi-tsʰo)

     x   x   x

     x

     import car

     'imported car'

In neither compound is W1 an argument of W2, yet in both cases compound stress is on W1. If compound stress were on W2, and since primary stress cannot be deleted, it would not be possible for there to be just one domain, where W2 does not bear stress.

     Let us now consider Taiwanese, which has right-headed word and compound stress (section 4). Further examples are shown (82) and (83).

(82)   B' E   F' A   B' E' F' A

     (bun-ge)(hok-hin)   or   (bun-ge hok-hin)

         x   x   x

              x

      literature revival

     'Renaissance'

(83)   B' E C' C   B' E' C' C

     (jin-siu)(po-hiam)   or   (jin-siu po-hiam)

         x   x   x

              x

     life insurance

     'life insurance'

In these compounds, W1 is an argument of W2, and Cinque expects the primary stress to fall on W1. However, the primary stress is always on W2; that is why the weaker stress on W1 can optionally be deleted and W1 joins the domain of W2. One might suggest that perhaps W1 here is an adjective rather than a noun, so that it no longer is an argument. This is the proposal Cinque (1993:290f) made to account for the contrast between *stellar OBSERVATION*, where stress is on W2, and *STAR observation*, where stress is on W1. But unlike English, which distinguishes nouns and adjectives with morphology, Taiwanese does not make such a distinction. There is therefore no indication that W1 in (82) and (83) are adjectival. Moreover, as I have argued, all Taiwanese [M N] compounds are right-headed. Perhaps all Ms are adjectival in Taiwanese, therefore no M is an argument, hence stress is always on N in [M N] compounds? While this is in principle possible, there is no independent evidence for it. Besides, one cannot explain why in Shanghai compound stress is always left-headed, even when M is not an argument. Thus, one still cannot reconcile Taiwanese and Shanghai with a universal compound stress assignment.

Let us consider a final possibility for saving the universal compound stress rule. As mentioned earlier, Cinque assumes that some compounds can be reanalyzed as simple words. If all [M N] nominals are simple words in Shanghai and Taiwanese, one can say that Shanghai has left-headed word stress and Taiwanese has right-headed word stress. Thus the two languages no longer show a variation in compound stress, since there are no compounds any more. But this suggestion does not work either. To say that an expression is a single word is to say that its internal structure is not visible. But I have shown that in both Shanghai and Taiwanese compound-internal structure must be visible, otherwise one cannot explain word-length sensitivity and the varying effects of contrastive stress.[15]

I conclude that Shanghai and Taiwanese have different directions of compound

stress. There is therefore no universal compound stress assignment.[16]

5.2. The Prosodic Structure Theory. A important issue in grammar is the exact relation between phonology and syntax. A prominent theory was proposed by Selkirk (1981) and developed in several subsequent studies (e.g. Selkirk 1984, 1986, Nespor and Vogel 1986, Inkelas and Zec 1990). Following Selkirk 1981, I call it the Prosodic Structure Theory (hereafter PST). There are three basic elements in the PST. First, the boundaries of prosodic constituents (above the Foot level) are projected from (selected) boundaries of syntactic domains.[17] Typically, a lexical X^0 boundary projects a Prosodic (or Phonological) Word boundary, and an XP boundary projects a Phonological Phrase boundary. Second, phonology has limited access to syntax, in the sense that the projection of morphosyntactic boundaries to prosodic boundaries is the only interface between the two. After the projection, phonology is entirely independent. Third, prosodic structure is constrained by the Strict Layer Hypothesis (Selkirk 1984), according to which prosodic constituents fall into a limited number of categories, such as the Syllable, the Foot, the Prosodic Word, the Phonological Phrase, and so on. These categories are hierarchically structured, so that, for example, a Phonological Phrase will only dominate Prosodic Words, and a Prosodic Word in turn will only dominate Feet.

The present study agrees with the PST in several ways. First, morphosyntactic boundaries are projected as phonological boundaries. Second, only limited information from syntax is assumed. In particular, information on syntactic categories (e.g. N, V, A) is not assumed, nor is c-command relations (see Chen 1987 and Zhang 1992, who assume c-command for Taiwanese and Shanghai). What is needed is just the level of X-bar structure, so that an X^0 projection receives compound stress and an XP projection revives phrasal stress. Third, there is no need to refer to syntactic information once proper

boundaries have been projected. Fourth, mismatches between phonological domains and morphosyntactic domains can be accounted for by allowing independent metrical processes after the syntax-to-phonology mapping (e.g. stress clash resolution). Finally, the same conclusions will be reached if the present study adopts the end setting mechanism of PST (Selkirk 1986, after Chen 1985/7), by which only one end of a pair of syntactic boundaries needs to be projected (cf. Halle and Idsardi 1992 and Idsardi 1992, who also assume one-ended metrical domains).[18]

There is, however, a difference between a metrical constituent and a prosodic constituent. Every metrical constituent necessarily has a head, but prosodic constituents (above the Foot level) have just boundaries and no heads.[19] I have shown, however, that tonal domains in Shanghai and Taiwanese have heads, therefore they must be metrical constituents and not prosodic constituents.

It is possible to build metrical structure within the PST. According to Selkirk (1986:376) and Nespor and Vogel (1989:70f), although morphosyntactic structure only projects prosodic constituents, one can convert them into metrical constituents by assigning each a head. In this sense, metrical phonology is sub-theory of the PST. It is no surprise, therefore, that a metrical analysis should have so much in common with the PST.

But is it possible to project metrical constituents directly from morphosyntactic boundaries, as is generally assumed in metrical phonology? What is the reason for having an intermediate stage of headless constituents?[20] The answer is that there are phonological processes that require just a domain but not a head, that is, processes that have no relation to stress. For example, Selkirk and Shen 1990 argue that tonal domains in Shanghai are not conditioned by stress, therefore such domains are prosodic constituents and not metrical constituents. I have shown, however, that tonal domains in

Shanghai are metrical domains, despite the fact that phonetic stress is not obvious to the native speaker. One would wonder, therefore, whether other processes that seem to require just a domain but not a head may turn out to be metrically conditioned after all.[21]

One can modify the PST so that a head is required for every prosodic constituent. This will make the PST closer to metrical phonology. But there is another difference: the PST assumes the Strict Layer Hypothesis, which posits a limited number of prosodic categories, hence a limited number of hierarchical levels. In contrast, metrical phonology does not assume the Strict Layer Hypothesis, and since there is in principle no limit to the number of morphosyntactic layers, there is no limit to the number of metrical layers that can be projected. Consider the English example in (84) (Hayes 1994).

```
(84)    Line 5:     x
        Line 4:   ( x                          )
        Line 3:   ( x                  )
        Line 2:   ( x            )
        Line 1:   ( x      x )  x      x      x
        Line 0:   ( W  ) ( W ) ( W )  ( W )   ( W )
                    [[[[whale  oil ] lamp] stand] dealer]
```

This compound projects (at least) nine metrical domains at five levels. At the lowest level (Line 0), each word (W) projects a domain. Next, the compound formed by the first two words projects a domain in line 1. Then the compound formed by the first three words projects a domain on Line 2. And so on. The same situation applies to phrasal/sentence stress. The longer the phrase/sentence, the more levels there are (Halle and Vergnaud 1987, Gussenhoven 1991, Cinque 1993, Hayes 1994, and others). Clearly, such projections are incompatible with the Strict Layer Hypothesis.

One may suggest that perhaps a compound projects just two levels, the word level, and the compound level; all intermediate levels are omitted. This proposal will give the correct stress for (84), as shown in (85).

(85)   x
    Compound: (x   x   x   x   x)
    Word: (W) (W) (W) (W) (W)
               [[[[whale oil] lamp] stand] dealer]

But by omitting intermediate levels one loses the contrast between left-branching and right-branching compounds, as shown in (86).

(86)   a. Left-branching   b. Right-branching

(x)	(x)	compound level
(x)(x)(x)	(x)(x)(x)	word level
[[W W] W]	[W [W W]]	morphosyntax

Morphosyntactically (86a) and (86b) have different structures. But without the intermediate level their metrical structures become identical. This analysis runs into difficulty with Shanghai and Taiwanese, since left-branching and right-branching compounds have different domain patterns. Consider (87) and (88) in Shanghai:

(87)   Left-branching

a.   LH LH LH
       L H L   L H LH   LH L H
      (ha' N dP)   or   (ha' N)(dP)   *(ha')(N dP)

      [[black fish] head]

      'the head of a black fish'

b.   LH LH LH
       L H L   L H LH   LH L H
      (Hõ mo' zã)   or   (Hõ mo')(zã)   *(Hõ)(mo' zã)

      [[red wood] bed]

      'a bed made of redwood'

(88)   Right-branching

    a.   LH LH LH
         L H L   L H LH   LH L H
         (ha' N dP)   *(ha' N)(dP)   *(ha')(N dP)

         [black [fish head]]

         'a fish's head which is black'

    b.   LH LH LH
         L H L   L H LH   LH L H
         (Hõ mo' zã)   *(Hõ mo')(zã)   *(Hõ)(mo' zã)

         [red [wood bed]]

         'a wood bed which is red'

Left-branching compounds can form either one or two domains, the latter being used in slower speech. In contrast, right-branching compounds can only form one domain. Besides, in neither case can the first word (syllable) form a domain by itself.

    The distinction between left- and right-branchings can be captured if all levels of morphological structures are projected to metrical domains, as shown in (89) (<> = added stress mark to satisfy the Continuous Column Constraint, Hayes 1994)

(89)   Left-branching   Right-branching

    a.   x   x   x   x   x   x
        [[(W1) (W2)] (W3)]   [(W1) [(W2) (W3)]] one-word level

    b.   x   x
        (x   x) x   x (x   x) two-word level
        [[(W1) (W2)] (W3)]   [(W1) [(W2) (W3)]]

         x   x
        (x   ) x   x (x   ) clash deletion
        [[(W1) W2] (W3)]   [(W1) [(W2) W3]]

    c.   x   x
        (x   )   (<x> x   ) three-word level
        (x   ) x   x (x   )
        [[(W1) W2] (W3)]   [(W1) [(W2) W3]]

```
d.        x                          x
       ( x          )          (<x>              )      clash deletion
       ( x      )   x               x
    [[(W1)  W2] (W3)]          [(W1) [ W2  W3]]
```

At the one-word level, each word forms a separate domain. At the two-word level, stress clash arises, and one must delete the stress from W2 in the left-branching compound and from W3 in the right-branching compound. On the three-word level, there is no stress clash in the left-branching compound, but there is in the right-branching compound between W1 and W2, leading to the deletion of the W2 stress. In the output, therefore, there is stress on W1 and W3 in the left-branching compound, but just on W1 in the right-branching compound. Since a monosyllabic foot is optional, the above analysis predicts that a left-branching structure can form either one or two domains, but a right-branching structure can form only one. In addition, in neither case can W1 form a domain by itself. This prediction is correct. Thus, facts from Shanghai (and Taiwanese) suggest that the levels of prosodic or metrical domains must be more than is usually assumed in the PST, possibly unlimited.

Let us now consider another motivation for prosodic categories, namely, they provide specific domains in which phonological rules apply. As Selkirk (1986:372) states, 'there are phonological rules (of various types) which have their characteristic domains defined in terms of prosodic structure.' Similarly, Inkelas (1989:356) states that 'claims that a given phonological rule has as its domain the syllable, or the foot, cannot be supported in a theory which identifies all phonological rule domains as constituents in the prosodic hierarchy.' In other words, the PST hypothesizes that no phonological process takes a metrical domain as its domain of application (except when a metrical domain happens to coincide with a prosodic domain). With regard to Shanghai, Selkirk and Shen (1990) propose that regular tonal domains are the Prosodic Word, and special tonal domains under focus are the Phonological Phrase.

I have shown, however, that tonal domains in Shanghai and Taiwanese are not only metrical domains, but are sensitive to more than one level of metrical structure. A tonal domain can be smaller than a morpheme in a multisyllabic word, at various levels of a compound, or over a word and part of another word. In addition, as Zhang (1992:266) points out, a tonal domain in Shanghai can extend across phrase boundaries even in the absence of functional words. An example from Zhang is repeated in (90).

(90)   LH LH LH LH
     LH LH L H   L H L H
    (kP) (No) (lo- pe)   or   (kP No)(lo-pe)

    dog bite boss

    'The dog bit the boss'

(90) can form either two or three domains. What makes the first two syllables merge? Can the last three syllables, or all syllables, merge? Consider the PST analysis in (91).

(91)   Phonological Phrase (XP Left):   (((

    Prosodic Word (X^0 Left):   (((

    Syntax   [kP [No [lo-pe]]]

                        dog bite boss

In this analysis, tonal domains are determined by two prosodic levels: Prosodic Word, projected from the left boundary of a lexical X^0, and Phonological Phrase, projected from the left boundary of an XP. Both levels give three domains. There is no indication what would make the first two domains merge.

Zhang (1992:262f) suggests that domain merger is due to the rhythmic effect, which is characterized as a preference for disyllabic domains over monosyllabic domains. Now consider the example in (92).

(92)   LH LH LH LH
             L H LH LH   L H L H
    a.   (lo- pe) (No)(kP)   b.   *(lo-pe)(No kP)

             boss bite dog

             The boss bit the dog.'

(92a) also contains two monosyllabic domains, but in this case they cannot merge. Why does the rhythmic effect fail to obtain here? If the rhythmic effect simply merges two monosyllabic feet into a disyllabic one, one expects (92b) to be good. But it is not.

In the metrical approach, an explanation is available. The crucial role is played by the metrical head. Consider (90) first, shown in (93).

(93)   a.   x   b.   x
             (x)   (x)
              x (x   x)   x   x
             (S)(S)(S-S)   (S   S)(S-S)
             [kP [No lo-pe]]   --->   [kP [No lo-pe]]

             dog bite boss

Following Cinque 1993, I assume that phrasal stress is assigned cyclically and that the object has greater stress than the verb and the predicate has greater stress than the subject. In (93), each word first forms a domain, with left-headed stress. On the VP level, stress falls on the object. At this point, there is stress clash between the verb and the object. If one delete the stress from the verb, the verb will remain unmetrified, since it cannot be merged with the object, due to left-headed word stress. For this reason, clash deletion is not applied. On the sentence level, stress again falls on the object. Thus, (93a) ends up with three domains, which is a good pattern. On the other hand, there are three reasons for deleting the stress on the verb. First, its stress clashes with the primary stress on the object. Second, there is stress clash between the subject and the verb. Third, deleting the stress from the verb would create a disyllabic domain and eliminate two monosyllabic domains. For these reasons, deleting the stress from the verb becomes a

strong option, giving (93b).

Next consider (92), whose metrical structure is in (94).

(94)
```
                    x
        (           x)
          x     (x   x)
        ( S-S) (S) (S)
        [lo-pe [No kP]]
```

boss bite dog   'The boss bit the dog.'

In (94), there is also a stress clash between the verb and the object. Here the object again carries the primary stress, which cannot be deleted. In addition, since word stress is left-headed, the object cannot take in the verb from its left. Thus, the object and the verb cannot merge.[22] Can the verb merge with the subject? Here the motivation is not as compelling as in (93). First, there is no clash between the verb and the subject at the same time. Second, deleting the verb stress will either create a trisyllabic domain (merging the verb with the subject), or an unmetrified word (not merging the verb with the subject, since the latter is already a binary foot); in either case, there is no improvement in foot structure.

It turns out, then, that the so-called rhythmic effect is based on metrical structure, which explains why two monosyllabic domains can merge only sometimes. This analysis demonstrates that tonal domains in Shanghai (and Taiwanese) are sensitive not just to one prosodic level, but to metrical domains at all levels.

While it cannot be said that every phonological process is applicable at every levels of prosodic or metrical domain, it is clear that some phonological processes are, as is the case for tonal domains in Shanghai. This weakens the claim that a given phonological process can apply only in a given prosodic category. It also weakens the motivation for setting up prosodic categories.

McCarthy and Prince (1993b:146) suggest that a prosodic category can be

recursive, in particular a Prosodic Word can contain another Prosodic Word. This proposal can solves the problem of recursive compounds and distinguish left- and right-branchings, yet it weakens the strong version of the Strict Layer Hypothesis. Consequently, the PST and metrical phonology will be another step closer to each other.

6. Conclusions

I have argued that both Shanghai and Taiwanese have a metrical system, that stress at word and compound levels is left-headed in Shanghai and right-headed in Taiwanese, and that a tonal domain is a metrical domain.

The present study makes better predictions of tonal domains in Shanghai and Taiwanese than previous studies. In addition, it explains tonal asymmetries between the two languages, especially with regard to word-length sensitivity, optional domains, and contrastive stress. The idea that tone sandhi in Chinese is sensitive to metrical structure has been proposed before. For example, Yip 1980 and Wright 1983 suggest that tonal domains in Shanghai and Min are stress domains, Shih 1986 suggest that the domain of the Mandarin third tone sandhi is a foot, and Chen 1992 and Zhang 1992 note that tonal domains in Taiwanese and Shanghai are subject to the rhythmic effect. The present study extends previous insights and provides specific phonological evidence for characterizing the metrical system and its interaction with the tonal system.

Theoretically, the present study has several implications. First, it shows, once again, that both tonal and metrical systems can exist in the same language (e.g. Goldsmith 1981, Hyman 1987, Ao 1992, Hyman and Katamba 1993). Second, it shows that a tonal domain is a metrical domain, in support of similar proposals by Hyman 1987, Sietsema 1989, Ao 1992, Kenstowicz 1987, Kisseberth 1993, and others. Third, the

present study supports the view that metrical structure can be determined purely on formal grounds, even in languages that lack data on phonetic stress. This conclusion offers the prospect that metrical systems may be found in many other languages, if not all, that have previously been thought to lack stress. Fourth, contrary to the proposal of Cinque 1993, compound stress is not universal but can vary from language to language. Finally, the fact that a tonal domain is sensitive to metrical structure at several levels weakens the Strict Layer Hypothesis of the prosodic hierarchy and questions the view that no phonological process can apply in a metrical domain (Inkelas 1989).

Notes

[1]It is possible to specify just one end of a pair of constituent boundaries (Chen 1985/7, Selkirk 1986, Halle and Idsardi 1992 and Idsardi 1992). Since the alternative is not consequencial to the present article, it is not discussed here.

[2]According to Halle and Vergnaud 1987, metrical constituents are not build directly on syllables (or moras), but on a line of stress bearing units projected from syllables (or moras). For simplicity, I will omit Line 0 and show the lowest level of metrical constituents on syllables (or moras) directly.

[3]A Language reviewer asks whether stress reduction removes the entire Line 1 as in (ia), or just the stress on the third syllable, as in (ib).

(i)   a.   b.   x
               x   (x   )
             (S S S S)   (S S) S S

(ia) predicts that tone movement can reach as far as the fourth syllable; (ib) predicts that it can only reach the second syllable. I will show that (ia) is correct.

[4]A Language reviewer asks whether the lengthening is due to the minimal word effect or to the need for the extra tone to be picked up by another TBU. The test would be to see whether a syllable with a level tone (H or L) would lengthen in a monosyllabic domain. Unfortunately, no syllable in Shanghai has an underlying level tone.

[5]The influence of foot on tonal domain has been noted before (e.g. Shih 1986, Chen 1992, Zhang 1992), and has been called the rhythmic effect. However, the rhythmic effect has not been interpreted in terms of metrical phonology.

[6]As a reviewer points out, Hammond (1986) suggests the possibility for a left-headed domain to take a syllable from the left, hence the foot ceases to be left-headed. The present study shows that this option is not universally viable.

[7]As a reviewer points out, it is circular to define an unstressed syllable as one without tone and then to claim that an unstressed syllable will lose its tone. However, lack of stress can be independently defined on phonetic grounds, such as duration and rime reduction (e.g. Lin and Yan 1988).

[8]My transcription differs slightly from those of Selkirk and Shen's.

[9]The idea that in faster speech a tonal domain can be larger was proposed by C. Cheng (1973) and adopted by Shih (1986) for the Mandarin third tone sandhi.

[10]Some expressions may end in one or more weak syllables (i.e. unstressed and toneless). In this case, the last full syllable counts as domain final.

[11]The transcriptions for Taiwanese vary in the sources and are not always in the IPA. Since segment quality is not a concern, I have not regularized the transcriptions.

[12]For arguments that Chinese locatives like 'top' and 'middle' are nominals rather than postpositions, see Li 1990 and McCawley 1992.

[13]A Language reviewer points out that it may not be a coincidence that word stress and compound stress have the same direction in Shanghai (both left-headed) and in Taiwanese (both right-headed). S/he suggests that if all polysyllabic morphemes are considered pseudo-compounds, then what I call word stress is a sub-case of compound

stress. The fact that both word stress and compound stress have the same direction in Chinese, then, follows from the fact that Chinese is a monosyllabic language.

[14]It is not very clear to me how one decides whether an M is an argument of N. I consider 'table' in 'table cloth' an argument of 'cloth' as Cinque considers 'kitchen' in 'kitchen towel' an argument of 'towel'. In addition, I consider 'red' in 'red cloth' not an argument of 'cloth' since Cinque considers all adjectives non-arguments of N.

[15]Thanks to a reviewer for clarifying this point. The same can be said to the claim that *blackbird*, *Madison Street*, and *orange peel* are single words in English. For example, if *Madison Street* is a single word, its internal structure should not be not visible, and the main stress should not be on the first syllable by regular English word stress rules.

[16]It is possible that in the normal case compound stress is either all left-headed or all right-headed. Complications in English compound stress may be due to influences from its historical origins.

[17]As Selkirk (1986:385) points out, syllable and foot boundaries must be constructed on words, and not projected from syntax.

[18]A Language reviewer points out a difference between Selkirk and Halle-Idsardi. For Selkirk, the other end will be filled in by an automatic rule, but for Halle-Idsardi, a constituent can remain one-ended throughout.

[19]The sub-word categories Syllable and Foot probably have heads. But Selkirk (1986:385) suggests that these categories (along with the mora) perhaps do not truly belong to the prosodic hierarchy. If so, then no true prosodic domain has a head.

[20]A Language reviewer points out that in Halle and Vergnaud 1987 and Halle and Idsardi 1992, constructing metrical boundaries and assigning metrical heads are done in

separate steps. There can, therefore, be a stage of 'headless constituents' in metrical phonology. However, metrical phonology differs from the PST in two respects. First, in metrical phonology head placement is obligatory, whereas in the PST it is not. Second, metrical phonology does not assume any non-metrical process to be able to take place between boundary construction and head placement, whereas the PST does.

[21]In this regard, the Italian consonant gemination (Nespor and Vogel 1986) appears to be metrical in nature. The change of syllabic weight is a metrical phenomenon, and the avoidance of a nonbranching constituent reminds one of stress clash.

[22]Unlike [V O] phrases, [V O] compounds can form one domain in Shanghai:

(i)   LH LH
       L   H
      (ma tse)   'buy vegetable-->shopping for food'

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University of Michigan

Ann Arbor, MI 48109-1285

duanmu@umich.edu