"Defying Explanation"? - Accounting for Tones in Wenzhou Dialect Disyllabic Lexical Tone Sandhi

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Abstract

Auditory and acoustic descriptions and hermeneutic tonological analysis are presented for the lexical tone sandhi in two subsets of disyllabic tonal combinations in the Southern Wu dialect of Wenzhou. The effects of stress are shown to be an important factor in accounting for the tones in one of the combinations.

1. Introduction

This paper is the last in a series describing fascinating and challenging aspects of disyllabic lexical tone sandhi in the Southern Wu Oūjiāng 甌江 dialect of Wēnzhou 溫州 (Wz). The Wu dialects of China are well known for their complex tone sandhi, and Wz is no exception. One of the many sources of the complexity is the often opaque morphotonemic relationship between a dialect's isolation tones, and the tones when they occur on morphemes within a word. It is a goal to try to make tonological sense of these relationships: to understand how the tones on a word arise from the combination of tones on its constituent morphemes.

Wz contrasts eight tones on monosyllabic words or citation forms, but as a result of neutralisation commonly found in Wu there are much less than (8^2 =) 64 combinations to be explained. An account of the morphotonemics in about a third of Wz tone disyllabic lexical sandhi can be found in Rose (2001). A further 16 combinations were analysed in Rose (2000), and another 12 in Rose (2002). The remaining eight combinations are the focus of this paper.

1.1 Citation tones

Phonetic description and names of the eight Wz citation tones are given in table 1. Figure 1 shows the F0 values of the eight Wz citation tones of a male native speaker plotted as a function of absolute duration. Each curve is a mean of ca. 10 tokens. From table 1, and figure 1, it can be seen that the eight Wz tones comprise upper ("a", [+ upper register]) and lower ("b", [-upper register]) values of the same four pitch shapes: *level* (tones Ia and IIIb); *rising* (tones IIa and IIb); *falling* (tones IIIa and Ib); and *dipping* (tones IVa and IVb). Length also appears to be an important auditory dimension for some tones. Thus the high-rising tone IIa is notable for its shortness, and the lower-mid level tone IIIb and especially the dipping tones IVa and IVb sound long. This paper has to do with what happens to the falling and level pitched tones Ia, Ib, IIIa and IIIb, (which are plotted with thicker lines in figure 1, and shown bold in table 1.) when they occur in disyllabic Wz words. One of the things the paper will show is that, although in Wz these four tones group according to their pitch shape into two classes of level (Ia, IIIb) and falling (IIIa, Ib) pitched tones, the disyllabic lexical tone sandhi points to natural classes that require exactly the opposite pairing, namely mid-level [33] and mid falling [331] tones Ia and Ib; and high falling [51] and lower-mid level [222] tones IIIa and IIIb. This pairing of course wreaks immediate havoc with any scheme that tries

A	B	C
Ia	**mid-level**	**[33]**
IIa	short high-rising	[34]
IIIa	**high-falling**	**[51]**
Ib	**mid-falling**	**[331]**
IIb	low-rising	[114]
IIIb	**long low-level**	**[222]**
IVa	long mid-dipping	[3312]
IVb	long low-dipping	[2212]

Table 1: Wenzhou citation tones. A = tone name, B = simple auditory descriptor, C = Chao integer pitch

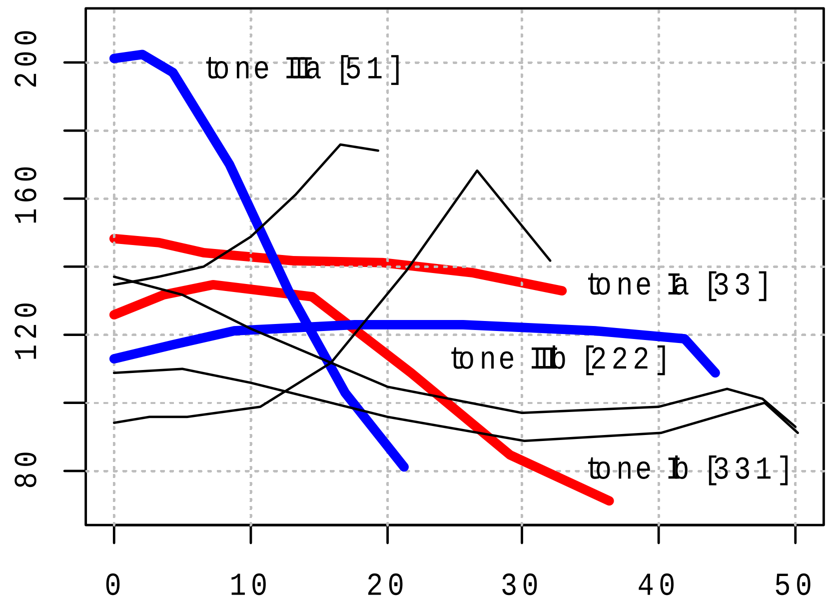

Figure 1: Mean F0 shapes of the eight Wenzhou citation tones. x axis = mean duration (csec.), y axis = mean F0 (Hz). Thick lines denote F0 of tones discussed in this paper.

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to make sense of the sandhi in terms of rules operating on shared underlying tone features, since there is nothing that the two members of the natural classes share!

The combinations dealt with in this paper are shown in table 2. It can be seen that they consist of the two "I" tones on the first syllable, followed by either themselves, or the "III" tones. It will be shown that both the I tones and the III tones constitute separate natural classes by virtue of their common behavior in the tone sandhi. For example, the I tones on the second syllable act as the conditioning environment for changes to I tones on the first syllable tones, or the III tones undergo the same changes on the second syllable, conditioned by the I tones on the first. First is presented some necessary phonological background information, then combinations with I tones on both syllables will be described, since they are somewhat less complicated.

Table 2: Tonal combinations described.

S1 tone		S2 tone
Ia [33]		Ia [33]
	+	Ib [331]
Ib [331]		IIIa [51]
		IIIb [222]

2. Tonological background

2.1 Morphonemics

The upper ("a") and lower ("b") Wz citation tones are distributed in typical Wu fashion with respect to several segmental and suprasegmental features of the syllable, in particular the manner of articulation of syllable-initial obstruents. Like other Wu dialects, Wz has three morphophonemically separate sets of syllable-initial stops (voiceless aspirated; voiceless unaspirated; and voiced), and two sets of syllable-initial fricatives (voiceless and voiced). The first two sets of stops occur on syllables with the upper ("a") tones and are realised by voiceless aspirated and voiceless unaspirated allophones. The third set of stops, which co-occurs with the lower ("b") tones, has different realisation depending on position in the word. Word-internally the realisation is modally voiced. Word-initially, the third series of stops is realised in this corpus predominantly by voiceless, coincident VOT articulations, but there is a small amount of free variation with modal, VOT lead tokens. The same applies *mutatis mutandis* to the two sets of fricatives: voiceless in upper, "a" tones; voiced word-internally, and voiceless in free variation with voiced word-initially in lower, "b" tones. In this paper, the morphophonemically voiced series are transcribed with voiced symbols (so "b" for example stands for [b] intervocalically, and [p] in free variation with [b] word-initially).

2.2 Tonal features and geometry

The phonological interpretation of Wz sandhi shapes requires reference to phonological constructs of tonological *melody*, *register* and *depression*. The first two of these are often used in the tonological representation of Asian tone languages, and refer to the tonal pitch shape, and the division of a speaker's tonal pitch range into an upper and lower register [+/-U] (Yip 1980). Thus one possible representation of a tone with a high rising pitch, e.g. [35], is [LH, +U], i.e. consisting of a LH melody in the upper pitch register; and a tone with a low falling [31] pitch can be represented as [HL, -U]. Depression ([+/- D]) refers to the lowering of pitch at the onset of a tone. Thus one possible representation of a tone with a convex [341] pitch is as a depressed high fall [51], viz: [+U, HL, +D]. Depression is a well-known phenomenon in the tonology of African tone languages, e.g. Zulu, but has recently also been shown to play an important part in Wenzhou tone sandhi (Rose 2001, 2002). I also assume, but not crucially so, Bao's (1990) tone feature geometry, but with Depression incorporated as an independent attachment to the Tonal Root Node.

Ia + Ia		Ib + Ia	
feɪ tsz̩ʔ	*aeroplane*	nĩ tɕ^{h}ɐŋʔ	*young*
[32 33]	飛機	[32 33]	年輕
Ia + Ib		**Ib + Ib**	
t^{h}i dɔ	*paradise*	beɪ dʑaʊ	*ball*
[21 11]	天堂	[21 11↑]	皮球

Table 3: Examples of Wz disyllabic words with I tones on both syllables.

3. I plus I combinations

3.1 Auditory characteristics

Table 3 shows the auditory characteristics of tones in disyllabic words with input I tones on both morphemes. The particular input tonal combination, e.g. "Ia + Ia", is given at the top, and under it an actual example. Thus it can be seen that a word like t^{h}i dɔ *paradise*, with an input mid level [33] Ia tone on the first syllable and an input mid falling [331] Ib tone on the second, has a low falling [21] pitch on the first syllable and a low level [11] pitch on the second.

Table 3 shows that in combinations consisting of I tones, the pitch on the second syllable is mid level [33] if the input tone is Ia, and low level [11], or low level with a slight rise [11↑], if the input tone is Ib. The pitch contour on all first syllable tones is only slightly falling, although the fall is more salient if it is followed by the low pitches. The pitch of the first syllable sounds slightly higher when it occurs before the mid level [33] pitch. I suspect the word-final glottal-stop on the input Ia tones is an individual feature, since it is missing in cognates from speakers of other closely related Ou dialects.

3.2 Acoustic characteristics

The acoustics corresponding to the combinations in table 3 are shown in figure 2. This figure shows F0 on the first and second syllable rhymes, and on their intervocalic consonant if voiced, in Wz disyllabic words with I tones on both syllables. The same speaker is used as in figure 1. Each curve is the mean of at least three different words. In each of the panels, two F0 curves are shown, corresponding to a different first syllable input tone: one (solid circles) for the mean value with tone Ia on the first syllable, and one (empty circles) for the mean value with tone Ib on the first syllable. Thus the F0 shape with solid circles in the top panel of figure 2 shows mean values for input tone Ia before input Ia, and the F0 shape with empty circles shows mean values for input tone Ib before Ia. This graphing permits examination for

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possible assimilatory effects. The F0 shapes have been aligned with respect to Rhyme onset in second syllable. In the bottom panel, vertical lines indicate adjudged onset and offset of the voiced intervocalic consonant. F0 is shown on the intervocalic consonant only in the bottom panel, because as explained in section 2.1, syllable-initial consonants on morphemes with "a" tones, as in the top panel, are voiceless.

3.2.1 Second syllable F0 shapes

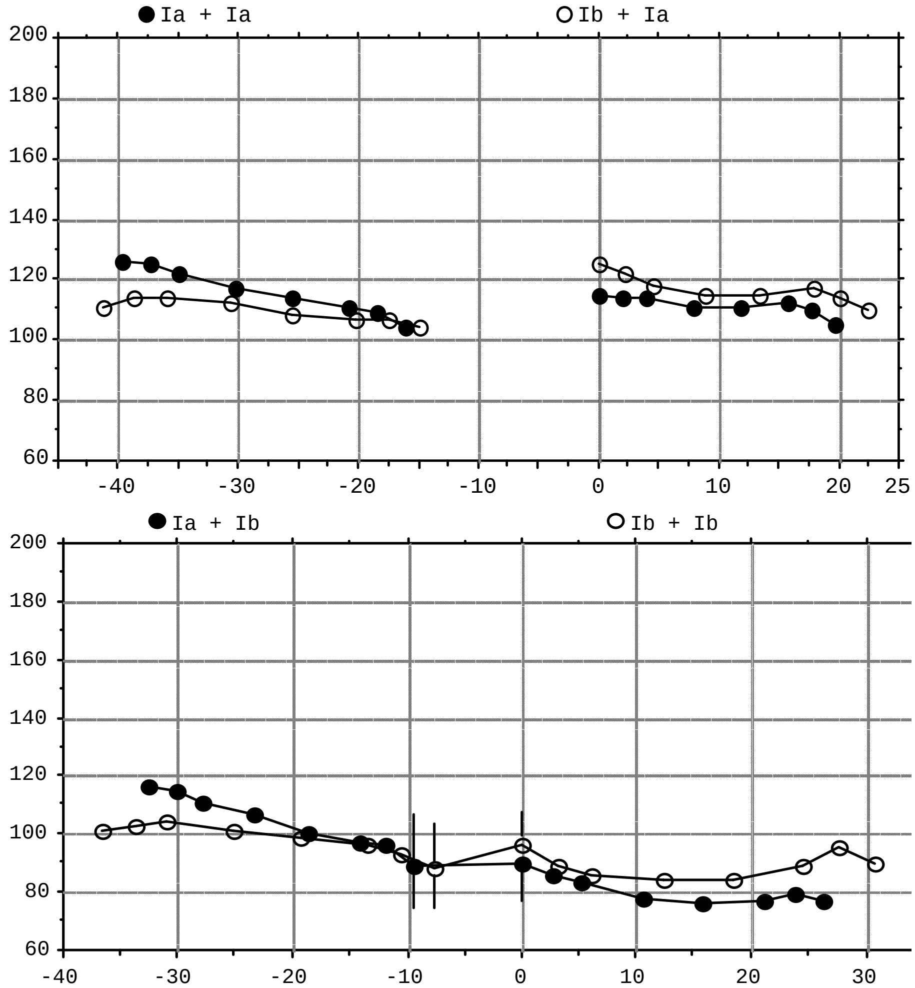
From Figure 2 it can be seen that for input tone Ia on the second syllable, the F0 lies nearly all between 120 and 100 Hz. For input Ib on the second syllable, the F0 lies lower than for Ia, between ca. 100 and 70 Hz. The F0 shapes on the second syllable Rhyme all have small negative offset perturbations. Those on the Ia tones, together with the preceding slight rise, are probably associated with the word-final glottal stop. Falling (or in one case level) consonantally-induced onset perturbations are also visible over the first half of their Rhyme. When these intrinsic features are discounted, it can be seen that the tones' extrinsic F0 shapes are as expected from their pitch description, namely level for input Ia and level or level and rising for Ib. The 5 to 10 Hz difference observable between the F0 shapes for a given input tone on the second syllable is presumably an intrinsic function of the F0 derivative on the first syllable. A greater negative rate of change on the first syllable results in the second syllable F0 lying slightly lower (solid dots). The difference in F0 derivative on the first syllable is also presumably responsible for the greater F0 rise (and consequent pitch percept) on the second syllable Ib tone after input Ib. This kind of conditioning – by rate of F0 change on a preceding syllable - has not been noted for tones before.

3.3 Tonological interpretation: second syllable tones

A non-controversial tonological interpretation for the second-syllable shapes corresponding to input Ia is that they realize a citation target. 'Citation target' is one of the categories of relation between citation tones and tones in sandhi, and refers to cases where a tone in sandhi 'can be identified as one of the citation tones, once allowance is made for intrinsic influence of various conditioning factors...' (Rose and Toda 1994: 271). Thus the second syllable shapes for input Ia can be considered intrinsic-allotonically related to the mid level Ia citation [33] tone.

It is clear that the same relationship cannot be predicated of the second syllable Ib shapes and the citation tone Ib. The former have low or low and slightly rising [11(↑)] pitch, whereas the latter has a mid falling [331] pitch, and this difference is of course clearly reflected in their F0 shapes. In this case it seems sensible to posit an extrinsic word-final [11(↑)] allotone. It can be noted that tone Ib morphemes have a similar low allotone word-finally after tones IVa and IVb (Rose 2000), and that in fact the [331] citation pitch for Ib does not occur in sandhi at all.

Figure 2: Mean F0 shapes for disyllabic words with input tones Ia and Ib on the first syllable, followed by (top) input tone Ia , and (bottom) input tone Ib on the second. Axes = F0 (Hz) and duration (csec.)



3.3.1 First syllable F0 shapes

As expected from their pitch description, the first syllable F0 shapes before input Ia can be seen to lie slightly higher than those before input Ib. Otherwise it is clear that the same shapes are involved before Ia as before Ib, and that the difference between the two sets is conditioned by the height of the second syllable, with the first syllable assimilating in height to that of the second. This is worth noting, since it is usually assumed that the tone on a first syllable will *dissimilate* from that on a second (Xu 1997). As mentioned above, the first syllable F0 shapes also differ in derivative, with those corresponding to input Ia (solid dots) having a slightly greater rate of change than that observed for shapes corresponding to Ib (empty dots). In addition, there are clear differences in onset perturbation, with input Ib shapes (empty dots) showing a mildly rising onset.

3.4 Tonological interpretation : first syllable tones

What kind of changes do these first syllable shapes instantiate? That is difficult to say, as there is a degree of indeterminacy involved (the disyllabic data underdetermine the theory here). It appears that some kind of contour neutralisation has taken place between Ia and Ib, but with the preservation of the Depression difference (manifested in the rising vs. falling F0 onsets to the tones). This - neutralisation with preservation of Depression - is very similar to what has been shown to happen to other word-initial tones in Wz (Rose 2001, 2002), which makes this a plausible interpretation. However, the falling pitch contour still needs to be explained. Since one of the input tones involved - Ib - is actually phonologically low falling, one possible explanation would be to assume that there has been neutralisation in favour of the mid-falling Ib on the first syllable, with Depression preserved. Another possibility is that tone melody and register are lost on the first syllable and a mildly falling default pitch supplied by a late phonetic rule.

3.5 Other descriptions

It is worth noting that the sandhi just described differs considerably from other auditory descriptions of Wz. Qian (1992) for example, has [44 44] and 44 24] for combinations of Ia and Ia/Ib, and [22 44] and [22 24] for combinations of Ib and Ia/Ib. This implies that tone Ia everywhere has the same realisation as its citation form (which he transcribes [44]), and that there is a clear contrast between tones Ia and Ib on the initial syllable. Neither of these, as seen, occurs in the present data. His [24] transcription does imply the presence of a low rising tone for Ib on the second syllable, although the amount of rise transcribed is far greater than in the present data.

Zhengzhang (1964: 108) has [22 33] for Ia after both Ia and Ib, so agrees with the present data in not showing a Ia/Ib contrast on the first syllable, and in also having a first syllable pitch lower than the second. For combinations of Ia/Ib + Ib, however, he has [22 2], with no indication of a rising pitch on the second syllable.

Ia + IIIa			Ib + IIIa		
ˈtsʰɐŋ	tsʰĕʔ	*vegetable* 青菜	ˈbeɪ	tsʰə̆ʔ	*temper* 脾氣
22(↑)	4		11(↑)	4	
Ia + IIIb			**Ib + IIIb**		
ˈsa	dʊ̆ŋʔ	*cave* 山洞	ˈdʑjo	dø̆ʔ	*silks and satins* 綢緞
22(↑)	4		11(↑)	34	

Table 4: Examples of Wz disyllabic words with input III tones on the second syllable, and input I tones on the first.

4. Sandhi: I plus III combinations

4.1 Auditory description

Table 4 shows the auditory characteristics of Wz disyllabic words with I tones on the first syllable morpheme and III tones on the second. The most salient feature of these combinations is that they sound trochaic, with clear prominence on the first syllable (indicated by the stress mark). No other combinations in Wz disyllabic have this trochaic nature. As can be seen from table 4 they consist of a long first syllable with pitch which is low [11] if the input tone is Ib, and low-mid [22] with input tone Ia. The pitch contour of the first syllable often has a slight rise at the end, indicated by (↑). This rise is most salient when there is low pitch on the first syllable. It looks to be part of a commonly encountered intrinsic-suspendible anticipatory assimilation of the first syllable to the second in rate of cord vibration. The second syllable, which corresponds to an input III tone, carries a short high [4] or high rising [34] pitch, the latter being again part of an intrinsic perseverative assimilation aided by the presence of the voiced intervocalic consonant. The second syllable invariably ends in a glottal stop, which is part of the tone and not segmental.

4.2 Acoustic characteristics

Figure 3 shows the mean acoustics (F0 and duration) corresponding to these auditory characteristics. The same speaker is involved as before. F0 shapes are aligned at the onset of the first syllable Rhyme; the boundaries of the intervocalic consonant are shown by short vertical lines.

The first salient feature in this figure is the difference in duration between the Rhymes of the two syllables: the first syllable Rhyme, which is ca 30 csec., is on average about three times as long as the second. This no doubt contributes to the trochaic impression of these combinations.

As far as the F0 is concerned, on the first syllable are seen two pairs of mildly concave shapes, separated by about 20Hz. The upper pair, in the top panel, corresponds to input tone Ia, and the lower pair, in the bottom panel, to input tone Ib. On the second syllable are four short F0 shapes with the same high peak F0 value (ca. 170 Hz) and falling offset perturbations. F0 shapes on second syllables with voiceless initial consonants (i.e. with input tone IIIa) are effectively level; F0 shapes on syllables with voiced initial consonants (tone IIIb) have rising F0. These features are as expected.

The acoustic characteristics on the first syllable in these combinations can be accounted for in terms of the interaction between extrinsic targets associated with low and low-mid level pitch, and intrinsic effects associated with first syllable segmental composition; with the second syllable F0 height; and with the voicing specification of the intervocalic consonant. This situation is largely parallel to that described in detail for the tones of the Wu dialect of Zhenhai with low-level and mid-level pitch on the first syllable (Rose 1990: 18,19). The second-syllable F0 shapes are explainable in terms of intrinsic effects on an extrinsic short high pitch target. The intrinsic effects are from phonation rate on the first syllable, and voicing of the intervocalic consonant. Again, this pattern of intrinsic conditioning is the same, and with comparable magnitudes, as that observed for Zhenhai (Rose 1990: 22, 23).

4.3 Tonological interpretation

Whereas it is reasonably clear how the tonal shapes of disyllablic words with I tones on their constituent morphemes might arise from the concatenation of their citation forms, it really is not at all clear how one gets, for

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example, from [331] + [51] to [11 4], or from [33] + [222] to [22 4]. Why the neutralisation of the very different III tones [51] and [222] on the second syllable? Why the realisation of this neutralisation as short, and high [4]? Whence the low level [11] from the Ib citation [331] on the first syllable? Why the lower [22] of citation Ia? Why the low register forms on the first syllable?

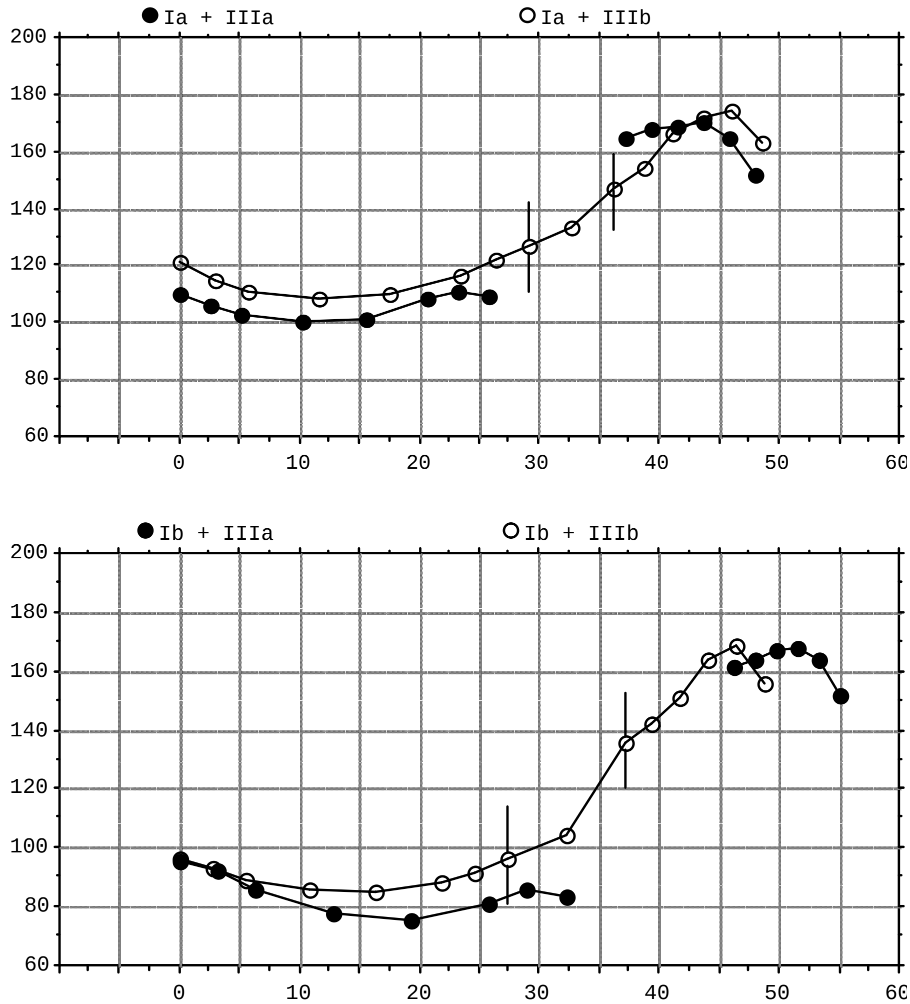

Figure 3: Mean F0 shapes for disyllabic words with input tones IIIa and IIIb on the second syllable preceded by input tone Ia (top) and input tone Ib (bottom) on the first. Axes = F0 (Hz) and duration (csec.)

One interpretation of what is happening sees the sandhi changes ultimately as the effect of a stress shift onto the first syllable, with consequent positive and negative effects of stress. Assume, non-controversially, tonological representation of IIIa as a high falling tone, with high register (+U), and falling contour (c = HL), each tone associated with a mora. Assume further that IIIb is -U register, with c = H, also associated to two morae. The first change necessary is a register shift from -U to +U on the second syllable after I tones: -U → +U / I __. By this change, IIIb [22] becomes an *upper* register h tone. This change is not totally weird, since a second-syllable neutralisation in register has already been demonstrated for Wz for all the other tones (Rose 2001, 2002). Now delete the second mora, with associated tone, for both second syllable tones. By this change the tones of both IIIa and IIIb become (+U, H), which is the desired output for the second syllable. An alternative to this is to simply state the categorical shift: IIIb → IIIa /I __, and then delete the second mora. The loss of the second mora on the second syllable can be plausibly motivated by a stress shift onto the first syllable, and is consistent with the so-called negative effect of stress demonstrated for Standard Chinese (Kratochvil 1968). What causes the shift is not clear, although it is claimed there are tendencies for some tones in Chinese to be metrically weak (Chen 2000). (To the extent that "weak" is defined in terms of lack of stress, this is of course a circular argument). So perhaps a formalisation is possible here whereby III tones are inherently weak relative to I tones, and this triggers the mora loss.

The changes to the first syllable tones are again plausibly interpreted as resulting from stress, this time its so-called positive effect. One of the positive effects of stress on low tones is to make them lower (Kratochvil 1968), so if we assume, uncontroversially, that Ia [33] is [+U, L], that will account for its downwards shift in pitch to [22]. This will not plausibly get us a [11] from a citation Ib however, with its [331] pitch. But it has already been demonstrated that Ib has an extrinsic [11↑] allotone on second syllables after I tones. If we assume that Ib has this allotone on the first syllable too before III tones, a lowering effect under positive stress also becomes plausible, although one problem with this is that one would expect the F0 to be lower than observed. Another positive effect of stress, for level tones, is lengthening. The result of this effect may possibly be seen in the ca 10 csec. longer durations of the first syllable tones.

Thus it is possible to conceive a derivation in phonetically plausible terms to account for the observed surface features for I + III combinations.

4.4 Other descriptions

Published descriptions agree in describing a neutralisation on the second syllable, but differ on its realisation. Zhengzhang's (1964: 108, 1980: 248) description is the closest to this paper. He describes the second syllable as a "light" (輕) [53] or [43], which becomes [5] in fast speech (輕 is the Chinese phonological term corresponding to atonicity). Qian's (1992: 655) notation of [52] for pitch on the second syllable again implies a neutralisation of IIIa and IIIb, but in favour of an input IIIa high falling tone. As far as the first syllable is concerned, Qian's (1992: 655)

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descriptions are closest to those in this paper, recognising a distinction in pitch height between Ia, and Ib before IIIa/b. He transcribes Ia as [44] and Ib as [22], so his pitches are a little higher than observed here, and they also imply citation realisation, at least for Ia. Zhengzhang's transcriptions on the other hand imply a neutralisation of Ia and Ib on the first syllable realised as a low dipping or low rising pitch notated variously as [213], [13], [113] and [214], the latter two said to be characteristic of slow speech.

4.5 Other Dialects

It is interesting to note that in neighbouring Ou dialects, for example Xiàngyáng 象陽 to the East, the lexical sandhi in combinations of I tones and III tones is rather different from Wz, although the citation tones are very similar. In Xiangyang I + III combinations, the pitch of the first syllable tone is rising (from mid if the input is Ia, from lower if Ib), and the second syllable tone has a high falling pitch, like citation IIIa. There is no trochaic impression. This allows us to see that the derivation of the Wz second syllable H from a high-falling HL tone was probably correct – at least diachronically so.

5. Summary

This paper has shown how the tones in two types of Wz lexical sandhi might arise from the combination of the citation tones of their constituent morphemes. Previously identified factors of *citation target* and *extrinsic allotone* were shown to be operative in determining the shapes of I + I combinations, although accounting for the first syllable tone in these combinations is still a problem. In trochaic I + III combinations the positive and negative effects of stress were identified as a new factor.

In his discussion of the phonological and phonetic processes underlying the wide range of tone sandhi phenomena in Chinese dialects, Chen (2000: 81) states that "... there remains a vast assortment of tonal alternations that defy classification and description, let alone explanation". Although the processes involved in Wenzhou tone sandhi are undoubtedly complicated, this (and previous) papers have shown that it cannot, at least, be said to be unclassifiable, indescribable or inexplicable, (although a separate question deserving attention is whether perhaps diachronic explanations for the sandhi complexity might be better).

5. Acknowledgements

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