**INTRODUCTION**

This paper describes and analyses a part of the lexical tone sandhi in the Southern Wu Quijiang dialect of Wenzhou (Wz). The Wu dialects 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 morphophonemic 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. An account of the morphophonemics in about a third of the Wz tone sandhi can be found in Rose (in press); Zhengzhang (1984) contains an auditory description of tone sandhi in a variety of Wenzhou dialect. Wenzhou dialect contrasts eight tones on monosyllabic words or citation forms, but as a result of neutralisation commonly found in Wz there are much less than 8(6 = 16) combinations to be explained. This paper focuses on sandhi combinations specifically involving two of the tones on the first syllable.

**CITATION TONES**

Phonetic description, tonological representation in Yip’s (1980) framework, and names of the eight Wz citation tones are given in table 1. A detailed description of the auditory (pitch and length) and acoustic (F0, duration, amplitude) characteristics of the tones can be found in figure 1. From Rose (1994), shows the F0 values of the eight Wz citation tones of a male 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”) and lower (“b”) citation tones. The upper (“a”) tones have coincident F0 articulations, but there is a small amount of free variation with modal, F0 value. The upper (“a”) and lower (“b”) citation tones are voiced word-initially, 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 both word-initially and word-internally.

**TONE SANDHI**

Table 2 shows the pitch of tones of Wenzhou tone sandhi in disyllabic words with input complex tones IVa and IVb on the first syllable, and all tones on the second. The particular tonal combination of a “Wz” pitch is given at the left, and under it an actual example. Thus it can be seen that a word like じゅるく声 moonlight with an input low dipping tone IVb on the first syllable and an input mid level tone IVa on the second has a short low pitch on the first syllable and a mid level pitch on the second thus: (1 33). By convention, the tones are shown grouped by historical pairs (la lb etc). Interestingly, the synchronicregister pairing sometimes does not reflect this. Thus on the second syllable, la pairs phonetically with lb: both are [33]. It can be seen that the combinations in table 2 have, with one exception, two main characteristics. The first syllable is very short and located in various positions in the pitch range, and the pitch of the tone on the second syllable closely resembles that of the input citation tone. The exception to this is where the second syllable has mid-falling tone IVb; in this case the tone on the first syllable is of normal length - not short - and the low (level-rising) pitch of the tone on the second syllable does not resemble the (mid-falling) lb citation tone pitch at all.
The acoustic corresponding to the combinations in Table 2 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 spoken by the same male native speaker as in Figure 1. Each curve is the mean of three different words. In each of these figures, two F0 curves are shown corresponding to each second syllable tone: one for the mean value after the first syllable, and one for the mean value after the second syllable. This permits assessment of progressive assimilatory effects. The F0 curves are aligned at the onset of the second syllable vowel, in order to best show the degree of similarity between them. Expected intrinsic duration differences in the first syllable F0 shapes associated with the intervocalic consonant can be seen in the figure. Thus F0 shapes before "b" tones are slightly longer; and F0 shapes after "a" tones show a sharper negative offset perturbation (these features are also noted for the Wu dialect of Zhenhai in Rose (1990)). The short duration of the first syllable tones — ca. 100 ms — can also be seen.

Tones on the second syllables will be discussed first, since they have simpler phonetics and morphophonemics. Then first syllable tones are discussed. As noted above, combinations with input ltb on the second syllable input tones are an exception, from the realisation of both first and second syllable tones, and these are addressed last of all.

Second syllable tones. The auditory impression from Table 2 suggests that, apart from ltb, the tones on the second syllable after tones ltb and ltb are similar to their citation values. Four of them — tones la, lla, ltb and lla — have a single allotone with the same pitch as in citation. Three tones — ltb, ltb and ltb — appear to have two allotones of the same pitch as in citation. Thus tone ltb is [33] the allotone pitch is not consistent, since the citation tone pitch is also [22]. A glance at Figure 2b shows that the shifting relative to citation ltb might well be due to the well-known progressive assimilatory effect from the previous syllable, since ltb is clearly higher before lla and ltb. It can be noted here that the F0 shape and duration of ltb after ltb are effectively the same as for tone lla after tones ltb & b. This does not result in any confusion, because morphemes with tone ltb on the second syllable are still distinguishable from morphemes with la by the voicing value of the initial obstruent (before ltb they are voiced), and by the pitch of the first syllable (before ltb, tone ltb on the first syllable has a higher pitch [43] vs. [1, 33] for ltb + la).

The same kind of assimilatory conditioning occurs with tones ltb and ltb on the second syllable, but with slightly different consequences. Figure 3b presents the normalised F0 shapes of citation tones ltb together with the normalised shapes of syllables, and the two values each of ltb and ltb were then z-score normalised and compared with the corresponding normalised citation tone shapes. A z-score normalisation requires normalisation parameters (of mean and standard deviation) to be calculated from comparable terms (Rose 1987). In this case, then, the parameters were calculated from all seven data points in the tones which sounded to have the same pitch shape both in citation and after tones ltb and ltb, viz: tones la, lla, ltb, and lla. The values of the normalisation parameters - mean and standard deviation respectively - were 129.0, sd = 32.1 for the tones, and 120.0, sd = 26.0 for the tones after tones ltb and ltb, with n = 28 in both cases. These values show that tones after ltb/ltb are realised in a narrower range and around a lower mean F0 than tones in citation form.

For tones la, lla, ltb, and lla, the normalisation showed agreement in considerable detail between the citation F0 shapes and the shapes after tones ltb and ltb. For tones ltb, ltb and ltb, however, the agreement between citation form and allotones after tones ltb/ltb was not quite so close. These are shown in Figure 3, together with the normalised curves for tone lla for comparison. Figure 3a shows that the normalised ltb F0 shape after ltb is lower than the citation ltb shape, and that the ltb shape after ltb is higher, and that the higher allotone is in fact very close to the curves for tone la. The auditory description of ltb after ltb as [33] is of course consistent with this, but the [22] description of the lower allotone pitch is not consistent, since the citation tone pitch is also [22]. A glance at Figure 2b shows that the shifting relative to citation ltb might well be due to the well-known progressive assimilatory effect from the previous syllable, since ltb is clearly higher before lla and ltb. It can be noted here that the F0 shape and duration of ltb after ltb are effectively the same as for tone lla after tones ltb & b. This does not result in any confusion, because morphemes with tone ltb on the second syllable are still distinguishable from morphemes with la by the voicing value of the initial obstruent (before ltb they are voiced), and by the pitch of the first syllable (before ltb, tone ltb on the first syllable has a higher pitch [43] vs. [1, 33] for ltb + la).
form. Secondly, it can be seen that the FO of lVb has been raised after lVb on the first syllable so that it is the same as the FO of lVb after lVa, whilst the opposite has happened to the FO of lVb after lVa. This is not so for the other syllables. The magnitude of this effect is big enough to swamp the difference between the FO of lVa and lVb. The effect of this is to neutralise tones lVa and lVb on the second syllable, although the identity of the morphemes is still clear from their initial consonant.

The tonological interpretation for all the second syllable cases just discussed is one of a 'citation target'. This 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 & Toda 1994: 271). The analytical implication is therefore that no tonological change in the derivation is required for any of the tones lVb, lVa, lVb, lVb/lVb, lVb/lVb. (There is, for example no paradigmatic change to another tone, as commonly happens in Chinese tone sandhi.) It is interesting to note that this is somewhat parallel to the situation in the Northern Wu dialect of Zhenhai, where after tone lVb on the first syllable, citation target occurs. The main phonetic conditioning factor here, apart from the narrowing and lowering of range mentioned above, is the perseverative assimilation from the preceding syllable. It is interesting to note, however, that the assimilation is not totally systematic. Figure 2 shows no assimilatory conditioning of second syllable tones lVb, lVb, and lVb, presumably because there is no difference between the first syllable tones to condition it. However, tone lVb also shows no conditioning, despite a large difference in the potential conditioning factor on the first syllable. Tones lVb and lVb show less coarticulation resistance than lVb, therefore.

First syllable tones

The auditory descriptions show that input tones lVb and lVb differ markedly in pitch and length from prepausal position, showing the widest extremes of allotonic realisation of the Wenzhou tones. In contrast to their prepausal position, the allotonic, overlong allotones have in initial position very short unidirectional allotones located in various positions within the pitch range. (There is also the exception before lVb which is not short.) In three cases the tonal contrast between lVb and lVb appears neutralised. Thus before tones lVb, lVb or lVb, input tone lVb is the same as lVb with a higher (short) low level pitch. Thus before tones lVb, lVb and lVb the lVb/lVb difference is compensated for by a lower pitch, which is lower than before lVb/lVb. and tone lVb has a (short) low level pitch.

Figure 3: Above: normalised FO shapes for Wu tones lVb and lVb in citation form (solid symbols), and after tones lVb and lVb (empty symbols). Below: normalised FO shapes for Wu citation tones lVb (solid symbols) and after tones lVb, lVb (empty symbols).

Ib there is no audible difference in pitch or duration between tones lVb and lVb in citation form, and the short low level pitches. Before the other tones, there is an audible difference in pitch between lVb and lVb in citation forms. Before the third syllable, the difference is one of pitch height, tone lVb being (short) low, and tone lVb (short) mid. Before tones lVb, lVb and lVb the lVb/lVb difference includes pitch contour too. Before these tones, tone lVb has a low slightly rising pitch shape which is slightly lower before lVb than before lVb/lVb, and tone lVb has a (short) high or mid level pitch.

The tonological interpretation of these first syllable forms is complicated. It is probably best to understand the rather large differences in length between tones lVb and lVb on the first syllable and their overlong prepausal forms in terms of a shortening of the prepausal form of tones lVb and lVb before all second syllables except when they carry tone lVb. In this way the idiiosyncratic fall and final rise on the prepausal allotones are conventionally accounted for as being underlying. In the tonological framework adopted for this paper, this must be expressed as the loss, in first syllable position, of the last two tonal segments of tones lVb (which have an underlying HLH melody, see table 1). Interestingly, this appears to be the opposite of the historical development. The proto-Wu cognates of Wu tones lVb were short and occurred on syllables with a final stop, and these features have been retained in most of the Modern Wu dialects. For example, proto-Wu *ta 'fat' put forth has become Zhenhai lVb, but Wu Hua: 3:312. Thus it is the short first-syllable forms in Wu that most resemble Proto-Wu, and the proto-Wu short tones lVb have grown rather long tails in Wu, which is perhaps related to the loss of the syllable-final stop.

In order to account for the neutralisation of lVb to [1] before lVb and lVb, it is best to first posit, before tones lVb, lVb and lVb, a categorical shift of lVb to lVb, and then change the lVb to lVb, which is [H - U] to lVb, which then becomes [L - U], or [1]. A separate derivation by rule of lVb would otherwise be too complex. Note that it is very difficult to motivate these changes, the conditioning of which is totally opaque. The remaining short first-syllable forms, before tones lVb/lVb and lVb, can be understood as retaining the contrast between lVb and lVb, which themselves show conditioning by the twin factors of anticipatory assimilation of the second syllable tone, and the voicing specification on the intervocatal consonant. Both of these factors have been shown to be operative in the phonetic realisation of the sandhi of other Wu dialects (Rose 1990).

Combinations with lVb on second syllable Finally, the combination of lVb and lVb to has to be considered. In this combination, the acoustics of which are shown in figure 2h, the first syllable is not short, and has a mid (lVb) or low (lVb) falling pitch, and the second syllable, with tone lVb, has a low level and slightly rising pitch very different from its mid falling input tone. There are two plausible underlying inputs of this. The first involves a conventional tone spreading of the first syllable pitch contour over both syllables (with prior loss of the tone on the second syllable). The second involves a loss of the final H on the underlying HLH first syllable tone, and an extrinsic allotonic realisation of lVb as [112] after lVb. Although the first accounts rather well for the low pitch of the second syllable with its small final rise, and the equalised FO contours agree well, tone lVb actually has a low level-rising prepausal allotone after tones lVb/lVb, where first syllable contour spreading is not plausible, and so the second solution is preferable.

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REFERENCES