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The phonology of the glottal stop in Garo*

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1. Introduction

Burling (1992) provides many detailed and in my view accurate observations on the phonology of the Tibeto-Burman language Garo. He also points out that the glottal stop [ʔ] acts in some ways like a tone and unlike a regular consonant. The properties of the Garo [ʔ] are summarized in (1).

(1)
a. [ʔ] occurs only in the coda but not in the onset.
b. [CVʔ] syllables are similar to [CV] instead of [CVC].
c. [ʔ] is the only coda that is transparent to vowel assimilation.
d. [ʔ] is subject to deletion, but other C codas are not.
e. [ʔ] is not restricted to the coda position, but may occur on other segments.

Since [ʔ] is usually considered a consonant (for example, by the International Phonetic Association), (1) comes as some surprise. However, Burling's observation that [ʔ] differs from other Cs is well founded.[1] In this article I discuss how the properties in (1) can be accounted for in current phonological theory. I also argue that the Garo [ʔ] is not a tonal feature.

The interaction between [ʔ] and tone is fairly well-known in Asian languages. Although Burling finds [ʔ] to act like a tone, he does not consider [ʔ] a tone per se. On the other hand, Li (1992) takes a stronger position and states that "the syllable-final -ʔ in Southern Min dialects is a tone feature rather than a true consonant. The same interpretation seems to hold true for other Chinese dialects..." My discussion on whether [ʔ] is a tone feature is addressed more to the latter view.

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1 According to the distinctive features system of Chomsky and Halle (1968:67), [ʔ] is not [+consonantal] but [-consonantal], just like the glides [y w]. This view is maintained by Halle (1992) in the current version of feature theory, namely, feature geometry. Burling's observation is in line with the analysis of Chomsky and Halle.

2. The Garo [ʔ]

First of all, (1a) and (1d) need not imply that [ʔ] is something other than a segment, or that it is a tonal property. With regard to (1a), one notes that [ŋ] in English occurs in the coda but not in the onset. Similarly, in Mandarin Chinese [ŋ] as a contrastive phoneme occurs only in the coda and not in the onset (although for some speakers [ŋ] can occur in the onset as an allophone of the "zero onset"). But in neither Chinese nor English is [ŋ] considered a suprasegmental or tonal property. With regard to (1d), one notes that it is not uncommon that some coda consonants are more prone to deletion than others. For example, of the six historical codas [p t k m n ŋ], Mandarin Chinese has lost [p t k m], and of the three nasal codas [m] has been the first to disappear. Exactly why some Cs are more vulnerable than others has yet to be fully understood, but there is no evidence that those that disappear early are in any way less of a segment or more of a prosodic property.

The other three properties of [ʔ], namely, (1b), (1c), and (1e), do require more discussion. I examine each in turn.

2.1. The similarity between [CVʔ] and [CV] syllables

Burling gives three cases, summarized in (2), in which [CVʔ] is like [CV] and unlike [CVC].

(2) a. The phoneme /i/ is phonetically [i] in [CV] and [CVʔ] and [ĩ] in [CVC].
b. In the Bangladeshi dialects the phoneme /e/ becomes [i] in [CVC] but remains [e] in [CV] and [CVʔ].
c. In some Bangladeshi dialects the phoneme /o/ becomes [u] in [CVC] but remains [o] in [CV] and [CVʔ].

As Burling points out, if [ʔ] is a consonant, [CVʔ] and [CVC] should be similar environments for the V; in fact, however, [CV] and [CVʔ] go together.

To understand what is going on, let us digress to three other issues: the syllable structure of [CV], the structure of geminates, and the notion of complex segments.

As Burling (p.38) points out, the Garo V is longer in [CV] than in [CVC] and [CVʔ]. This is no accident for a monosyllabic language, which Garo is. The same is true in many Chinese languages (Duanmu 1993). In particular, [CV] syllables have been found to be phonetically as long as [CVC] syllables.[2] In

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[2] For example, Howie (1976) has shown that in Mandarin Chinese CV and CVN syllables have similar durations. Kao (1971) found similar results for CV and CVN in Cantonese. On the other hand, Kao reports that Cantonese [CVC] with [p t k] codas is shorter than [CV]. However, Kao did not include the unreleased closure duration of the [p t k] codas. According to my own work, when the closure period of the [p t k] codas are included, the durations of [CV] and [CVC] become much closer.

addition, the longer V in [CV] is not due to phonetic effects, since in non-monosyllabic languages, such as English, CV is not known to be as long as [CVC]. On the other hand, it would be redundant to posit a phonemic length distinction in vowels, since vowel length is fully predictable: long in CV and short in [CVC] and [CVʔ]. The solution is to propose a fixed syllabic structure, CVX, where X is either a coda or the length of a vowel (an extra timing slot).[3] This analysis has three merits (apart from implications for tone and stress, see Duanmu 1993). First, it does not increase the underlying segment inventory. Second, it simplifies the syllabic inventory. Third, it correctly predicts vowel lengths. This means that, as is in Mandarin, what is transcribed as [CV] in Garo is in fact [CV:].

Let us now consider long segments, or geminates. Since geminate consonants do not concern us, I consider geminate vowels only. In multitiered phonology, vowel length is not represented as a feature in the vowel itself, but as the number of slots it is linked to on the "skeleton tier". (3) shows the structural contrast between [a] and [a:].[4]

```
(3)   X          XX          Skeleton tier
      |          \/
      a           a          Segment tier
      [a]        [a:]        Letter representation
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Each X on the skeleton tier represents a unit of timing. The short vowel in (3) has one timing unit, and the long vowel has two. In this representation information on length does not reside in the segment itself, but in the skeleton tier. Therefore, recognizing vowel length does not imply increasing the underlying segment inventory. (4) shows how a fixed syllable structure predicts vowel length in [pan] and [pa] = [pa:].

```
(4)   a.   CVX   --> CVX          b.   CVX   --> CVX
                     |||                           |\/
           pan       pan               pa          p a
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The CV-tier is similar to the X-tier supplemented with syllabic information (Levin 1985). When there is a coda, the vowel takes one skeletal slot, as in (4a), and when there is no coda, the vowel takes two skeletal slots, as in (4b).

Next consider complex segments. A complex segment, or what is traditionally called double (or multiple) articulation, is one that involves two (or more) articulators at the same time. For example, [t] is a simple segment

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3 Burling (p.c.) points out, however, that he was not sure whether the Garo V in CV is twice the length of V in CVC.

4 In the moraic theory (e.g., Hayes 1989), the skeleton tier is replaced by the mora tier, so that [a] is linked to one mora and [a:] to two moras. In addition, each symbol on the segment tier is in fact a shorthand for the feature structure of that segment.

involving the articulator coronal (traditionally called alveolar), and [t^W] is a complex segment involving the articulators coronal and labial. When there are two articulations, the one with greater oral constriction is called the primary articulation. Thus, in [t^W] the primary articulation is [t], and the secondary articulation is [^{W}].

Let us now return to the similarity between [CVʔ] and [CV]. For concreteness, consider the structures for the rimes [a], [aʔ], and [ap], shown in (5).

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(5)   a.   XX        b.   XX         c.   XX
           \/             \/\             | |
           a              a ʔ             ap
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As discussed earlier, [a] has a long vowel, and [ap] has a short vowel. In [aʔ] the vowel can be long, too. This is because the articulator for [a] is dorsal (tongue body), and that for [ʔ] is the vocal cords (glottis). Since these are independent articulators, there is nothing to prevent them from occurring together, giving what is called a glottal vowel. This is what is shown by (5b), where the sound under the first X slot is [a] and that under the second slot is [aʔ], i.e., a glottalized [a]. Indeed, it is possible that the glottal articulation is spread over both slots, as shown in (6), which is a long vowel that is glottalized throughout.

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(6)    ʔ
       /\
       XX
       \/
       a
```

Two questions arise. First: do (5) and (6) predict that the vowel in the rimes [a] and [aʔ] have the same phonetic durations? Second: why can [a] spread over both slots in (5b) but not in (5c)? For the first question, the answer is no. This is because segments do vary in duration owing to their intrinsic properties. For example, high vowels are inherently shorter than low vowels. One expects, therefore, that the vowel is probably longer in the rime [a] than in [aʔ], since glottalization ([+constricted glottis]) makes vocal cord vibration harder and hence shorter. For the second question, one notes that the articulator for [p] is labial, which is independent of the articulator dorsal for [a]. But what sound would it be if both articulators are used at the same time? Consider the structure in (7).

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(7)   a.   XX        b.   X
           |/\            /\
           a p            a p
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If [a] in (5c) spreads to the second X slot, the result is (7a), where the sound under the second X slot is a complex segment, shown in (7b). As mentioned earlier, in a double articulation the articulator that has greater oral constriction is the primary articulation. Since [p] has greater constriction than [a], (7b) will primarily be a consonant [p], instead of a vowel [a]. In contrast, in (6) [a] is the *primary articulation rather than [ʔ], since [ʔ] has no oral constriction but [a]* has.[5] In this analysis, then, the vowel is long in (5a) and (5b) but not in (5c).[6]

A solution to the problems in (2) now emerges. The vowels change when they are linked to one X slot, but remain unchanged when they are linked to two X slots. The stability of long segments, or 'geminate integrity', is well known in phonology (Hayes 1986, Schein and Steriade 1986). Thus, (2) presents no surprise when seen in this light.

2.2. The transparency of [ʔ] in vowel assimilation

A segment is transparent if it allows an assimilation (or dissimilation) process to pass through it. A segment is opaque if it blocks such a process. According to the standard view in multitiered phonology, assimilation is the spreading of some feature or feature structure (to be discussed below). A segment in the path of spreading is transparent if it does not contain (any part of) the element that is being spread. Consider the representations in (8).

(8) a. B is transparent b. B is opaque

In (8a), the feature (or feature structure) F spreads from A to C across B. Since B does not have F, it is transparent and spreading is possible, i.e., C can assimilate to A. In (8b), F2 is either identical to F1 or contains part of the elements in F1, so F1 cannot spread across B; in other words, B is opaque, and C cannot assimilate to A.

In Garo, vowel assimilation occurs when the first syllable either has no coda or has the coda [ʔ] and when the second syllable has no onset (Burling

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5 According to Halle (1992), articulatory constriction (stricture features) refer to the part of the vocal tract above, but not including, the vocal cords. There are good reasons for this view. For example, the vocal cords primarily provide the sound source for speech, whereas the rest of the vocal tract primarily provides modulation on the sound source. In addition, the vocal cords seem to constitute the greatest constriction in many sounds, not only in all vowels and glides but also in sonorants like [l r] and possibly voiced fricatives. There is, however, no phonological evidence that such sounds act as a natural class.

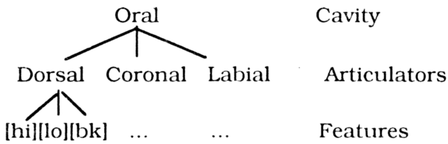
6 Even though (7a) is in principle a possible structure, one can argue that the [a] in fact does not spread to the second slot, possibly because Garo (or any other language) does not have the sound represented in (7b).

1992:39-40). When the first syllable has no coda, the assimilation is between two adjacent vowels, which presents no transparency problem. The question at hand is why [ʔ] is transparent whereas all other consonants are opaque. Let us first determine what is being spread. Consider the data in (9) (Burling, *ibid*):

(9)	a.	chaʔ-iŋ-a	-->	chaʔ-aŋ-a	'eating'
	b.	suʔ-iŋ-a	-->	suʔ-uŋ-a	'igniting'

In (9a), the assimilating vowel is [a], whose articulator is dorsal. In (9b), the assimilating vowel is [u], whose articulators are dorsal and labial. In current feature theory, an assimilation process is the spreading of one structural unit; in other words, all the features that participate in an assimilation must belong to the same structural unit. What structural unit is involved in (9a) and (9b)? Following Halle (1992) and Kenstowicz (1994), the organization of oral features is shown in (10), which is part of the entire feature geometry of a sound:

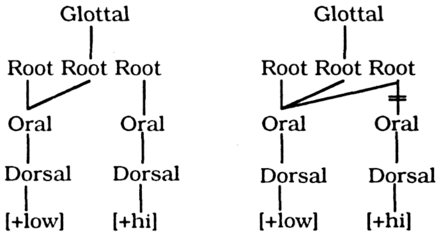
(10)



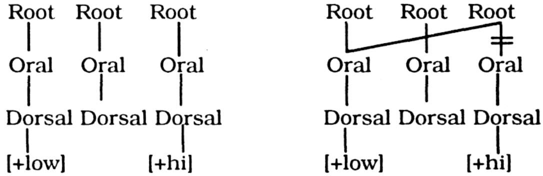
There are three organizational levels. The top level can be called cavity. The next level comprises articulators. The Oral cavity dominates three articulators, Dorsal, Coronal, and Labial. The bottom level is features, each being dominated by a specific articulator. For example, the Dorsal articulator dominates three features, [high], [low], and [back]. According to (10), if one wants to spread both Dorsal and Labial, as is needed in (9b), the structural unit involved must be Oral, i.e., the entire tree under the Oral node.

Having determined the spreading unit, one also knows which segments are transparent and which are opaque. Any segment that contains any specification under the Oral node is opaque, and any segment that has no specification under the Oral node is transparent. Of all the coda consonants (Burling, p. 35), [ʔ] is the only one that has no oral specification; naturally, it is the only transparent segment to vowel assimilation. Indeed, [a] may have already spread onto [ʔ] within the first syllable, as discussed in section 2.1. (11) illustrates the transparency of [ʔ] and the opacity of [k].

(11) a. aʔ-i --> aʔ-a



b. ak-i -/-> ak-a



In feature geometry, every segment has a Root node, to which all branches are attached. In (11a) there is nothing to block the spreading of the Oral node from [a] to [i]; the newly spread Oral node replaces the original Oral node of [i] (shown by the double crossing lines). In (11b) [k] has its own Oral node, which blocks the spreading from [a] to [i] (shown by the crossing lines). In summary, the transparency of [ʔ] and the opacity of other consonants are both expected.

2.3. The occurrence of [ʔ] on other segments

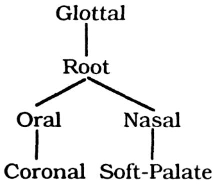
Burling points out that although [ʔ] is written as a separate segment, the glottal property can propagate over other segments. Burling's observation is repeated in (12).

(12) In [CVʔN] syllables (where N is either a nasal or [l]), [ʔN] is simultaneous, instead of sequenced.

In fact, the vowel can be glottalized as well. The auditory quality of vowel glottalization is mainly a sharp abruptness. In Chinese languages this happens in [CVC] syllables where the coda is either a glottal stop or a glottalized [p t k]. According to Burling's pronunciation, the same seems to be true in Garo.

It seems then that [ʔ] can occur both on a vowel and on a consonant. I have already discussed the simultaneous occurrence of [V] and [ʔ] in (5) and (6), namely, [V] and [ʔ] involve different articulators (dorsal for [V] and vocal cords for [ʔl]), and so there is nothing to prevent them from occurring simultaneously. The same can be said for [ʔN]: [ʔ] and [N] also involve independent articulators, therefore it is possible for them to occur simultaneously. (13) shows the articulators in [ʔn] as a single segment, or a glottalized [n].

(13) Feature geometry of [ʔn] as a single segment

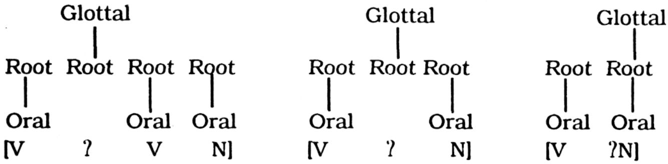


Burling observes an interesting behavior of the [ʔN] coda. Many [CVʔN] words can alternate with a bisyllabic form [CVʔ-VN], where [ʔ] and [N] are separated by a copy of the original V. An example is given in (14).

(14) joʔl-a, joʔ-ol-a 'rise, of water'

As Burling points out, (14) poses an orthographic problem. Phonetically, one cannot tell the sequence between [ʔ] and [N] in a [ʔN] coda, but (14) seems to suggest that [ʔ] comes before [N]. This problem can be solved by assuming that the bisyllabic form is the original one, which undergoes the process in (15) (omitting many details).

(15) a. b. c.



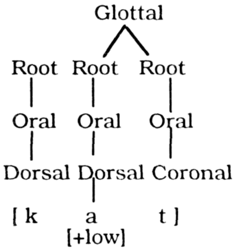
(15a) shows the original form. (15b) shows the result after deleting the second vowel (probably because Garo has trochaic stress.[7]) (15c) shows the result when the two consonants merge into one (transcribed as [ʔN]).

Since [ʔ] totally lacks oral features, there is nothing to prevent it from occurring on other codas, namely, [p t k], which it does. This means that the [p

7 Personal communication, R. Burling.

t k] codas are all glottalized (even though they are not so transcribed, apparently because of phonemic economy). Consider the structure in (16).

(16) Feature geometry of [kat], with glottalized [a] and [t]



In (16) the glottal articulation is distributed over the vowel [a] and the coda [t]. This representation agrees with Burling's observation that "the glottal stop acts more like a feature of the syllable and less like a linearly ordered segment than do the vowels and (other) consonants of the language" (p.50).

3. [ʔ] and tone

I have shown how the properties of [ʔ] can be accounted for in feature geometry. The fluidity of [ʔ], so to speak, is due to the fact that [ʔ] lacks oral (and nasal) articulators, and not due to [ʔ] being a suprasegmental feature. In this section I discuss whether [ʔ] is a tone.

The fact that some features are mobile, i.e., able to move across or reside in several segments, is no sufficient reason for calling it a tone. For example, [round] and [back] are mobile features in languages with vowel harmony (such as Turkish), but there is no evidence that they are tonal.

In fact, the traditional distinction between 'segmental' and 'suprasegmental' features is not as fundamental in multitiered phonology. In the traditional view, such as that held by the Firthian school, a suprasegmental (or prosodic) feature is one that resides on a unit larger than a segment. For example, tone is considered a typical suprasegmental, since it seems to reside on syllables, rather than on segments. In arguing that [ʔ] is like a tone, it is natural to argue that [ʔ] is a suprasegmental. However, there is a distinction between a feature that *must* reside on a unit larger than a segment, and one that *may* reside on more than one segment. Consider the structure in (17), where both the vowel [a] and the coda [t] are glottalized.

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(17)  ʔ
      /\
      XX
      | |
      a t
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The glottal feature [ʔ] in (17) appears to be a suprasegmental, since it resides over two segments (two X slots), or the entire rime. But [ʔ] does not have to reside on a rime. It can, for example, reside on just one segment. And when it resides on two segments, it repeats its relation to each segment individually, instead of taking the two hosts as a whole. In this regard, [ʔ] is like any other feature whose host is the segment.

This is not to say that if [ʔ] is not a suprasegmental, then it cannot be a tone. In fact, contrary to the popular view, there is evidence that tone is not a suprasegmental feature either (Duanmu 1994). In particular, the tone bearing units often (if not always) turn out to be segments in the rime. For example, a light syllable has one rime slot, so it can bear one tone (either H or L); a heavy syllable has two rime slots, and it can bear two tones (LH = rise, or HL = fall). To determine whether [ʔ] is a tonal feature in Garo, therefore, arguments have to come from elsewhere.

It is reasonable to assume that for a language to be tonal, there should be a contrastive use of pitch contour. Garo does not appear to do so. Nevertheless, in Asian tone languages stopped syllables (i.e., those whose coda is [ʔ] or a glottalized [p], [t], or [k]) do have different pitch contours from unstopped syllables; usually, the pitch contour is shorter on a stopped syllable than on unstopped syllables. As a result, tones on stopped syllables are usually listed separately in traditional descriptions.

But as far as pitch contour is concerned all stopped syllables are similar, whether the coda is [ʔ] as in Shanghai, or [p t k] as in Cantonese, or [ʔ] and [p t k] as in Xiamen; in other words, there is no reason to separate the [ʔ] coda from the [p t k] codas. In addition, there is a phonetic explanation for the shortness of stopped tones (tones on a stopped syllable), namely, the voiced part of the stopped syllable is short, so one does not expect the tone to be as complete as it is on an unstopped syllable. The fact that a phonological feature may have variable phonetic realizations in different environments is not unique to tone. For example, both the vowel [a] and the consonant [b] are phonologically [+voice] (both choosing [z] as the plural suffix in English, for example), but phonetically there is less vocal cord vibration in [b] than in [a]. In the same vein, the shortness of stopped tones does not necessarily imply that they are phonologically different from unstopped tones.

The fact that a stopped tone and an unstopped tone can be phonetically different but phonologically similar has been proposed in Shanghai.[8] According to Xu et al. (1988), the unstopped tone Yang Qu is phonetically [113] (in Chao letters), and the stopped tone Yang Ru is phonetically [<u>12</u>] (the underlining indicates shortness). The two tones differ phonetically in length, in the amount of rise, and in the overall shape, with [113] having a longer portion of flat contour. Phonologically, however, both Yang Qu and Yang Ru are LH, which can be determined by their effect on the following syllables in the same tone domain (Selkirk and Shen 1990, Duanmu 1993, and others).

Not only can a stopped tone be phonologically similar to an unstopped tone, but a stopped syllable can carry different pitch contours. Consider the Shanghai data in (18).

(18)	a.	zəʔ R	'ten'
	b.	zəʔ tsaʔ L H	'ten units'
	c.	paʔ zəʔ L H	'eight-ten (eighty)'

The stopped syllable [zəʔ] 'ten' has a glottalized vowel, yet it can carry three kinds of tones; it has a rise (R) in (18a), a low (L) in (18b), and a high (H) in (18c) (see Selkirk and Shen 1990 and Duanmu 1993, among others, for tonal distributions in Shanghai). Now if [ʔ] is already a tone, how can it be possible for [zəʔ] to show a three-way tonal contrast without losing [ʔ]?

The examples in (18) shows that [ʔ] and tone are independent features. Articulatorily, [ʔ] is related to the constriction of the glottis, whereas tone is related to the tenseness and/or the thickness of the vocal cords. It is conceivable that these features can interact with one another, just as aspiration and voicing can interact with each other, yet they are phonologically distinct and should not be identified as the same.

Before closing this section, I would like to comment on a historical point. As Burling (p.50) notes, if [ʔ] in Garo represents a minimal tonal system, there is the question of whether Garo is beginning to acquire a tonal system or nearing the end of losing a tonal system. Since historical and comparative data are lacking, Burling hypothesizes that the latter is the case. However, from the viewpoint of tonogenesis (e.g. Matisoff 1973), tones in Tibetan and Southeast Asian languages come from the loss of onset and coda consonants. The same is probably also true in Chinese languages (Baxter 1992). Now the onset and coda inventories in Garo are comparable to (spoken) Lhasa Tibetan (which acquired

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8 This variety is called Mainstream Shanghai by Xu et al. (1988). It is different from the variety studies by Sherard (1972), which is Old Shanghai.

tone quite recently), and more complicated than those in Chinese languages (which acquired tone earlier but have shown no sign of tone loss yet). It is more likely, therefore, that Garo is yet to acquire tone, instead of having already gone through the process of tonogenesis AND being near the completion of tone loss.[9]

4. Conclusions

I have shown how the properties of the Garo glottal stop can be accounted for in current phonological theory without calling it a suprasegmental. In addition, there is no other reason to consider [ʔ] a tone feature.

9 A further fact of relevance is that language tends to be more conservative in the countryside than in cities. For example, although Lhasa Tibetan has acquired tone, many nomad varieties of Tibetan are still non-tonal (Qu 1981). Since Garo is (until recently) spoken primarily by mountain dwellers (Burling, p.c.), one expects it to be slow in acquiring tone.

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