DEVOICING, ASPIRATION, AND VOWEL SPLIT IN HAROI: EVIDENCE FOR REGISTER (CONTRASTIVE TONGUE-ROOT POSITION)

ERNEST W. LEE

0. INTRODUCTION

Haroi has the most complex vowel system of any Chamic language, having eleven simple vowel positions plus length contrast, glided vowels, and nasalisation (cf. Mundhenk in this volume). Contrast this with Roglai which has six simple vowels plus length and nasalisation. The Roglai vowel inventory quite closely parallels the vowel inventory reconstructed for Proto-Chamic (Lee 1966). At least part of the inventory of vowels in Haroi came from the splitting of vowels of the reconstructed Proto-Chamic. The most obvious split, because of its frequency, is the development of Haroi i̯a (a glide from high central unrounded to a neutral central quality) and a, both from PC *a. The development of i̯a shows a clear connection with a preceding Proto-Chamic voiced obstruent in the majority of instances, but in other instances i̯a is connected with a preceding Proto-Chamic high vocoid (either syllabic or non-syllabic). Either the voiced obstruent or the high vocoid, however, may be separated from the affected vowel by one to three phonetic segments. In addition the reconstructed voiced obstruents regularly show up as voiceless (except those which are preglottalised) and often as aspirated in Haroi.

The purposes of this paper are: 1) To note the various historical developments of devoicing, aspiration, and vowel split in Haroi. 2) To postulate that a single feature of tongue-root position (with probable concomitant larynx lowering) as a register system[1] which originated from obstruent voicing and vowel height can alone account for all of these diverse developments that otherwise appear to be motivationally unrelated

and also account for the apparent distance of the motivating feature from the affected segment. 3) To suggest that devoicing of the syllable initial obstruents may actually be caused by tongue-root advancement.

1. HISTORICAL DEVELOPMENTS

1.1. *DEVOICING*

Of the Chamic languages, devoicing[2] of syllable initial voiced obstruents (Rule 1)[3] has occurred in Eastern Cham (Doris Blood 1962.12), Western Cham (Hor and Friberg, in this volume), Cat Gia Roglai (my own word lists) and in Haroi (word list by Hella Goschnick and from examples given by Mundhenk in this volume).

$$\text{Rule 1.} \quad * \begin{bmatrix} +\text{cons} \\ -\text{son} \\ +\text{vd} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{cons} \\ -\text{son} \\ -\text{vd} \end{bmatrix} \; / \; . \; \_$$

The evidence for reconstruction of voiced obstruents for Proto-Chamic is twofold: 1) Other Chamic languages as Rade, Jorai, and Northern Roglai have both voiced and voiceless obstruents for the lexical items reflected only by voiceless stops in Haroi and Cham: PC *dlai, Rade dlie, Jorai dlai, Roglai dlai, Haroi tlɨai *'forest'*; PC *tlau, Rade tlau, Jorai tlau, Roglai tlau, Haroi tlàu *'to laugh'*. 2) Many of the items are of Austronesian origin and voiced obstruents have been reconstructed for Proto-Austronesian. These contrast with voiceless obstruents: PA *pajay, PC *padai, Haroi pathɨ̀ai *'unhusked rice'*.

Other examples of devoicing in Haroi are: 1) In the presyllable (any non-ultimate syllable): PC *darah, Haroi čarɨah *'blood'*; PC *danau, Haroi čanɨau *'pond'*. 2) In the main syllable (the stressed ultimate syllable): PC *kubau, Haroi kaphɨ̀au *'water buffalo'*; PC *habəu, Haroi ʔaphɨau *'ashes'*; PC *blah, Haroi plɨah *'to split'*; PC *bras, Haroi prɨ̀ah *'husked rice'*; PC *ʔugha, Haroi ʔakha *'root'*.

Proto-Chamic preglottalised stops do not devoice, but in these cases the voiced elements are not syllable initial: PC *jaʔbu, Haroi čabu *'to dry (in sun)'*; PC *paʔdiaʔ, Haroi padeaʔ *'hot'* (Haroi /b/ and /d/ are phonetically preglottalised).

1.2. *ASPIRATION*

The obstruents which devoiced in Haroi also regularly became aspirated if the obstruent was immediately preceding the vowel of the main syllable of the word (Rule 2): PC *kubau, Haroi kaphɨ̀au *'water buffalo'*; PC *pubah, Haroi paphɨah *'mouth'*; PC *dada, Haroi čathɨa *'chest'*; PC *habəu, Haroi ʔaphɨau *'ashes'*; PC *bap, Haroi phɨauʔ *'full'*; PC *digəi, Haroi

čakhɨi *'tooth'*; PC *?adəi, Haroi ?athɨi *'younger sibling'*.

$$\text{Rule 2.} \quad * \begin{bmatrix} +\text{cons} \\ -\text{son} \\ +\text{vd} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{cons} \\ -\text{son} \\ -\text{vd} \\ +\text{asp} \end{bmatrix} \; /\_\text{VC}_0\# \qquad \text{(s=[š}\sim\text{tš])}$$

The alveo-palatal PC *j would appear to have become first aspirated and then later became an alveopalatal fricative [š] alternating with an affricate [tš] (cf. Mundhenk in this volume): PC *hujān, Haroi ?asɨan (s=[š∿tš]) *'rain'*.

A Proto-Chamic voiced obstruent in a presyllable before a main syllable beginning with the liquid /l/ is also reflected by aspiration in Haroi: PC *jalān, Haroi čalɨan [tʸʰalɨ·an] *'road'*.[4]

In the other positions the obstruent simply devoices without concomitant aspiration: 1) Preceding a consonant in the main syllable as in PC *dlai, Haroi tlɨai *'forest'*; PC *blәi, Haroi plɨi *'to buy'*; PC *brәi, Haroi prɨi *'to give'*; PC *bras, Haroi prɨah *'husked rice'*; 2) Presyllable preceding non-liquids as in PC *danau, Haroi čanɨau *'pond'*; PC *buŋã, Haroi paŋɨa *'flower'*.

1.3. *VOWEL SPLIT*

1.31. Related to voicing feature of preceding obstruent

Along with the devoicing of the obstruents in Haroi is a consistent split of vowels. From the word list available, the most evident shift (Rule 3) is that main syllable PC *a (long or short, oral or nasal) went to ɨa (a high central unrounded vocoid gliding to a neutral central vowel): PC *hujān, Haroi ?asɨan *'rain'*, PC *dlai, Haroi tlɨai *'forest'*; PC *padai, Haroi pathɨai *'unhusked rice'*. The shift of main syllable *a to ɨa takes place not only where there is a devoiced obstruent in the main syllable as above, but also where there is a more remote devoiced obstruent in the presyllable: PC *gunãm, Haroi kanɨam *'cloud'*; PC *buŋã, Haroi paŋɨa *'flower'*; PC *bala, Haroi palɨa *'tusk'*; PC *jalān, Haroi čalɨan *'road'*.

$$\text{Rule 3.} \quad *a \rightarrow ɨa \; / \; . \begin{bmatrix} +\text{cons} \\ -\text{son} \\ +\text{vd} \end{bmatrix} \text{x}\_\text{C}_0\#$$

Proto-Chamic murmured stops (phonemicised as stop plus h) do not show the same effect on vowels which suggests that they either devoiced earlier than the plain voiced stops or that the devoicing preceded the development of the aspiration of 1.2.: PC *jhāt, Haroi sat *'bad'*; PC *?ugha, Haroi ?akha *'root'*.

If there was no original voiced obstruent between an original voiceless obstruent and the main syllable vowel, then the main syllable *a did not shift (Rule 4): PC *pināŋ, Haroi panaŋ *'areca nut'*; PC *takai, Haroi čakai *'leg'*; PC mata, Haroi mata *'eye'*; PC *tlau, Haroi tlau *'to laugh'*; PC *rusa, Haroi lasa *'deer'*.

$$\text{Rule 4.} \quad *a \rightarrow a \;/\; . \begin{bmatrix} +\text{cons} \\ -\text{son} \\ -\text{vd} \end{bmatrix} x\_C_0\#$$

Less common, but still quite evident is the reflection of PC *əi by ɨi where there was a preceding voiced obstruent in the proto-language (Rule 5), but by oi when there was a preceding voiceless obstruent (Rule 6): PC *digəi, Haroi čakhɨi *'tooth'*; PC *brəi, Haroi prɨi *'to give'*; PC *ʔadəi, Haroi ʔathɨi *'younger sibling'*; PC *blәi, Haroi plɨi *'to buy'*; but PC *kumәi, Haroi kamoi *'female'*; PC *l_sәi, Haroi lasoi *'cooked rice'* (PC *əi reflects Proto-Austronesian *-ih in all of these examples).

$$\text{Rule 5.} \quad *əi \rightarrow ɨi \;/\; . \begin{bmatrix} +\text{cons} \\ -\text{son} \\ +\text{vd} \end{bmatrix} x\_\#$$

$$\text{Rule 6.} \quad *əi \rightarrow oi \;/\; . \begin{bmatrix} +\text{cons} \\ -\text{son} \\ -\text{vd} \end{bmatrix} x\_\#$$

Proto-Chamic *əu apparently was reflected only by au (Rule 7) at some stage with a subsequent shift of au to ɨau (Rule 8) along with the shift of *a to ɨa in the same environments described above: PC *habəu, Haroi ʔaphɨau *'ashes'*; PC *bahrəu, Haroi parɨau *'new'*; PC *bilәu, Haroi palɨau *'feather'*; but PC *patəu, Haroi patau *'stone'*; PC *kukəu, Haroi kakau *'claw, nail'*; PC *ʔasəu, Haroi ʔasau *'dog'*.

$$\text{Rule 7.} \quad *əu \rightarrow au$$

$$\text{Rule 8.} \quad *au \rightarrow ɨau \;/\; . \begin{bmatrix} +\text{cons} \\ -\text{son} \\ +\text{vd} \end{bmatrix} x\_\#$$

Proto-Chamic *u is reflected by u in Haroi following reconstructed syllable initial voiced obstruents (Rule 9), but by ô following syllable initial voiceless obstruents (Rule 10): PC *tijuh, Haroi časuh *'seven'*; PC *ʔiduŋ, Haroi ʔathuŋ *'nose'*; but PC *pitu?, Haroi patô? *'star'*; PC *thun, Haroi thôn *'year'*; PC *ʔapui, Haroi ʔapôi *'fire'*.

$$\text{Rule 9.} \quad *u \rightarrow u \;/\; . \begin{bmatrix} +\text{cons} \\ -\text{son} \\ +\text{vd} \end{bmatrix} x\_C_0\#$$

$$\text{Rule 10.} \quad *u \rightarrow \hat{o} \;/\; . \begin{bmatrix} +\text{cons} \\ -\text{son} \\ -\text{vd} \end{bmatrix} x\_C_0\#$$

Similarly *i is reflected by i following reconstructed syllable initial voiced obstruents (Rule 11), but by ê (ey before ?) following syllable initial voiceless obstruents (Rule 12)[5]: PC *?abih, Haroi ?aphih *'all'*; but PC *čim, Haroi čêm *'bird'*; PC *tasi?, Haroi časèy? *'ocean'*.

$$\text{Rule 11.} \quad *i \rightarrow i \;/\; . \begin{bmatrix} +\text{cons} \\ -\text{son} \\ +\text{vd} \end{bmatrix} x\_C_0\#$$

$$\text{Rule 12.} \quad *i \rightarrow \underset{1}{\left\{\begin{matrix} \hat{e}y \\ \hat{e} \end{matrix}\right\}_1} \;/\; . \begin{bmatrix} +\text{cons} \\ -\text{son} \\ -\text{vd} \end{bmatrix} x\_ \underset{1}{\left\{\begin{matrix} ? \\ C_0 \end{matrix}\right\}_1}$$

1.32. Related to height feature of preceding vocoid

Not all of the vowel splits occur where there has been voicing of obstruents involved; the same splits appear to be related to the height feature of a preceding vocoid if the onset of neither the presyllable nor the main syllable began with an obstruent.

As following a reconstructed voiced obstruent, so following a high vocoid, PC *a in the main syllable is replaced by ɨa if there are no voiceless obstruents preceding the *a within the phonolotical word. Hence Rule 13 assumes the previous application of Rule 4. The following examples are exhaustive for the data available: 1) Following a high vocoid in the presyllable: PC *?inã, Haroi ?anɨa *'female animal'*; PC *lumãn, Haroi lamɨan *'elephant'*; PC *lumã?, Haroi lamɨa? *'fat'*; PC *limã, Haroi lamɨa *'five'*; PC *humã, Haroi hamɨa *'field'*; PC *?ula, Haroi ?alɨa *'snake'*; 2) Following the semivowel y as onset of a monosyllabic word: PC *yāŋ, Haroi yɨaŋ *'god, spirit'*; PC *yāp, Haroi yɨau? *'to count'*. There are no examples of syllable initial y following a presyllable without an obstruent and no examples of w as onset of a monosyllabic word, but syllable initial w following a presyllable appears not to affect the following vowel: PC *hawai, Haroi havai *'rattan'*; PC *?awa, Haroi va *'uncle'*.

$$\text{Rule 13.} \quad *a \rightarrow ɨa \;/\; \underset{1}{\left\{\begin{matrix} C_1 \\ \# \end{matrix}\right\}_1} \begin{matrix} -\text{cons} \\ +\text{son} \\ +\text{high} \end{matrix} \underset{1}{\left\{\begin{matrix} C_1 \\ \emptyset \end{matrix}\right\}_1} \_C_0\#$$

The following sets show the contrast of reflexes of PC *a following high and low vocoids: PC *?inã, Haroi ?anɨa *'female animal'* and PC *?anāk, Haroi ?ana? *'offspring'*; PC *humã, Haroi hamɨa *'field'* and PC *?amã, Haroi ?ama *'father'*. (The Proto-Chamic forms above have the same vowel in the presyllables as Proto-Austronesian.)

The following sets are those with high vocoid and reconstructed voiceless obstruents in either syllable preceding the *a which is not replaced by ɨa: PC *tupa?, Haroi čapa? *'straight, right'*; PC *?usar, Haroi ?asal *'seed, flesh'*; PC *sula, Haroi hala *'leaf'*; PC *tulāŋ, Haroi calàŋ *'bone'*.

The evidence for most of the other vowels is not available from the word lists except that PC *ia is reflected by ia as expected in one example: PC *lumiã?, Haroi lamia? *'to put away'*.

Finally, it should be noted that several of the examples from 1.31. could also be repeated in 1.32. since words like Haroi ?asɨan from PC *hujān *'rain'* and Haroi paŋɨa from PC *buŋa *'flower'* reflect forms with both a preceding voiced obstruent and a preceding high vocoid.

2. MOTIVATING FACTOR(S) FOR VOWEL SPLIT AND ASPIRATION

On the surface it would appear that the voicing of the obstruent or perhaps devoicing was the motivating factor in the development of aspiration and vowel split in Haroi, but this could not account for the parallel vowel split connected with preceding high vocoids.

Even if we posit voicing as the conditioning factor in some cases and vocoid height in other cases, there are still several unanswered problems: 1) Is not a shift from a voiced stop to a voiceless aspirated stop (e.g. *b to p^h) an unnatural sound change? 2) What physiological feature of voicing can cause a vowel to become higher and glided? 3) How can voicing and/or vocoid height affect the quality of a segment removed from it by as many as three intervening segments? 4) What physiological features do high vocoids and voiced obstruents share that would enable them to have the same effect on the following vowels?

I will attempt to demonstrate that all of the questions can be answered by positing register as a feature of some earlier stage of Haroi although it does not appear to be currently a feature of Haroi. This possibility was suggested from reading Gregerson's (1976) discussion of tongue-root as a feature in Mon-Khmer. Although Haroi is not Mon-Khmer, it is located in a Mon-Khmer milieu and both Western and Eastern Cham to which Haroi is closely related also have register systems. Following Gregerson and others, I assume tongue-root advancement (**TRA**) v. tongue-root retraction (**TRR**) to be the primary physiological factor

involved in register systems of Southeast Asia. Gregerson (1976:345-6) states:

> "In view of these observations it seems possible to suggest that the advancement or retraction of the tongue-root can constitute a major air stream regulator. In a forward position the tongue body ideally raises vowel height, produces enlarged resonant pharynx cavity, and permits the uninhibited flow of air through the glottis for voicing of consonants. Conversely, in a retracted posture the tongue body lowers the tongue height, reduces the pharyngeal resonance, and restricts the flow of air thereby producing a voiceless state for consonants."

2.1. *SHIFT FROM VOICED STOPS TO VOICELESS UNASPIRATED STOPS IS UNNATURAL?*

Gandour (1974a:347) attempts to resolve the problem of having an unnatural sound change *b to p^h etc. for the Tai languages by positing a series of murmured consonants $\underset{\cdot\cdot}{b}$, etc. rather than plain voiced stops so that the change can follow a "...natural line of phonetic development - *b [I am sure he intended $\underset{\cdot\cdot}{b}$] → $p^{\tilde{h}}$ → p^h → p..." (some Tai languages retain p^h as a reflex). This would leave the Proto-Tai system with a series of murmured stops but apparently with no plain voiced stops.

Such a solution does not seem feasible for Haroi. Murmured stops need to be reconstructed for Proto-Chamic because of evidence in Cham, Roglai, and Rade. For Cham the murmured stops are reflected only in the use of voiced aspirated symbols in the script, but Rade and Roglai both retain murmured stops. As might be expected the murmured stops are much less frequent than the plain voiced stops in these languages. In Haroi the Proto-Chamic murmured stops (phonemicised as stop plus h) are reflected by voiceless aspirated stops except for PC *jh which is reflected by s. This shift to voiceless aspirated stops and s appears to have preceded the development of tongue-root contrast since the vowels following Proto-Chamic murmured stops are unaffected.

In addition to the murmured stops simple voiced stops are reconstructed for Proto-Chamic and many of these are in lexical items for which simple voiced stops are also reconstructed for Proto-Austronesian. It would seem unwise to posit these as murmured in both Proto-Austronesian and Proto-Chamic in order to account for Haroi aspiration. Rather, the **TRA** feature such as I am positing for an earlier stage of Haroi is often described for Southeast Asian languages as being breathy (cf. Cambodian, Hre, Jeh (Gregerson 1976:323,8)).

The actual physical properties of **TRA** and **TRR** vary from language to language and from one stage to another in the same language without loss of the **TRA-TRR** contrast (cf. Kenneth D. Smith, 1968). Hence, it would be very natural for Haroi to develop breathiness as a part of the **TRA**

feature and for this breathiness to become aspiration in the absence of any intervening segment between the stop and the nucleus of the syllable. The change of *b to p^h, etc. via a **TRA** feature is not unnatural, but rather is quite natural.

2.2. *HOW CAN OBSTRUENT VOICING MOTIVATE VOWEL HEIGHTENING AND GLIDING?*

Gregerson (1976:330-6) asks the same question and answers it in considerable detail with evidence which is not repeated here. He concluded that both vowel heightening and centering glides (cf. Cambodian (Gregerson, 1976:323)) are also normal concomitants of a **TRA** feature.

It is not then the voicing of the obstruent but the **TRA** feature which produces the vowel heightening and gliding. This accounts for the Haroi centering glide **ɨa** from PC ***a**. Assuming PC ***i** and ***u** to have already had a relatively advanced tongue-root position, the development of the Haroi phonemes **i** and **u** reflect the **TRA** feature and the phonemes **ê** and **ô** reflect the **TRR** feature with which vowel lowering is associated. This assumes that at some stage what is now reflected as **ɨa, i, u** and **a, ê, ô** were subsets of high v. low or tense v. lax allophones of a single set of vowels with **TRA-TRR** being the conditioning factor. With the loss of **TRA-TRR** as a contrastive feature, two separate series of vowel phonemes developed.

2.3. *HOW CAN VOICING OR VOCOID HEIGHT AFFECT REMOTE SEGMENTS?*

The affected vowel in the Haroi splits was always the nucleus of the main syllable, but the voiced obstruent or high vocoid of Proto-Chamic connected with the shift could be the initial segment of the main syllable, the nucleus of the presyllable, or the onset of the presyllable. It is not natural for a segment so far removed to affect another segment. Rather the conditioning factor needs to be one which belongs to a larger unit. Register is normally a feature of an entire syllable or phonological word because of the slower movement of the tongue-root (cf. Gregerson 1976:358ff.). Hence it becomes natural for a presyllable which is **TRA** to cause a following syllable to also become **TRA** or for a presyllable which is **TRR** to cause a following syllable to become **TRR**.

2.4. *WHAT COMMON DENOMINATOR DO HIGH VOCOIDS AND VOICED OBSTRUENTS HAVE TO PRODUCE IDENTICAL SOUND CHANGE?*

Gregerson suggests that we

> "...assume that, rather than several register features issuing from the one voiced:voiceless in some sequential sense, all the features (voicing, pitch, vowel aperture, and voice quality) coexisted (as in modern Mnong) constituting a multi-

> feature prosodic opposition dichotomizing all syllables (or phonological words). It is suggested that all of these phonetic features are effects of an underlying opposition between tongue-root advancement vs. tongue-root retraction. Voiced initials are an effect of advancement and voiceless initials of retraction of the tongue body." (343)

I would rather assume that all of these features potentially existed as manifestations of **TRA** v. **TRR** rather than assuming that all of them had to coexist at any one time. I would further posit that the **TRA-TRR** contrast in the precursor of present day Haroi *did* develop from the voicing contrast and the vocoid height contrast.

High vocoids tend to have greater tongue-root advancement than low vocoids. This is supported by the electromyographic research of Smith and Hirano (1968:147) who state:

> "The posterior of the genioglossus [the principal tongue muscle which pulls the root forward] shows marked activity for high vowels and 'lingual' consonants. This muscle is consistently and reliably more active for the tense, high vowels i, e, and u than their lax counterparts ɪ, ɛ, and ʊ. All other things being equal, the activity is greater for phonologically high vowels than for lower vowels."

For the stops, however, Timothy S. Smith (1971:63) found that the mid-pharyngeal width is greater for voiced stops than voiceless stops (as others have already noted), but he also found that it is not attributable to muscular activity. He observed that

> "...the activity of the posterior genioglossus muscle during the voiced alveolar stops [of English] was not significantly different from the activity during the voiceless stops. In fact the voiceless stops often showed slightly greater activity."

He also observed that the widening cannot be from depression of the hyoid bone either since the hyoid bone was 4 mm higher for the voiced stop than for the voiceless. He then concluded that "the widening of the pharyngeal cavity during voiced stops is primarily due to the passive reaction of the non-tensed vocal tract." (65)

This appears to suggest that any tongue-root advancement for English voiced stops is passive. I would suggest that perhaps for Proto-Austronesian and perhaps also for Proto-Chamic a similar situation may have existedm but that somewhere along the line, the passive advancement of the tongue-root conditioned by the increase in supreglottal pressure attained in the production of voiced obstruents became an active **TRA** feature and then that the **TRA** feature associated with voicing and the **TRA** feature associated with vowel height merged and became a feature of the syllable contrasting with **TRR** of all other syllables. It is very likely that larynx lowering accompanied the **TRA** feature as in the Mon-Khmer languages of the area. Gregerson has noted that larynx lowering

and the TRA feature are natural concomitants and so form an unmarked relationship.

It is acknowledged here that at least one other Austronesian language outside the Chamic group undoubtedly does have a register system. Catford (1964) mentions larynx lowering, but does not mention the tongue-root in his discussion of Javanese. His general description, however, has the classic earmarks of a register system. He says:

> "Lowered-larynx sounds occur (in phonological opposition to normal or raised-larynx sounds) in Javanese. Here the stops and affricates commonly written b, d, ḍ, dj, g are, like the corresponding series, p, t, ṭ, tj, k, completely voiceless: the series b, d, etc., however, are produced with the larynx considerably lowered (a downward-forward displacement of the hyoid bone of up to about 1 cm can easily be observed). During the stops this produces no acoustic or auditory effect, but the lowered larynx position persists into the following vowel, where it can be observed acoustically as a downward shift of formant 1, and auditorily as a 'muffled' or 'centralized' vowel quality." (34-35)

The factors which I have posited for the origin of the TRA-TRR contrast must be ranked to show which syllable became TRA and which TRR. Rules 14 and 15, in which **S** = syllable and **x** = any or no string, are ordered.

$$\text{Rule 14.} \quad *S \rightarrow \begin{cases} \text{TRA if } \left\{ \begin{array}{l} \# \begin{bmatrix} -\text{cons} \\ +\text{son} \\ +\text{high} \end{bmatrix} \\ \cdot \begin{bmatrix} +\text{cons} \\ -\text{son} \\ +\text{vd} \end{bmatrix} \end{array} \right\} x \\ \text{TRR if } \cdot \begin{bmatrix} +\text{cons} \\ -\text{son} \\ -\text{vd} \end{bmatrix} x \end{cases}$$

$$\text{Rule 15.} \quad *S \rightarrow \begin{cases} \text{TRA if } x \begin{bmatrix} +\text{syl} \\ -\text{cons} \\ +\text{high} \end{bmatrix} x \\ \text{TRR if } x \begin{bmatrix} +\text{syl} \\ -\text{cons} \\ -\text{high} \end{bmatrix} x \end{cases}$$

Rule 14 generates a TRA syllable if the syllable began with a non-syllabic high vocoid or a voiced obstruent and a TRR syllable if it began with a voiceless obstruent. For the remaining syllables, Rule 15 generates a TRA syllable if the nucleus was a high vocoid and a TRR syllable if the nucleus was a low vocoid.

At the first stage of the TRA-TRR contrast then, there would have been two possibilities for monosyllabic words: TRA and TRR. Disyllabic

words would have had four possibilities: TRA+TRA, TRA+TRR, TRR+TRA, and TRR+TRR. Eventually, however, the four possibilities began to merge leaving only two. This merger was undoubtedly due to the sluggish nature of tongue-root movement. Figure 1 shows the direction of merger of the tongue-root feature; the vertical arrows indicate the direction of merger if the main syllable initial consonant was *not* an obstruent and the horizontal arrows indicate the direction if the main syllable initial consonant was an obstruent.[6] The resultant words were either TRA+TRA or TRR+TRR which elevated the register system from a syllable to a word level feature with TRA and TRR phonological words.

Syllable Pre	Main		Syllable Pre	Main
TRA	+ TRA	←	TRR	+ TRA
↑			↓	
TRA	+ TRR	→	TRR	+ TRR

Figure 1. DIRECTION OF MERGER OF TONGUE-ROOT FEATURE.

After the development of aspiration of the initial stop of the main syllable of TRA words, the loss of voicing of the stops, and the merger of presyllable high vowels with the presyllable low vowels, and the split of the main syllable vowels, the TRA-TRR contrast itself was lost leaving only the indelible traces in the new vowel set and in the aspirated stops.

One puzzling factor that remains is whether Cham and the Haroi precursor developed register together or whether it was an independent development in each. The difficulty in trying to make it a shared innovation stemming from the era when they were still one language is that Northern Roglai which is evidently much closer to Cham than either Cham or Northern Roglai is to Haroi shows no evidence that I have been able to observe of a register system. Voiced stops are retained as simple voiced stops, the vowel system is no more complex than Proto-Chamic with no evidence of allophones having any relation to preceding obstruents or high vocoids, and with a high-low contrast of vowels in the presyllable retained. Southern Roglai which is closer to Cham does, on the other hand, give some evidence of tongue-root placement in the allophones of vowels.

The one possible bit of evidence for tongue-root involvement that pervades most of the Chamic languages is that voiceless stops in the presyllable reflect Proto-Austronesian voiced stops if the main syllable

begins with a voiceless obstruent. Rade, however, appears not to have this shift although the extensive reduction of presyllables in Rade obscures the picture: PA *depah → Rade ?epa *'span'* which clearly reflects a voiced consonant since an intermediate stage with t- in the presyllable would have been expected to become k- in Rade. (Rade ?e is the normal reflex of any presyllable beginning with a voiced coronal regardless of the quality of the following vowel.)

3. MOTIVATING FACTOR(S) FOR DEVOICING

One intriguing factor which interests me is the widespread devoicing of syllable initial stops (throughout the Southeast Asian area) in connection with the development of register or tone. Some of the examples are Chinese (Cheng and Wang, 1970), Cambodian (cf. Gregerson, 1976:342), Mon (cf. Gregerson, 1976:342), Tai (Li, 1954), Cham, Haroi, and others. Gregerson (1976:351-7) discusses in detail the relationship of pitch (as well as the factors already covered in this paper) to tongue-root position and does not need to be discussed further.

The question I want to pose is: Why does language after language devoice the syllable initial stops (including, at least in Cham and Haroi, intervocalic stops which one would not have expected to devoice) as the register or tone system develops? This is especially relevant in light of Gregerson's suggestion that the advanced tongue-root "permits the uninhibited flow of air through the glottis for voicing of consonants." (1976:346). If the advanced tongue-root produces a situation favourable for voicing, why do languages like Haroi and Cham devoice stops when other Chamic languages like Northern Roglai and Rade that have little or no evidence of active tongue-root involvement do not devoice? (I have already mentioned that the voiced stops reconstructed for Proto-Chamic are firmly supported by evidence from the widespread Austronesian language family.)

So far Cheng and Wang (1970:CW10) are the only ones I have found who consider the question. They offer no answer but simply say:

> "Nonetheless, it remains to be discovered what were the exact physical characteristics that the oblique tone had which facilitate the devoicing of the initial consonant."

I do not claim to have a definitive answer to the question, but am suggesting that there is something physiological about active tongue-root advancement which facilitates devoicing.

Voicing is a marked feature (relative to laryngeal activity). It is natural for sonorants, but extra muscular activity is required in the larynx to produce voicing for obstruents which have a major constriction

in the oral cavity (cf. Chomsky and Halle, 1968:300-1).

While tongue-root advancement widens the pharyngeal cavity, it also stretches the vocal cords (cf. Ladefoged, 1971:7 and Ohala and Ladefoged, 1970:13) apparently making maintenance of obstruent voicing more difficult. Timothy S. Smith's findings concerning the tendency for slightly greater activity of the genioglossus muscle for voiceless stops than for voiced stops would tend to support the possibility that tongue-root advancement as well as tongue-root retraction is more favourable to voicelessness of obstruents than to voicing.

If, as I have suggested for the precursor of Haroi, passive enlargement of the pharyngeal cavity with the tongue-root pushed forward provided the impetus for the development of an active tongue-root advancement, then it is highly possible that as tongue-root advancement took over the contrastive function formerly carried by the voicing, the marked feature of voicing yielded to the unmarked feature of voicelessness even in intervocalic position. In other words, obstruent voicing is best maintained in the environment of a neutral or relaxed tongue-root position rather than when it is actively advanced or retracted. It should be noted, however, that as long as the **TRA-TRR** contrast is maintained, the actual tongue musculature and pharyngeal cavity for the originally contrastive series of obstruents will be quite different even though acoustically and auditorily the same. The acoustic and auditory difference will only be evident from segments in the rest of the syllable (cf. Catford, 1964:34-5).

NOTES

1. I gratefully acknowledge Kenneth J. Gregerson's paper (1976) on tongue-root and register in Mon-Khmer and the very stimulating discussions with him which put me on the track in developing this paper and which has provided me with the foundation upon which I build. I also appreciate the helpful comments received from Kenneth L. Pike, David D. Thomas and Hella Goschnick. Without Goschnick's Haroi word list and Tegenfeldt's description of the Haroi phonemes, the latter of which is included in this volume, this study would not have been possible.

2. See also Note 6 and the final paragraph of section 2.4. for an example of devoicing involving more of the Chamic languages.

3. Most notations follow Schane (1973) in the rules in this paper with the addition that x is used to indicate any or no string and the period (.) is used to indicate syllable boundary which may be coterminus with the boundary of any larger phonological unit.

4. Mundhenk analyses this as an allophone of the simple stop rather than as phonemic aspiration since it is non-contrastive in this position. Contrast this with Haroi čathɨa *'chest'* and čakhɨi *'tooth'* above where the č is not aspirated.

5. In rules 12 and 13, the subscript numeral before and after the braces is used, following Harms (1968:59), to indicate that the top line in each set of braces is to be read as part of one environment and the bottom line in each set of braces as part of another environment.

6. Alternatively, it is possible that there was no assimilation or merger if the main syllable began with an obstruent, but there is some evidence from the other Chamic languages supporting a regressive tongue-root assimilation (see final paragraph of this section).

BIBLIOGRAPHY

BLOOD, Doris

1962 'Reflexes of Proto-Malayo-Polynesian in Cham.' *Anthropological Linguistics* 4/9:11-20.

BROAD, David J.

1968 *Some physiological parameters for prosodic description.* (Speech Communications Research Laboratory monograph 3.) Santa Barbara, California: Speech Communication Laboratory, Inc.

CATFORD, J.C.

1964 *Phonation types: the classification of some laryngeal components of speech production.* In honour of Daniel Jones, edited by David Abercrombie *et al.*, 26-37. London: Longmans, Green and Co.

1968 'The articulatory possibilities of man.' *Manual of phonetics*, edited by Bertil Malmberg, Amsterdam: North-Holland Publishing Co.

CHENG, Chin-Chuan and William S.Y. Wang

1970 *Phonological change of middle Chinese initials.* (Project on linguistic analysis, 2nd series.) Berkeley, California: Department of Linguistics, University of California. 10.CW1-69.

CHOMSKY, Noam and Morris Halle

1968 *The sound pattern of English.* New York: Harper and Row.

GANDOUR, Jack

1974a 'Consonant types and tone in Siamese.' *Journal of Phonetics* 2:337-50.

GANDOUR, Jack (cont.)

1974b 'The features of the larynx: N-ary or binary?' The tone tome: studies on tone from the UCLA tone project, edited by Ian Maddieson. (Working papers on phonetics.) Los Angeles: University of California. 27:147-59.

GREGERSON, Kenneth J.

1973 'Tongue-root and register in Mon-Khmer.' *Austroasiatic Studies*, Part I (Oceanic Linguistics Special Publication 13:323-69). Honolulu: University Press of Hawaii.

HARMS, Robert T.

1968 *Introduction to phonological theory.* Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

HIRANO, Monoru, William Vennard, and John Ohala

1968 The function of laryngeal muscles in regulating fundamental frequency and intensity of phonation. (Working papers in phonetics.) Los Angeles: University of California. 10: 111-14.

LADEFOGED, Peter

1971 *Preliminaries to linguistic phonetics.* Chicago: The University of Chicago Press.

LADEFOGED, Peter, Joseph L. DeClerk, and Richard Harshman

1971 Factor analyses of tongue shapes. (Working papers in phonetics.) Los Angeles: University of California. 19:39-46.

LEE, Ernest W.

1966 Proto-Chamic phonologic word and vocabulary. Unpublished dissertation, Indiana University.

Li, Fang-kuei

1954 'The relationship between tones and initials in Tai.' *Studies in comparative Austroasiatic linguistics*, edited by Norman Zide, 82-8. The Hague: Mouton.

LISKER, Leigh and Arthur S. Abramson

1964 'A cross-language study of voicing in initial stops: acoustical measurements.' *Word* 20:384-422.

LISKER, Leigh and Arthur S. Abramson (cont.)
1971 'Distinctive features and laryngeal control.' *Language* 47: 767-85.

MADDIESON, Ian
1974a 'A note on tone and consonants.' The tone tome: studies on tone from the UCLA tone project, edited by Ian Maddieson. (Working papers in phonetics.) Los Angeles: University of California. 27:18-27.

1974b 'A possible new cause of tone-splitting-evidence from Cama, Yoruba and other languages.' The tone tome: studies on tone from the UCLA tone project, edited by Ian Maddieson. (Working papers in phonetics.) Los Angeles: University of California. 27:28-46.

OHALA, John and Peter Ladefoged
1970 Further investigation of pitch regulation in speech. (Working papers in phonetics.) Los Angeles: University of California. 14:12-14.

PIKE, Kenneth L.
1943 *Phonetics: a critical analysis of phonetic theory and a technic for the practical description of sounds.* Ann Arbor: University of Michigan Press.

1967 'Tongue-root position in practical phonetics.' *Phonetica* 17:129-40.

RICE, Lloyd
1972 Analysis of tongue parameters for vowels. (Working papers in phonetics.) Los Angeles: University of California. 23:32-6.

SCHANE, Sanford A.
1973 *Generative phonology.* (Prentice-Hall Foundations of Modern Linguistics Series, edited by Sanford A. Schane.) Englewood Cliffs, New Jersey: Prentice-Hall.

SMITH, Kenneth D.
1968 'Laryngealization and de-laryngealization in Sedang phonemics.' *Linguistics* 38:52-69.

1972 A phonological reconstruction of Proto-North-Bahnaric.

(Language Data 2.) Santa Ana, California: Summer Institute of Linguistics.

SMITH, Timothy S.
1971 A phonetic study of the function of the extrinsic tongue muscles. (UCLA working papers in phonetics 18.) Los Angeles: University of California.

SMITH, Timothy and Minoru Hirano
1968 Experimental investigation of the muscular control of the tongue in speech. (Working papers in phonetics.) Los Angeles: University of California. 10:145-55.

SONNESSON, Bertil
1968 'The functional anatomy of the speech organs.' *Manual of phonetics*, edited by Bertil Malmberg, 45-75. Amsterdam: North-Holland Publishing Co.

STETSON, R.H.
1951 *Motor phonetics: a study of speech movements in action.* Amsterdam: North-Holland Publishing Co.