The interplay between tone, stress, and syllabification in Thai[1]

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0. Abstract

In this study, tone is analyzed as an autosegment closely related to individual phonetic features of segments and such suprasegmental features as stress and syllable structure. Tone assignment in Thai is modular, having a cyclic mode of application throughout word formation, in accordance with two well-formedness conditions on tone. The first well-formedness condition is formulated in terms of syllable structure. Specifically, although Thai tone is lexical, the optimal five lexical tones are constrained by syllable structures. That is, the [-continuant] feature of the coda prohibits mid tone. The distribution of tone is further controlled by the underlying phonetic features of the onset, resulting in distinct tone patterns despite identical rime structures. Due to the autosegmental nature of tone, the second well-formedness condition ensures that one and only one tone can be associated to a phonetic segment. The hypothesis that tone is an autosegment, separated from, but correlates with the stress and syllable structure will be proven via a historical linguistics account of tonogenesis. Additional evidence which supports the claim that both the onset and coda can induce tone will be drawn from different tone outputs governed by varying morphological as well as phonological structures which arise throughout the derivation and compounding of Thai native words and foreign loanwords. Finally, the influence of Thai stress on tone distribution and syllable structure will be treated for the first time in the literature when new data from language games involving foreign loanwords are examined.

I. Background

Thai has *five* lexical tones in the unmarked cases (cf. (1))

(1) Mid: k h a a[2]   'a grass (imperata cylindrica)'

    Low: k h à a   'galangal, a rhizome'

    Falling: k h â a   'to kill; a servant'

    High: k h á a   'to engage in trade'

    Rising: k h ǎ a   'a leg'

However, not all five tones occur freely and various researchers, working within both the segmental and autosegmental theories, have attempted to describe the tone occurrence restrictions. We will first outline some of the arguments supporting the segmental analyses (Henderson 1949; Leben 1971, 1973; Gandour 1974) which Yip (1980, 1982) rejected in favor of an autosegmental approach.

Leben argues for a segmental nature of Thai tones because tone may be dependent on vowel length. He points out one tone change phenomenon in Thai which is triggered by a vowel shortening rule. Assuming contour tones to be derived (Leben 1971; Gandour 1974), from the evidence that as a result of vowel shortening, the contour tone in the first element is neutralized to mid in the combinative speech style (cf. (2a)); while tone remains unaltered when vowel shortening does not apply (2b)[3], Leben concludes that there is a vowel shortening rule (VV->V) and a convention that simplifies HL or LH to a "compromised" mid tone, phonetically. Furthermore, in the cases of underlying level tone, e.g. a high level tone, no tone change results despite vowel shortening (2c).

(2) a. thîi nǎy   -> thi 'nǎy   'where?'

      sǐi khǎaw   -> si 'khǎaw 'white'

      sǎaw sǎaw   -> saw sǎaw 'young girls'

      wâaŋ wâaŋ   -> waŋ wâaŋ 'at your leisure'

  b. thâw ray   -> thâw ray   'how much?'

  c. náam chaa   -> nám chaa 'tea'

According to Yip, if tone is segmental, when a vowel deletes, tone should be deleted as well (LH->L or H) rather than a compromised mid tone (*M). She also cites Gandour's observation that elsewhere in the language, LH is converted to

H, as in *chǎn* -> *chán* 'I'; *phǒm* -> *phóm* 'I, male', and *khǎw* -> *kháw* (third person pronoun). Moreover, upon a close examination of Henderson's data, Yip found examples of HL tone on short vowels followed by a glottal stop or zero in sentence intonation such as *bâ(ʔ)*, *lâ(ʔ)*. Furthermore, Yip cites counterexamples which include cases of tone change accompanying vowel shortening with underlying *level* tones.

(3) yàaŋ rai   -> yaŋ ŋai 'how?'

  yàaŋ níi   -> yaŋ ŋíi 'this way, like this'

Due to the gaps in Henderson's data for the discussion in her article, Yip cannot offer a firm conclusion but suggests that the tone change in (3) may be morphological rather than phonological or it may be stress conditioned (not by complete absence of stress, like the neutral tone, but rather by secondary as opposed to main stress). This view is supported by Henderson's discussion of the neutral tone in unstressed syllables (1949: 37, fn. 27)

The actual pitch of the neutral tone may vary according to context, but is most commonly mid level.

Also, Henderson (1967) affirms that the stress in forms like (2a), such as *thîi nǎy* -> *thi' nǎy*, falls on the second syllable.

At this point, we would like to suggest treating the vowel shortening and tone change in (2) - (3) as postlexical phenomena which are caused by the stress pattern in Thai. Specifically, Thai is stress-final within a given phonological domain, i. e. a word, a compound, a phrase, or a sentence. Although the two processes usually cooccur as they usually take place in unstressed syllables, they are independent from each other as we may find tone change without vowel shortening (4a) and vice versa (4b).

(4) a. nǎŋ sʉ̌ʉ -> naŋ sʉ̌ʉ   'book'

  tháʔ lee -> tha lee   'sea'

máʔ ráʔ   -› ma ráʔ   'bitter melon'

kràʔ còk   -› kra còk   'mirror'

thoo ráʔ thát -›thoo ra thát   'television'

kaa láʔ mɛɛ -› kaa la mɛɛ   'a kind of sweet'

pray sàʔ nii -› pray sa nii   'post office'

b. taa plaa   -› ta'plaa 'callous (lit. eye+fish)'

   pàak kaa   -› pàk kaa 'pen (lit. mouth+crow)'

   yàaŋ nán   -› yàŋ ŋán 'that way, like that'

   yàaŋ níi   -› yàŋ ŋíi 'this way, like this'

The last example, yàaŋ níi -› yàŋ ŋíi, is found in Henderson as another variant of yàaŋ níi -› yaŋ ŋíi (cf. the last example of (3) above). It is cited as a counterexample in Yip 1982.

The preceding discussion of tone neutralization is disapproved of by Gandour who claims that acoustic results showed no evidence of such neutralization (though he eventually admits it in Gandour (1979: 140)). However, we, the native speakers of Thai (Warotamasikhadit 1967; Surintramont 1973) can hear the tone change which approximates the mid tone, although not exactly identical to underlying mid tone, and the shortened vowels which are not exactly equivalent to underlying short vowels, either. Given the nature of these postlexical rules which can be stylistic variants, and therefore optional, the inconclusiveness of the data is expected. Therefore, it may be safer to consider, as a point of departure, the nature of Thai tones in isolative speech. That is, we should concentrate on the tone on each syllable when pronounced in isolation or emphatically since these tones are truly lexical tones which occur at the lexical level in the terms of Lexical Phonology.

We turn now to isolative speech style. Gandour (1974: 138) proposes that the tone domain for each tone is a sonorant segment in syllable rime. That is, a syllable with $CV(V)C_s$ structure, where C_s = a sonorant coda (traditionally called "*live*" syllable), can have all 5 tones, while syllables checked

with a stop (henceforth, *checked* or *dead* syllables) have the tone distribution, formulated in Yip (1982: 89), as follows.

(5) CVC H *HL *LH L *M
  CVVC *H HL   *LH L *M

   A segmental analysis like Gandour's clearly explains the absence of LH and HL on short CVC, and the presence of HL on CVVC. However, he attributes the absence of LH on CVVC as due to universal performance reasons. Yip, on the other hand, contests that HL on short CVC, and CVVC with high level tone are found in words other than loanwords and onomatopoeia (although they are less common), and that LH on CVVC is found in other languages.

(6) k h á a t 'card' (Eng. loanword)

    but also p ɔ́ ɔ t 'a woman's nickname'

 k h l â k 'crowded, tightly packed'

   The only real gaps, according to Yip, are LH and M. (She also notes that the few apparent examples of LH are all intonationally derivable.) It must be noted that neither Gandour nor Yip can account for *M. Regarding the absence of LH, Yip proposed a universal condition that prohibits the configuration *LH? which applies to Thai, Zahao, and Cantonese. She claims a laryngeal feature such as syllable-final glottalization as the [p, t, k, ?] stops in Thai involve a glottal closure. Initially, these stops and [c] are glottalized. According to Yip, a segmental analysis cannot account for the existence of words like *khlâk* which bear two tones on one vowel. Neither can the segmental approach describe the lack of three tone sequences in forms with three sonorant segments. To circumvent this fact, Gandour posits a requirement that either the first and second segments be the same, or the second and third. In an autosegmental solution, however, the restriction is stated with less complications -- only two tones are permitted per syllable.

   Another argument for a segmental account given by Leben (1973: 34) is the fact that tones move with their vowels.

Evidence is drawn from a Thai word game where rimes interchange between syllables.

(7) kôn yàу   ->   kàу yôn   'big bottom'

Yip (1980: 11), however, argues for floating tones which remain stable despite segmental change, i.e. transposition of rimes, in another Thai word game (following Gandour's observation).

(8) klûay hɔ̌ɔm   -›   klɔ̂ɔm hǔay   'banana'

    tên ram   -›   tâm ren   'dance'

A segmental suggestion will fail to account for the lack of tone movement. An autosegmental proposal, on the other hand, can account for both phenomena. In (7), rime movement occurs before the mapping of the suprasegmental tones, whereas (8) shows segmental change after tone association.

Although two distinct rule orderings can give rise to two different language games (as in (7) and (8)), upon a scrutiny of more data, we find tone patterns that cannot be accounted for by Leben's or Yip's proposal since they show different tone patterns from those existing in the base forms.

(9) chí khaa kôo   ->a. ʔchôo khaa kí 'Chicago'
    H   M   HL   *HL   M   H
                      (rime change, then tone mapping)
                      b.*chóo khaa kî̂
                         H   M   *HL
                      (tone mapping, then rime change)
                      c.choo khaa kì
                         M   M   L
                      (resulting tones not in base form)

    khaa buu kì -> a. khì buu kaa 'Kabuki'
    M   M   L   L   M   M
                  (rime change, then tone mapping)
                  b. *khi buu kàa
                     *M   M   *L
                  (tone mapping, then rime change)

c. khí buu kà?
H   M   L
(resulting tones not in base form)

Following Burzio 1991, who proposes a well-formedness condition for English in cases where the ordering of certain phonological rules cannot yield a correct result, the situation in Thai here can be explained by resorting to tone well-formedness conditions (cf. details in section V below). The proposed well-formedness conditions on tone advocated in the present study, in turn, find support in tonogenesis and syllable structure (cf. sect. III).

II. Tonal onsets

Tumtavitikul 1991 argues for a combined segmental and suprasegmental approach. She demonstrates the inadequacy of positing floating tones alone by proving the fact that certain Thai consonants, in fact, carry underlying tones.[4] This is illustrated by suffixed examples such as *leekh + aa ->* *leekhǎa* 'secretary' vs. *rookh + aa ->* *rookhaa* 'disease, illness'. The two forms have identical syllable structures in the base forms, i.e. a long syllable closed by an aspirated stop, plus an *aa* suffix. The two forms also exhibit tonal differences when suffixed by a short vowel plus a stop consonant, e.g. *leekh + a? -> leekhà?* vs. *rookh + a? -> rookhá?*. According to her, even though we may posit a floating H and L tone on the two forms, respectively, at the right edge of the base morpheme, or at the left edge of the suffixes, we still cannot account for such variations. Thus, she spells out tone assignment rules in (10) (emphasis mine).

(10) a. For *all* voiceless fricative onsets and *some* voiceless aspirated stop onsets, Rising tone surfaces on unchecked syllables.
b. Elsewhere, unchecked syllables surface with Mid tone.
c. For all resonant onsets and *some* voiceless aspirated stop onsets, short checked syllables surface with High tone.
d. Elsewhere, checked syllables surface with Low tone.

e. Rising tone in (a) is derived.

The problems which arise in the above analysis are that various issues are left out unanswered. First of all, Tumtavitikul does not account for the fact that the long and short versions of the suffix, i.e. aa vs. aʔ, are merely the Thai phonological variants of the Indic short nominal suffix -a. Secondly, the tonal rules in (10) seem to be arbitrary. Moreover, there are no explicit ways to distinguish the two types of voiceless aspirated stop onsets in (10a) and (10c) or two distinct classes of voiceless fricative onsets. Failure to define these distinctions results in arriving at wrong predictions. For example:--we would not have a monosyllabic minimal pair such as *fǎn* 'to dream, a dream' vs. *fan* 'tooth'; or a tonal contrast on the second syllable in multisyllabic words such as *chàʔ nǔan* 'an electric insulator' vs. *cháʔ nuan* 'a slate for writing on; a fuse', and *chàʔ lǐaŋ* 'a verandah, a balcony' vs. *càʔ ria.ŋ* 'a woman's name'. Finally, the application of too many complicated phonological rules which interact with each other does not facilitate language acquisition.

Alternatively, an analysis which is based on phonetic-phonological correlations and tonogenesis as well as the morphology-phonology interface, utilizing well-formedness conditions on syllable structure and tone at each stage of word formation will be argued for to which we now turn.

III. Tonogenesis and phonetic-phonology correlations

It could well be argued for that each Thai word is morphologically marked for tone in the lexicon. However, regarding loanwords from nontonal languages such as Pali, Sanskrit, English, etc., how the borrowed words get tones is of particular interest. An examination of the Indic and Thai consonantal systems reveals the following facts :

i) There was a loss in the voicing contrast so that both the Indic voiceless aspirated stops and voiced unaspirated stops were neutralized to voiceless aspirated stops, i.e.

kh, g ->kh; ch, j-> ch; ṭh, ḍ->th; th, d->th; ph, b-> ph. The original distinction between the two classes of consonants, however, is preserved in the resulting distinct tonal consonant classes (cf. appendix and details below).

ii) Voiced aspirated stops were lost in Thai pronunciation, i.e. **gh, jh, ḍh, dh, bh-> Ø** .

iii) The asymmetrical distribution of Thai voiced unaspirated stops, i.e. ***g** but **d, b** can be explained as due to a later Thai creation and thus, was not involved in tonogenesis.

iv) Both the retroflex and the dental consonants are neutralized to dentals, **ṭ, t -> t; ṭh, th -> th; ḍ, d -> d (-> th); ḍh, dh -> dh (->th); ṇ, n -> n.**

v) Moreover, laboratory experiments show that tone change can be induced by onsets:

> ....voiceless oral obstruents produce high tone (or a higher variant of a tone) on the following vowel, whereas voiced oral obstruents produce low tone (or a lower variant) on the following vowel. (Haudricourt 1961, Cheng 1973, quoted in Ohala 1978: 25)

> ....high air flow after voiceless, especially voiceless aspirated, obstruents, and low air flow after voiced obstruents caused the high and low pitches, respectively. (Ohala 1973, and Ohala 1978: 26)[5]

> The available data suggest that pitch following voiced stops is substantially similar to that following sonorants and that it is the pitch following voiceless stops that is perturbed upwards. (Lea 1972, Hombert 1975, Jeel 1975, quoted in Ohala 1978: 29)

The lost voicing and aspiration contrasts are preserved in the different tones assigned to the consonants in question. Thus, during the evolution from a voiced unaspirated stop to a devoiced aspirated counterpart, two features were encoded as one extrapolated tone:-- namely, [-voice] -> H and [+spread] -> H, equivalently HH-> H. To distinguish original voiceless aspirated stops from devoiced aspirated stops which were already assigned a high tone (in addition to unmarked [-vc.,

-sprd] onsets -> default M), the single feature [+spread] of the original voiceless aspirated stops must take on a low tone as they are a lower variant between the two types of consonants. This is as outlined in (11) and (12), respectively.

(11)   [-voice] [+spread]   ->   HH   ->   H
                \ /
                 O

That is, high tone in Thai onsets was caused by the devoicing and the aspiration of voiced unaspirates (e.g. **g -> kh**). This also applies to sonorants since sonorants pattern like original voiced stops in tone asssignment (cf. point (v) above), and because of the loss of voicing contrast in voiced and voiceless sonorants in Thai.

(12)   [+spread]   ->   L
          |
          O

(12) should include also all aspirated voiceless segments, e.g. [**kh**], sibilants of Indic origin [ṣ, š, s -> s], and the segmentless voiceless glottal fricative [**h**].

Contrary to Hombert 1978, Hock (1985: 98) states that "Both onset and post-nucleus consonants can induce tone, but onset consonants have a greater effect." The Thai data confirms Hock's claim in unmarked cases. For marked cases such as in checked syllables, we postulate that the glottalized feature of final stops [**p, t, k, ʔ**] in Thai has an effect on tone because these stops involve a glottal closure. Syllable-initially, these stops and [**c**] are glottalized while at the end of a syllable, they are unreleased stops, and therefore can increase syllable weight which in turn, can cause a low tone.[6] The formulation is as follows.

(13)   [-continuant]   ->   L
           |
           R

IV. Objectives
This paper seeks to answer the following questions via the use of phonetic-phonological explanations in the Feature

Geometry Theory (Clements 1985; Sagey 1986; Bao 1990; Duanmu 1990), the Autosegmental approach, and Burzio's 1991 Well-formedness Condition as an amendment to previous research.

i) *How is tone influenced by syllable structure?* Specifically, why only heavy (or checked) syllables have tone occurrence restrictions as in (5), reproduced in (14).

(14) | CVC | H | *HL | *LH | L | *M |
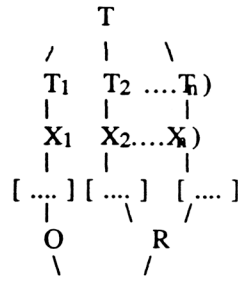 |------|-----|-----|-----|---|----|
     | CVVC | *H | HL | *LH | L | *M |

In addition to Yip's counterexamples to ***HL on CVC and *H on CVVC**, explanations will be given as to why these occurrences are marginal. Moreover, Yip's universal prohibition of the ***LH?** configuration will be explained. Finally, ***M** will also be accounted for with the same principle.

ii) *Why is a modular approach to Thai tonology preferred?* This is because within Feature Geometry Theory, the segmental analysis can be restated in autosegmental terms. With each phonetic feature constituting a separate tier from, but interactive with, the segmental and the tonal tiers, we can achieve an optimal analysis of tone assignment and tone change in the formation of native Thai words along with foreign loans, language games, and sentential tonology. That is, Thai tone must be assigned and reassigned according to the syllable structure of Thai words at every stage of derivation, from isolated lexical words to units larger than words or postlexical units.

iii) *How can stress interact with tone assignment?* Tone assignment and reassignment will be seen as an adaptation of Thai lexical and prosodic stress to accommodate different stress patterns of the donor languages.

V. Well-formedness Conditions, syllable structure and tone assignment

In this analysis, Thai syllables are proposed to be of two types:--*light* vs. *heavy* syllables--with the former containing [+continuant] rime, and the latter, [-continuant]. All short vowels are treated as followed by a glottal stop and long vowels are represented as sequences of two identical vowels. It will be argued for here that the tone bearing units (TBU's) in

Thai can be any segment in the syllable. Moreover, unlike previous proposals which utilize a noncyclic approach, this study will show that tone assignment in Thai is cyclic both at the syllabic and the morphological levels (cf. (15) and section VI). That is, tone is first assigned according to the phonetic properties of the onset of a syllable which constitutes the first tonal domain, represented here by a right bracket. Unspecified onsets induce mid tone which is also an unspecified or default tone. Devoiced aspirated onsets, on the other hand, raise the tone of the syllable to H (rule (11)) whereas original voiceless aspirated onsets are assigned L tone (rule (12)). Upon incorporation of each new segment in the syllable, a subsequent tonal domain is created (i.e. from tonal domain 1, 2... to T_n), while previously assigned tones are erased and a new tone is assigned in accordance with the [+/- continuant] feature of the new rime segment. That is, in marked cases, a rime-final   [-cont] segment induces L tone (rule (13)) while M is the default tone for unmarked [+cont] rime. The generation and regeneration of tone is seen in (15) where the association line is truncated and readjoined between the tonal tier (T's) and the segmental tier (X's) when each element is integrated in the syllable, from onset (O) to rime (R), thereby creating a gradually larger tonal domain. We show the tone assignment of a Thai native word **raa** 'mold' in (16). [r] is first assigned a H tone. Then, [a] is integrated with a new tone M assigned because [a] is [+cont]. The preceeding L tone is thus dissociated. When the final segment is incorporated into the syllable, the second tone is replaced by the final tone.

(15) Tone Assignment: T   ->

$$
\begin{array}{c}
\text{T}\\
\diagup \quad | \quad \diagdown\\
\text{T}_1 \quad \text{T}_2 \ldots \text{T}_n)\\
| \qquad | \qquad |\\
\text{X}_1 \quad \text{X}_2 \ldots \text{X}_n)\\
| \qquad | \qquad |\\
[\,\ldots\,]\,[\,\ldots\,]\quad[\,\ldots\,]\\
| \qquad \diagdown \quad \diagup\\
\text{O} \qquad \text{R}\\
\diagdown \quad \diagup\\
\sigma
\end{array}
$$

(16)
$$
\begin{array}{ccc}
\text{T} & \text{T} & \text{T}\\
| & | \quad \diagdown & \diagup \quad | \quad \diagdown\\
\text{H}) & \text{H} \quad \text{M}) & \text{H} \quad \text{M} \quad \text{M})\\
| & | \quad\quad | & | \quad\quad | \quad\quad |\\
\text{r}) & \text{r} \quad \text{a}) & \text{r} \quad \text{a} \quad \text{a})\\
\text{[+son]} & \text{[+son] [+cont]} & \text{[+son] [+cont][+cont]}\\
| & | \quad\quad | & | \quad\quad \diagdown \quad \diagup\\
\text{O} & \text{O} \quad \text{R} & \text{O} \quad\quad \text{R}\\
& \diagdown \quad \diagup & \diagdown \quad \diagup\\
& \sigma & \sigma
\end{array}
$$

Hence, for light syllables which have unmarked syllable structures, the default tone is mid unless specified otherwise in the lexicon. Consequently, the unmarked syllable structure allows its association with any one of the five lexical tones, the choice of which is lexically governed, and is reflected in the use of an explicit tone marker in the language. Heavy syllables, on the contrary, are subject to a well-formedness condition in Thai which prohibits mid tone (cf. (17a)). This is due to the fact that unlike sonorant codas which pattern like vowels, stop codas constitute heavy syllables and for the purpose of tone assignment, this heavy weight exerts itself in a low tone. Another well-formedness condition (17b) prohibits that no Thai segments contain more than one tone.

(17) Well-formedness Conditions:

a. Prohibition of Mid Tone:

$$
\begin{array}{c}
\text{*M)}\\
|\\
\text{[-cont])}\\
| \quad\quad | \quad \diagup\\
\text{O} \quad \text{R}\\
\diagdown \quad \diagup\\
\sigma
\end{array}
$$
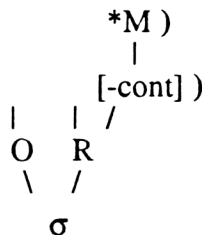
b. Tone Restriction: only *one* tone can be associated to a segment:
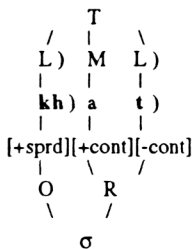
$$*T \quad T)$$
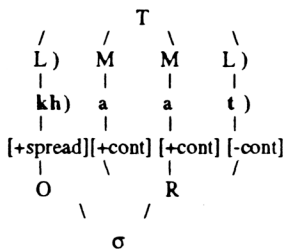$$\backslash \quad /$$
$$X$$
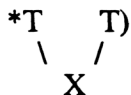
The fact that contour tones exist in Thai syllables is due to the preservation of previously assigned tone when the onset contains either the dual [-voice] and [+spread] feature or [+spread] alone. That is, the bracket erasure convention does not apply in these cases and therefore, two tones are assigned, one to the onset, and the other eventually to the coda. For low tone, since both the onset and the final segment bear non-distinct low tones, the two low tones are fused into one -- LL -> L (cf. (18a). For rising tone, there is an additional contour tone exaggeration effect whereby the LM tone sequence is enhanced to LH for maximal audibility (cf. (18b)). Thus, the cyclic tone assignment (15) and the well-formedness condition (17b) account for contour tones in short and long syllables.

(18) a. Low Tone in CV(V)C Structures :   Tone Conflation: LL -> L

i.   k h à t 'scrub'   ii.   k h à a t   'broken'

```
        T                               T
      / |  \                         /  /  \   \
    L )  M  L )                     L )  M   M   L )
    |    |   |                      |    |   |    |
    kh ) a   t )                    kh)  a   a    t )
    |    |   |                      |    |   |    |
 [+sprd][+cont][-cont]        [+spread][+cont] [+cont] [-cont]
    |     \   /                      |     \   |    /
    O      R                         O          R
     \    /                           \        /
       σ                                 σ
```

b. Rising Tone in CV(V)C Structures :   Contour Exaggeration: LM -> LH

i.   k h ǎ n 'bowl or basin used for dipping water'   ii. k h ǎ a n 'to call in reply'

```
        T                                   T
      / |  \                             /  /  \   \
    L )  M  M )                         L )  M   M   M )
    |    |   |                          |    |   |    |
    kh ) a   n )                        kh)  a   a    n )
    |    |   |                          |    |   |    |
 [+sprd][+cont][+cont]           [+spread] [+cont] [+cont] [+cont]
    |     \   /                          |     \   |    /
    O      R                             O          R
     \    /                               \        /
       σ                                     σ
```
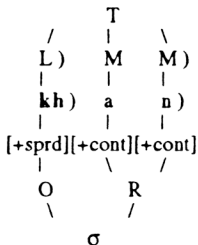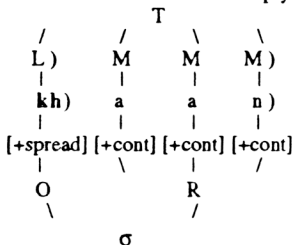
We turn now to the high tone in CVC and the falling tone in CVVC structures. High tone is first assigned to a devoiced aspirated onset. Because of the highly marked feature [-voice, +spread], the already assigned high tone is kept while integration of the remaining segments of the syllable generates an additional low tone in agreement with the stop coda. The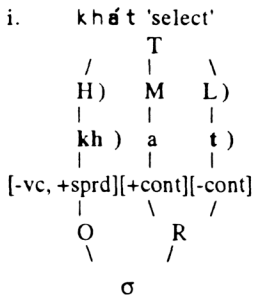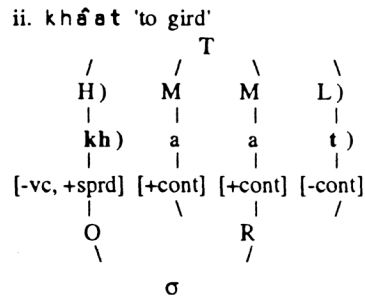 outcome is HL but due to the shortness of the heavy syllable, the final tone is not integrated, except in very few intonationally derivable lexical words. However, in long heavy syllables, either option is available. With the preservation of the final low tone, the syllable contains a falling tone as found in most Indic loanwords. In most English loans, in contrast, in response to the need to distinguish English words from already established Thai words, including Indic loans, the final low tone is simply dropped.

(19) a. <u>High Tone</u>:

i.   k h á t 'select'

```
            T
        /   |   \
      H)    M    L)
      |     |    |
      kh )  a    t )
      |     |    |
   [-vc, +sprd][+cont][-cont]
      |      \      /
      O        R
        \    /
          σ
```

b. <u>Falling Tone</u>:

ii. k h â a t 'to gird'

```
                T
        /     /    \     \
      H)     M      M      L)
      |      |      |      |
      kh)    a      a      t )
      |      |      |      |
  [-vc, +sprd] [+cont] [+cont] [-cont]
      |        \       |      /
      O                R
        \            /
              σ
```
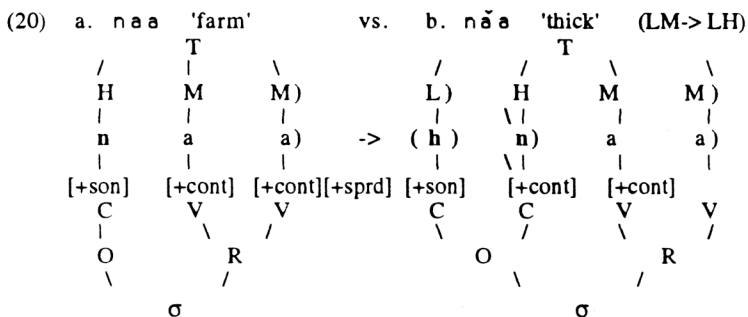
VI. Evidence

Tone forms an autosegmental tier as it can be separated from the segmental tier. However, the tone autosegment is linked to individual segmental features as in the Feature Geometry Theory. Evidence is found both on phonological and morphological grounds. We will first look at three types of cluster onsets:-- a) clusters with a segmentless tonal onset [h]; b) true cluster onsets; and c) unparseable cluster onsets.
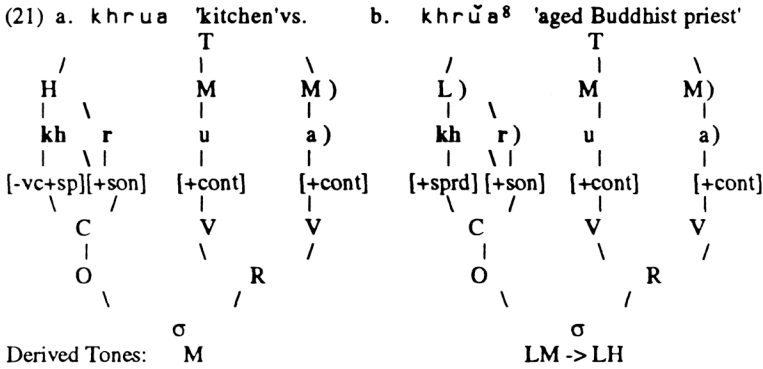
i) **Phonological Evidence**   Thai has one segmentless tonal onset which is a voiceless glottal fricative [h] with the feature [+spread]. Like all other aspirates which are [+spread], it bears a L tone. If tone were segmental, it would be impossible to convert the high tone to low in short heavy syllables with a sonorant onset just by adding this

segmentless [h] to the onset, e.g. **mát (H)** 'to tie' vs. **hmat (L)** [màt] 'fist' because this segment does not manifest itself phonetically. A rising tone obtained by adding this segmentless onset to a sonorant within the initial cluster would be impossible, too, e.g. **naa (M)** 'farm' vs. **hnaa (LH)** [nǎa] 'thick'.[7] (20) shows the elimination of the stranded consonant [h] from an unpronounceable Thai cluster [hn]. Despite the suppression of [h] from the segmental tier, its tone is not deleted and has the spreading effect onto the following onset. The well-formedness condition (17b) ensures that only one tone is assigned to the sonorant after spreading; thus, the tonal feature [H] of the sonorant must be dropped.

a. Segmentless Tonal Onset:

```
(20)  a.  naa   'farm'         vs.   b.  nǎa   'thick'    (LM-> LH)
          T                              T
      /   |    \                     /    /    \    \
      H    M    M )                  L )   H    M    M )
      |    |    |                    |    \ |   |    |
      n    a    a )     ->          ( h )  n)   a    a )
      |    |    |                    |    \ |   |    |
   [+son] [+cont] [+cont][+sprd] [+son]  [+cont] [+cont]
      C    V    V                    C     C     V    V
      |     \   /                     \    /      \   /
      O      R                        O            R
       \    /                          \          /
         σ                               σ
```

b. True Cluster Onsets: True cluster onsets are those which share the same C-slot underlyingly and therefore, do not permit vowel insertion to break the cluster. As such, only the first member in the cluster can attract tone while no tone can be assigned to the second member. In (21a), high tone is assigned to [kh] according to the features [-voice, +spread]. Because [r] is not provided with an independent C-slot, it cannot bear tone but receives the high tone from its partner through spreading. Likewise, the feature [+spread] triggers low tone in (21b) and spreads onto [r]. If tone were segmental alone, there would be no way to explain the single tone assigned to true cluster onsets.

(21) a. k h r u ɐ 'kitchen'vs.   b.   k h r ŭ ɐ[8] 'aged Buddhist priest'

```
              T                                    T
        /     |     \                        /     |     \
        H     M     M )                      L )    M     M )
      |  \    |     |                      |  \     |     |
      kh  r   u     a )                    kh  r )  u     a )
      |  \ |  |     |                      |  \ |   |     |
  [-vc+sp][+son] [+cont]  [+cont]      [+sprd][+son] [+cont]  [+cont]
      \   /    |     |                      \   /    |     |
        C      V     V                        C      V     V
        |       \   /                         |       \   /
        O       R                             O       R
          \    /                                \    /
            σ                                     σ
Derived Tones:   M                           LM -> LH
```

c. **Unparseable Cluster Onsets:** For consonants that cannot form an initial cluster in Thai, then, either the second member is dropped, e.g. sr -> s; cr -> c, or a default vowel [aʔ] is inserted to break the cluster to accommodate the Thai pronunciation, e.g. chn -> chàʔ-n. Before vowel epenthesis, however, the features of the first member of the cluster are collocated onto the second member, i.e. [-voice, +spread] of [ch] on [n] in (22a) and [+spread] in (22b), respectively. Thus, H and L tones are assigned to (22a) and (22b), in that order.
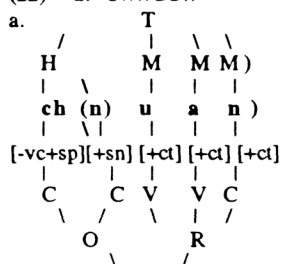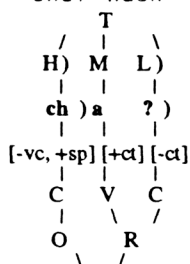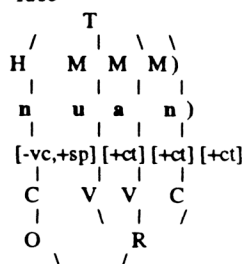
(22) a. chnuan → chá? nuan 'fuse'

```
a.        T              →          T                    T
      /   |  \  \                /  |   \           /   |  \  \
     H    M  M M)              H)  M   L)          H    M  M M)
     | \  |  | | |             |   |   | |         |    |  | | |
    ch (n) u  a n )           ch  )a   ? )         n    u  a n )
    |   \| |  | | |            |   |   | |         |    |  | | |
 [-vc+sp][+sn][+ct][+ct][+ct] [-vc,+sp][+ct][-ct] [-vc,+sp][+ct][+ct][+ct]
   |    |   |  |  |            |    |    |          |    |   |   |
   C    C   V  V  C            C    V    C          C    V   V   C
    \  /  \   | /               |   \  /            |   \  |  /
      O      R                  O    R              O       R
       \    /                    \  /                \     /
         σ                        σ                    σ
Derived Tones:   M              HL -> H               M
```

b. chnuan → chà? nŭan 'insulator'
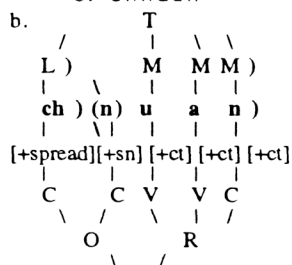
```
b.        T              →          T                    T
      /   |  \  \                /  |   \           /   |  \  \
     L )  M  M M)              L ) M   L)          L )  M  M M)
     | \  |  | | |             |   |   | |         |    |  | | |
    ch )(n) u  a n )          ch  )a   ? )         n )  u  a n )
    |   \| |  | | |            |   |   | |         |    |  | | |
 [+spread][+sn][+ct][+ct][+ct] [+sprd][+ct][-ct]  [+sp][+ct][+ct][+ct]
   |    |   |  |  |            |    |    |          |    |   |   |
   C    C   V  V  C            C    V    C          C    V   V   C
    \  /  \   | /               |   \  /            |   \  |  /
      O      R                  O    R              O       R
       \    /                    \  /                \     /
         σ                        σ                    σ
Derived Tones:  LM -> LH        LL -> L             LM -> LH
```
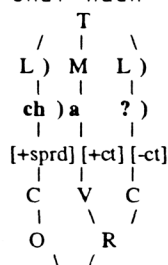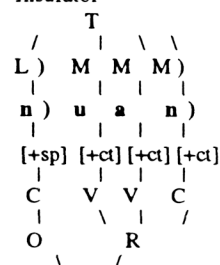
ii) Morphological Evidence Tonal consonants clearly manifest themselves in derived words through the infixation of **am (n)** (23), lexical derivation (24-26), and language games (32).

a. am (n) Infixation: A limited number of monosyllabic words become bisyllabic via **am (n)** infixation. Such an infixation is no longer operative in the Thai language and its idiosyncrasies must be recorded in the lexicon since the base for the **am (n)** infixation can be of any lexical category and the derived form usually maintains a synonymous or related meaning to that of the base form while the lexical category of the base may or may not be altered in the derived form. Examples are: -- s(r)èt 'to finish'-› s+ăm+ rèt 'to succeed'; t(r)ùat 'to check' -› t+am+ rùat 'police'; dəən 'to walk'-› d+am+ nəən 'to proceed; (Royal vocabulary) to walk'; khróp 'to complete' -› k+am+ róp 'time (as in "cycle")'; pràap 'to get rid of' -›

b+am+ ràap 'to subdue'; pruŋ 'to improve'->
b+am+ ruŋ 'to support'; tràt 'to speak (Royal
vocabulary)'-> d+am+ ràt 'to speak (Royal
vocabulary)'. For the first example, the cluster [sr] does not
form a true cluster onset in Thai since each consonant takes a
separate C-slot. Because the [r] is deleted from the cluster, it
allows the spreading of [+spread] from the first member of the
cluster onto the second member before **am (n)** infixation. The
tone in the infixed form is thus as predicted. (The changes p-
>b and t->d are explained in section III pt .(iii) above.)

(23) i)   s (r)èt   ->   s +ǎ m + rèt   'succeed'

Derived Tones: LL -> L   LM -> LH   LL -> L
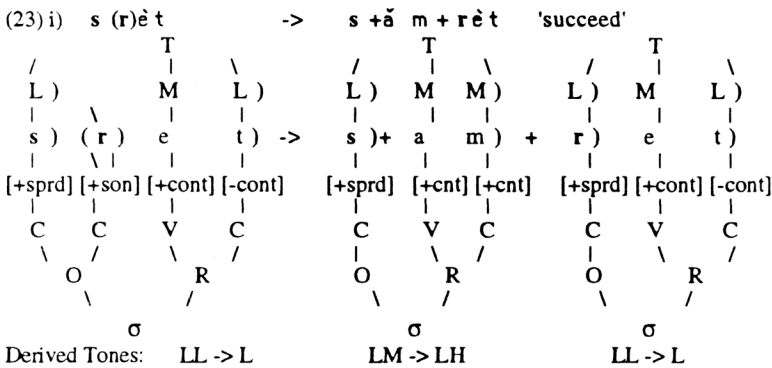
Only through an autosegmental analysis which permits
spreading can we arrive at a consistent explanation regarding
the retention of the tone of the base forms in the second
syllable of the derived words while the first syllable acquires a
new tone according to its phonological constructs. Moreover,
it allows the lack of tone sandhi in forms like sr̩ǔan ->
s+ǎm+ ruan 'laugh'; sǐaŋ -> s+ǎm+ niaŋ 'voice'.
In the latter cases, we can claim that am(n) infixation applies
first and therefore, bleeds spreading. Finally, for words that
are clearly marked with a lexical tone via the use of a tone
marker such as càay 'pay' -> c+am+ nàay 'distribute'
, it is evident that since the lexical tone is not part of the
syllabic structure, the lexical tone must then be retained in the
second syllable, leaving the first syllable free to obtain tone as
conditioned by its own syllable structure.

b. Derived Lexical Items: Most Indic loanwords suffered the following morpho-phonological changes: i) final vowel (plus nasal) truncation[9] (followed by cluster simplification, when applicable, and final stop neutralization to unreleased **p, t, k** stops; or **l, r -> n**); ii) otherwise, the final vowel is retained, either as a long vowel or as a short vowel accompanied by a glottal stop, primarily in suffixed forms and compounds.

In general, the Indic -a suffix is truncated in Thai. The following examples are from Pali (unless indicated otherwise) although the same set of rules applies also to Sanskrit: kul+a (-> kul) -> kun 'family'. (The intermediate stage of derivation is given in parentheses.) The distinct tone patterns are regulated by Thai syllable structure. Specifically, tone evolved from the loss of certain Indic phonetic properties of the onset and the new rime structures in the Thai language as discussed above, e.g. raṭṭh+aṁ -> rát 'country'; raaṣṭr+a (Skt.) -> râat 'country'; šaastr+a -> sàat 'science/art'; narak+a -> na rók 'the great hell'; jan+a -> chon 'the public; people', the last two examples exhibit an additional vowel change [a->o] word-finally in most Indic loans. (24) shows the effect of syllable structure on tone in simple loanwords with final vowel truncation.

i) Final Vowel Truncation:

(24) a. raṭṭhaṁ[10] (Pali)   ->   rát   'country'

```
a.     T              T   ->            T
     /  |  \      /   |  \          /   |   \
    H)  M  L)    L )  M  M )      H )  M  L )
    |   |  |     |    |  |        |    |   |
    r ) a  ṭ ) ṭh )  a  ṁ )      r )  a  t )
    |   |  |     |    |  |        |    |   |
[+son][+ct][-ct]  [+spr][+ct][+ct]  [+son][+ct][-ct]
    |   \  /     |    \  /        |    \   /
    O    R       O     R          O     R
     \  /         \   /            \   /
      σ            σ                σ
Derived Tones: HL->H and  LM -> LH      vs.  HL->H
```

b. raaṣṭra (Skt.)   ->   râat 'country; citizen'

```
b.       T                T       ->            T
     /  /  \  \       /        \   \        /  /  \  \
    H)  M  M  L )  M          M   L )     H ) M  M  L )
    |   |  |  |    |    \      |   |       |   |  |  |
    r ) a  a  ṣ )  ṭ    r      a   ? )     r ) a  a  t )
    |   |  |  |    |    \ |    |   |       |   |  |  |
[+son][+ct][+ct][-ct]  [...][+sn][+ct] [-ct]  [+son][+ct][+ct][-ct]
    |   \  |  /     \   /      \   /       |   \  |  /
    O      R        O     R     R          O      R
     \    /          \   /   \   /          \    /
       σ               σ                      σ
Derived Tones: HL and L          vs.          HL
```

The preservation of the suffix -a is less common and requires various adjustments. Despite the fact that Thai does not have comparable stress to the type of stress found in stress languages like English, Pali, and Sanskrit, Thai stress can be detected solely via its influences on stress-related phenomena such as tone and vowel length. Stated differently, given that the tone and the vowel length of each word in Thai are lexical as they constitute semantic differences, these tone and vowel length contrasts must be encoded in the lexicon. In addition, each lexical word has a potential to bear stress in a slow, emphatic speech. The capability to bear tone, vowel length contrast, and stress applies both to mono- and poly-syllabic words, in the optimal cases. By implication, this means that each syllable in poly-syllabic words can bear the tonal, vocalic, and stress distinctions as well. However, in normal speech, not all syllables or words are pronounced with equal

force or stress as regulated by the prosodic rhythmic patterns. We postulate that within a phonological domain, Thai primary stress falls on the last syllable, and the secondary stresses alternate with unstressed syllables. When a non-final syllable is destressed, it can cause vowel shortening and/or mid-tone neutralization as seen in (4a) above. The shortening of the short vowel [a] which, in Thai, must be accompanied by a glottal stop, is carried out by the deletion of the glottal stop. Our hypothesis that Thai is stress-final within a given phonological domain is corroborated by the fact that a glottal stop can be deleted in non-final, unstressed position, as in má? rá? -> ma rá? (with an additional mid-tone neutralization on the unstressed syllable) but it can never be dropped word-finally as shown in the ill-formedness of má? rá? -> *ma? ra or *ma ra. In effect, stress in Thai falls on the final position of a phonological domain, i.e. on the final syllable of a word, at the lexical level where lexical words are being constructed, or on the last syllable of a phrase at the sentential or postlexical level. This is due to the fact that the final syllable of the stress domain in Thai is heavy by position. The final stress in Thai overrides the stress patterns in the donor languages, which for Pali and Sanskrit may fall either on the stem or the suffix; and for English, either on the final or non-final syllable. As such, the domain-final syllable in Thai must contain at least two moras or a two-segment rime, so that the final syllable can bear stress. To render the short Indic suffix with a plain short vowel in Thai would violate the syllable-structure requirement. Consequently, the Indic short vowel must be lengthened or a glottal stop must be added to preserve the heavy weight assigned to the stressed position. This effect is attested in many doublets in Thai. For example: raaj+a -> raa ch+aa / raa ch+á? (or râat) 'king'; kaay+a -> kaa y+aa / kaa y+á? (o r kaay) 'body'; geh+a -> khee h+ăa / khee h+à? 'house'. The choice between the final vowel truncation, its lengthening, and the glottal stop insertion is arbitrary and thus, must be marked in the lexicon. In certain instances, the resultant distinct forms are all employed to denote different lexical meanings, e.g. likh+a (cf.

likh+ati) 'to write' -> lee kh+ăa 'secretary (=one who writes)' vs. lêek 'arithmetic (=written numbers)'; sukh+a 'happiness' -> su kh+ăa 'toilet (=happy place)' vs. sùk 'happiness'. Word-final glottal stop is retained only in emphatic speech or in Indicized contexts, e.g. su kha? in the Buddhist blessing-- ?aa yú wan ná? su khà? phá? lá? 'longevity, growth, happiness, and health'.

ii)   Indic   Suffixation   and   Vowel Lengthening: The effect of suffixal vowel lengthening is illustrated in (25).

(25) a.leekh + aa (Skt.) 'secretary'   vs.   raaj+ aa (Skt.) 'king'

b.sukh + ii (P) '(the) happy, blessed (one)' vs.   rookh + ii (P) '(the) sick '

```
         T                T                   T                 T
      /  |  \          /  |  \             /  |  \           /  |  \
     L ) M  L )      L ) M M )           H  M  M )         H     M M )
     |   |  |        |   |  |            |  |  |           |     |  |
     s ) u  ? )     kh ) i  i )          r  o  o )        kh     i  i )
     |   |  |        |   |  |            |  |  |           |      |  |
  [+spr][+ct][-ct] [+spr][+ct][+ct]  [+son][+ct][+ct]  [-vc,+sp][+ct][+ct]
     |   \  /        |   \  /            |  \  /           |      \  /
     O      R        O      R            O     R           O        R
      \    /          \    /              \   /             \      /
        σ                σ                  σ                 σ
```
Derived Tones: L and LM -> LH   vs.   M   and   M

The distinct tonal patterns caused by different syllable structures are most evident in the Thai reading of original Indic suffixed forms, e.g. Pali: khattiya -> khàt. tì? yá? (m.) 'man of the warrior caste' vs. khattiyaa -> khàt. tì? yaa, khattiyaanii -> khàt. tì? yaa nii (f.) 'woman of the Khattiya clan'; naaga -> naa khá? (m.) 'cobra, elephant; iron-wood tree; noble person' vs. naagii -> naa khii, naaginii -> naa khí? nii (f.) 'female cobra, female elephant; noble woman'.

Our postulation of syllable weight received from word-final stress is further corroborated by the fact that when simple words are compounded, neither an epenthetic long vowel nor a glottal stop are needed since the final syllable of the first member of the compounds is no longer stressed as the new stress domain is the last syllable of the entire compound. As a result, the tone of the unstressed syllable is neutralized to mid as observed by previous researchers (cf. (2-4) above). In emphatic speech, however, where all syllables are stressed, the glottal stop is retained and triggers an appropriate tone assignment according to the new syllable structure, e.g.

jan+a + pad+a (people+path) 'country-side' - >

chon+á + bȯt (emphatic speech) vs. chon+a +bȯt (normal speech); or when the second member of the compound nouns begins with a vowel, e.g. jal+a (Skt.) 'water' + aalay+a (Skt.) 'dwelling, house' -> chá? laa lay (emphatic speech) vs. cha laa lay (normal speech).

iii) **Indic Compounds:** Thai has borrowed heavily from the Indic vocabulary through Thai nativization processes. We will first demonstrate simple words borrowing. Examples are provided in (26a-b). The adaptations of certain phonemic sounds to fit the Thai phonetic inventory, e.g. dental and sibilant neutralizations, aspiration and devoicing of stop consonants (cf. section III above), where applicable, are all shown in step ∅ of (26a-b) below, since no ordering relation is assumed among these phonological rules. For each borrowed lexical item, the Indic syllabification is shown in step 1. Being a tonal language, Thai assigns tone according to the syllable structure and the historical phonetic properties of both the onset and rime (step 2). Final nasals are deleted (step 3). When a segment is deleted from a syllable, several adjustments are underway. First, as noted by Thai researchers, all syllables in Thai are closed by either a sonorant or a stop, including a glottal stop. This glottal stop may be deleted in unstressed position. However, since the stress domain of Thai words is the final syllable, a bare short vowel may not surface in word-final position. Consequently, no tone can be placed or retained on the ill-formed syllable structure (cf. the output after the word-final nasal is deleted *thǎ in rát.*thǎ in step

3). To remedy the situation, a glottal stop is inserted (step 4) which in turn, calls for tone reassignment since the stressed, checked syllable conditions a low tone in unmarked cases (step 5), unless the onset is marked as [-voice, +spread].

(26)a.raṭṭhaṁ (Pali)->rát	'country'
ø.raṭṭhaṁ->ratthaṁ	Dental Neutralization
1.ratthaṁ->rat.thaṁ	Syllabification
2.rat.thaṁ->rát.thăṁ	Tone Assignment
3.rát.thăṁ->rát.*thă	Final Nasal Deletion
4.rát.*thă->rát.*thă?	?-Insertion
5.rát.*thă?->rát.thà?	Tone Reassignment

The derivation in (26b) is in a similar fashion. Step ø denotes the neutralization of all sibilants. Syllable structure is assigned in step 1 followed by tone assignment in step 2 which succeeds only in the first syllable while the second syllable is devoid of any tone since its syllable structure is not permitted in Thai. Step 3 illustrates the non-applicability of the nasal deletion rule since the word in question does not contain a word-final nasal. Syllable adjustment by the insertion of a glottal stop takes effect in step 4 so that tone can be placed on the final syllable in step 5.

b.šaastra (Skt.)->sàat	'science/art'
ø.šaastra->saastra	Sibilant Neutralization
1.saastra->saas.*tra	Syllabification
2.saas.*tra->sàas.*tra	Tone Assignment
3. - -	Final Nasal Deletion
4.sàas.*tra->sàas.tra?	?-Insertion
5.sàas.tra?->sàas.trà?	Tone Reassignment

The outputs at this stage of the derivation serve as inputs to compounding. Step 6 illustrates the juxtaposition of two or more simple words. The glottal stop of the first member of the compound is deleted in step 7 because it no longer stands at the edge of the word since the word boundary

is now extended to cover the entire compound. Consequently, the previously-assigned tone is also removed as a consequence of loss of stress in non-final position. The elimination of glottal stop and mid-tone neutralization are also found at the postlexical or sentential level where words are put together to form phrases or sentences.

c.rát.thà? + sàas.trà?->rát.tha sàat
                'political science'
6.rát.thà?+sàas.trà?->rát.thà? sàas trà?
                Compound Formation
7.rát.thà?+sàas.trà?->rát.thà sàas trà?
                Non-final ? Deletion
8.rát.thà?+sàas.trà?->rát.tha sàas trà?
                Mid-Tone Neutralization

Most simple words (cf. (26' a-b)) and compound lexical items (cf. (26' c) entered the Thai lexicon with the truncation of the final vowel (and glottal stop) (step 9), followed by the resyllabification of the remaining phonetic material (step 10), cluster simplification (step 11), final stop neutralization (step 12), and tone reassignment in accordance with a new syllable structure (step 13) in case a different syllable structure is derived.

(26') a.rattham̐ (Pali)->rát   'country'
9.rát.thà?->rát.th   Final Vowel (and ?-)
                              Truncation
10.rát.th->rátth.   Resyllabification
11.rátth->rát   Final Cluster
                              Simplification
12.   -   -   Final Stop Neutralization
13.   -   -   Tone Reassignment

b.šaastra (Skt.)->sàat   'science/art'
9.sàas.trà?->sàas.tr   Final Vowel (and ?-)
                              Truncation
10.sàas.tr->sàastr.   Resyllabification

11.sàastr->sàas   Final Cluster
                           Simplification
12.sàas->sàat   Final Stop Neutralization
13.   -   -   Tone Reassignment

    c.rát.thà? + sàas.trà?-> rát.tha sàat
                          'political science'
9.rát tha sàas.trà?->rát tha sàas.tr
                        F. V (& ?-)Truncation
10.rát tha sàas.tr->rát tha sàastr.
                        Resyllabification
11.rát tha sàastr->rát tha sàas
                        F. Cluster Simplification
12.rát tha sàas->rát tha sàat
                        F. Stop Neutralization
13.   -   -   Tone Reassignment

c. Language Games Involving Foreign Loans Interactions between morpho-phonological structures and stress are most evident in tone assignment to foreign loanwords in language games (see section VIII below). We will attempt at a schematic characterization of Thai tone in language borrowing in the paragraph immediately below. (For a full discussion of Thai tonal adaptation of loanwords from both tonal and non-tonal languages such as Chinese, English, and Japanese, the reader is referred to Wong-opasi (in preparation).)

VII. Tones in Foreign Loanwords

     Gandour 1979 offers an insightful analysis of Thai tones in English loanwords in which he attributes the tonal development in English loans to the interactions between syllable structure and stress patterns of both English and Thai. Following Gandour, we exemplify the Thai tonal patterns in three classifications of words:--monosyllables, bisyllables, and polysyllables.

     i. Monosyllables Tone is assigned based on the underlying syllable structures of English. That is, unchecked

syllables receive the M tone while checked syllables acquire the H tone, e.g. cream ->khriim; share -> chɛɛ; free -> frii vs. jet -> cét; soup -> súp; card -> kháat; cake -> khéek. The underlying structure of English syllables is crucial to understand the counterexamples of a H tone on surface unchecked Thai syllables such as bank ->bén; pump -> pám and pipe -> páy; mouse (as in 'computer mouse') -> máw. In effect, tone is assigned first according to the English syllable structures before cluster simplification to avoid violations of Thai syllable structure constraints which prohibit word-final clusters containing two consonants in a row (*CVCC) or a diphthong followed by a consonant (*CVGC) as the above examples reveal.

ii. Bisyllables The intervention of stress in tone assignment is more obvious in words with more than one syllables. For penultimate stress which produce a falling tone on the final syllable, e.g. vísa ->wii sâa; párty -> paa tîi; dóctor -> dɔ́k tɛ̂ə, Gandour provides an explanation in (27).

(27) The stressed-unstressed English pattern correlates with a falling pitch contour. Since Thai rhythm requires that the last syllable in a phrase be stressed, it would appear that the falling pitch contour has been preserved in the Thai pronunciation, but that the point of the fall has beeen shifted to the final syllable in accordance with Thai rhythmic constraints. (Gandour 1979: 137)

However, the HL pitch pattern is rendered in two different ways in final checked syllables, namely, as L or H, e.g. crédit -> khree dìt; pássport -> pháat sa pɔ̀ɔt vs. bónus -> boo nát; sándwich -> sɛɛn wít. To account for these discrepancies, Gandour attributes them to competing strategies in tone assignment:-- phonetic vs. non-phonetic motivations like English orthographic influences.

In contrast, the correlations between ultimate stress and the mid tone, e.g. shampóo -› chɛm phuu; hotél -› hoo ten, are described as follows:

(28)   These English source words have an overall rising stress pattern, the second syllables being comparatively higher in pitch than the first, and longer. If these words were to be adapted with the falling tone of the second syllable, the resultant tonal pattern would be considerably different from the perceived stress pattern. Thus, the final syllables of these bisyllabic words are assigned a mid tone which results in a closer approximation to the English stress pattern.

The tonal adaptation in (28) is not without exceptions as given in (29). These exceptional tonal behaviors are cited without explanations in Gandour (1979: 139). (The comments in parentheses are made by the present author.)

(29) sóda-›soo daa   *soo dâa

bílliard-›bin lîat   *bin liat, bin líat

nécktie-›nék tháy   *nék thây

                        (but also nék thay)

Chrístmas-›khrít sa mâat

            *khrít sa màat; *khrít sa máat

iii. Polysyllables Polysyllabic words are assigned tone primarily according to English syllable structure, irrespective of the pitch patterns of English stress.

(30)   The rules for tonal assignment are based strictly on the interpretation of English syllable structure. Those syllables interpreted as smooth receive the mid tone in non-final position, the falling tone in final position; those syllables interpreted as checked receive the high tone in non-final position, the low tone in final position. Short open syllables in English source words that occur between a primary stressed syllable and a

following syllable are assigned a mid tone in accordance with the tone reduction rule in Thai. Since the tonal patterns remain fixed in the adaptation of variable stress patterns found in polysyllabic English words, we cannot attribute the resultant tonal patterns to perceptual interpretation of the variable pitch contours associated with the English stress patterns. (Gandour 1979: 140)

Again, alongside predictable tonal patterns in compúter -› khɔm phiw tâə; Chicágo -› chí? khaa kôo; hámburger -› hɛm bəə kâə; lóttery -› lɔ́t ta rîi, we also encounter exceptions such as names of certain countries pronounced with the M tone on the final syllable, e.g. América -› ?a mee ri kaa; Switzerland -› sa wít sa lɛɛn. According to Gandour, these exceptions are, again, due to a conventionalized reading pronunciation of **English** orthography (emphasis mine).

In spite of Gandour's keen observations of the influences from the donor language, we would like to elaborate an analysis which gives precedence to the stress pattern and syllable constructs of the host language. As seen in section VII above, for every generalization made on tone caused by stress and syllable structure of the mono-, bi-, and poly-syllabic English loans, there are exceptions which, following Gandour, suggests competing strategies in tone assignment. We will first comment on the influence of stress.

Concerning the stress patterns of English, although pre-final stress actually corresponds to the falling tone on final unchecked syllables in certain words, no conclusive evidence is found as we find both the HL and M tones assigned to the final unchecked syllable of bi- and poly-syllabic English words with non-final stress, e.g. vísa -›wii sâa vs. sóda -› soo daa (*soo dâa); Chicágo -› chí? khaa kôo vs. América -› ?a mee ri kaa (*?a mee ri kaa). Neither can we find a

uniformed tone assignment on final unstressed checked syllables, e.g. crédit -> khree dìt vs. sándwich -> seen wít. On the contrary, words with final stress in the English source always get the M tone on unchecked syllables, e.g. shampóo -> chem phuu (*chem phûu) while the L tone is invariably assigned to checked syllables, e.g. promóte -> proo mòot. This is due to the fact that the Thai final stress pattern is in agreement with that found in English, as pointed out by Gandour. We take this to reconfirm our already-proven claim for Indic loans that the domain-final syllable in Thai is heavy, and that only a long vowel or a short vowel with a glottal stop and L tone can surface in the unmarked cases. From this hypothesis, the discrepant tone assignments in English follow directly. A digression to a discussion of tone in monosyllables within the framework of the present analysis is necessary at this point.

We claim in section V that the default tone for light or unchecked syllables is M and that the unmarked tone for heavy or checked syllables is L. This generalization covers both Thai native words and Indic loans as it is supported by Gandour's 1982 study of the frequency of tones in Thai words, ranking the frequency percentage as follows:

(31) M (39.98%) L (20.72%) F (17.33%)
      H (11.81%) R (10.16%)
      (from a total of 61,222 tone occurrences in 25,000+ entries taken from Haas' 1964 dictionary)

The default tone assignment can also be extended to Non-Indic loanwords like English and Japanese. Examples are: (Eng.) beer ->bia; mile -> may; film -> fiim; (Jap.) zen ->sen; yen -> yen; (Eng.) date -> dèet; gate -> kèet; vote -> wòot. (Japanese checked monosyllablic loans are rare in Thai.)

However, there is an additional psychological factor in tonal development in foreign loans. That is, speakers of a borrowing language may employ a special tone to indicate that the word is clearly a foreign item in the lexicon of the donor

language as reported in Kiu 1977. In the case of borrowing in Thai, unlike Indic loans which entered the Thai lexicon at a very early stage during the formation of the Thai language and have thus become an integral part of Thai vocabulary, for later borrowings from non-Indic sources, the Thai speakers feel the need to signal the foreign nature of these lexical words. Hence, there is a tendency to assign more marked tones to non-Indic loans. We hypothesize that these marked tones are the high and the rising tones (cf. the tone frequency scale in (31)). The H tone is an across-the-board assignment to all checked syllables as an attempt to neutralize the variable tones conditioned by the underlying syllable strucutres in English and by the effects of tone sandhi in the Chaozhou dialect of Chinese. The rising tone, on the other hand, applies to unchecked syllables in Chaozhou, as another indicator, to distinguish the Chinese source since Thai and Chinese syllable structures are fairly similar.

Apart from external linguistic factors, the marked H tone is also based on phonetic grounds. As a result of tonogenesis from the Indic phonetic inventory, the majority of Thai consonants belong to the Low-consonants class, bearing the underlying [-vc., +sprd] phonetic features (cf. section III and the appendix). From the point of view of syllable structure in (5), we witnessed that both the CVC and CVVC structures can carry the L tone, while other tones are more restricted. The M tone is impossible due to the well-formedness condition in (17a), while the sequence LH never results in checked syllables because the tone imposed by the [-continuant] feature of the coda is the L tone (cf. (13)). The HL tone is barred from CVC syllables because the vowel is too short to bear a sequence of two tones in Thai. This leaves two possibilites, either the H or the L tone. While the Low-class consonants, including sonorants, have more restrictions than the other two classes of consonants, that is, they cannot bear a L tone when closed by a stop due to the underlying [-vc., +sprd] features of the onset (cf. (11)). Thus, the H tone is assigned uniformedly to all checked monosyllables despite the three options L, HL, and H, e.g. jet -> cét; soup -> súp; card -> kháat; cake -> khéek. This psychological inclination also competes with the natural phonetic motivation, as evidenced in the conflicting tone assignments, L vs. H, in

AIDS -> ʔèet. vs. Ed -> ét; vote -> wòot vs. Vogue -> wóok. The tendency for the high tone assignment to non-Indic loans is also reflected in Chinese loans, e.g. pὲʔ -> péʔ 'elder paternal uncle'; kòk -> kók 'country', despite a possible direct tone transfer by preserving the original tone in Chinese. Regarding unchecked monosyllables, since some English syllable structures, e.g. peculiar onsets:-- **fr-, fl-, sp-, st-, sk-, v-** or coda:-- **-r, -l, -nk, -nt, -mp**, etc., are sufficiently foreign to the Thai ears, the M tone is assigned without further needs to mark the non-native source. However, this strategy may compete with the preference for the H tone and both tones are found idiosyncratically, e.g. cent -> sen vs. saint -> sén (in Saint John School), but also sen (in Saint Joseph School).

The strategy to differentiate foreign loans with a distinct tonal pattern from those found in the majority of words in the borrowing language persists in polysyllabic words as well. However, in polysyllabic words, there is another phonetic requirement, namely, stress. Contrary to Gandour, we claim that the Thai stress pattern plays a major role in tone assignment than the English stress patterns. Specifically, English final stress can fit into the Thai final stress pattern easily, resulting in M tone for CVV structure and L for CV(V)C, and no tone adjustment is needed. Pre-final English stress, in contrast, calls for certain adaptations. This is because unstressed syllables in English are normally shortened to a schwa. However, the final stress pattern in Thai requires that the vowel of the final syllable may not be reduced. As in the Indic cases, the vowel in question must be lengthened and assigned the M tone as regulated by the syllable structure requirements, e.g. India -> ʔin dia, or be imposed a falling tone because of the psychological need to signal the foreign stress pattern, e.g. chíʔ khaa kôo, with the HL sequence combined on the last syllable. Otherwise, the shortened vowel in English must be assigned a glottal stop which entails the L tone, e.g. khaa buu kìʔ, with the split HL effect on two syllables, since the perceived overall pitch contour ML of the word approximates HL. The two

competing strategies sometimes coexist as we find two pronunciations for proper names such as **Ithaca** -> ʔíːt tha kâa vs. ʔíːt tha kâʔ; **Amko** -> ʔam kôo vs. ʔam kôʔ, and for other not well-established loanwords. The proposition that the stress contour in English is of minor importance to the Thai stress pattern is also corroborated by the fact that the English stress pattern must be prohibited when it is in opposition to Thai phonology. Specifically, the HL pitch contour of English cannot be retained when the last syllable is CVC because of the shortness of the vowel. Therefore, only the L tone is retained (which still preserves the overall falling pitch of English), e.g. promóte -> proo mòot, .or in the case of a sonorant onset, only the H tone is integrated on CVC, e.g. ténnis -> then nít, while HL is not ruled out on CVVC, e.g. Christmas -> khrít sa mâat, as in the case of Indic loans (cf. (19)).

VIII. Evidence from Language Games Involving Foreign Loans

It is clear that tone is governed by syllable structure, stress, and the phonetic properties of each syllabic segment as some resulting tones in the language games may not be there underlyingly. In (32), all of the syllables in the source words are assigned tone according to rules (30). It is possible that the H M HL sequence of chíʔ khaa kôo be inverted following rime movement (i.e. chôo khaa kíʔ). However, HL tone preservation is impossible when the rime is turned into a short heavy syllable (chóo khaa *kîʔ). To preserve the tones, syllable rimes must be adjusted (chóʔ khaa kîi). However, the preferred form is choo khaa kìʔ since both the new tones and rimes are in agreement with the Thai stress patterns. Likewise, khaa buu kìʔ may be rendered khìʔ buu kaa. Nevertheless, the mid tone can never be retained on short heavy syllables (*khiʔ buu *kàa) according to the well-formedness condition

(17a). The preferred syllable structures for bearing M tone is a long light syllable (khii), and for L tone in final position, it is a short heavy syllable (kà?), i.e. khii buu kà?. The best preferred form, however, is khí? buu kà?.

```
(32) a.  chí?  khaa  kôo              ->      choo  khaa  kì?
         T         T         T                T         T         T
       / I  \    / I  \    / I  \            / I  \    / I  \    / I  \
       H) M  L)  H  M  M)  M  M  M) -> H  M  M)  H   M  M) M   M  L)
       I  I  I   I  I  I   I  I  I     I  I  I   I   I  I  I   I  I
       ch) i  ?) kha    a) k   o  o)   ch o  o) kh  a   a) k   i  ?)
      [-vc][+ct][-ct] [-vc][+ct][+ct] [...][+ct][+ct]  [-vc][+ct][+ct] [-vc][+ct][+ct] [...][+ct][-ct]
       I   \ /   I   I  \ /   I   I  \ /    I   I  \ /   I   I  \ /   I   I  \ /
       O    R    O    R    O    R         O    R    O    R    O    R
        \  /      \  /      \  /           \  /      \  /      \  /
         σ         σ         σ              σ         σ         σ
Derived Tones:  H   M  (M->) HL (by sentential stress)  -> M   M              L
```

```
     b.  khaa  buu  kì?              ->khí?  buu  kaa
         T         T         T                T         T         T
       / I  \    / I  \    / I  \            / I  \    / I  \    / I  \
       H  M  M)  M  M  M)  M  M  L) -> H)  M  L)  M  M  M) M   M  L)
       I  I  I   I  I  I   I  I  I     I  I  I    I  I  I  I   I  I
       kh    a  a) b   u  u) k   i  ?) kh)i   ?) b   u   u) k   a  ?)
      [-vc] [+ct][+ct] [...][+ct][+ct] [...][+ct][-ct]  [-vc][+ct][-ct] [...][+ct][+ct] [...][+ct][-ct]
       I   \ /   I   I  \ /   I   I  \ /    I   I  \ /   I   I  \ /   I   I  \ /
       O    R    O    R    O    R         O    R    O    R    O    R
        \  /      \  /      \  /           \  /      \  /      \  /
         σ         σ         σ              σ         σ         σ
Derived Tones:  M   M      L   ->  (HL->) H        M              L
```

IX. Conclusion

We hope to have presented an extensively convincing analysis of tone assignment in Thai, under the assumptions that tonal assignment in Thai is modular, having a cyclic application, and that it must conform to the well-formedness conditions (17) at each stage of derivation. The modular tone assignment accounts for tone change at morpheme junctures, word boundaries, and within syllables. Through the cyclic application, Yip's stipulation of the prohibition of three-tone syllables can be dispensed with. The present study translates the three canonical tonal consonant classes (i.e. M, L and H) into morphophonological marking of underlying phonetic features resulting from historical sound change. We point out the importance of the recognition of tonal consonant classification as it facilitates the acquisition of tonal patterns in

Thai. Without such marking in the lexicon, we would have no way to derive varying tonal patterns in Indic loanwords. We would also have to devise various complicated tonal rules which at times may fail to yield the correct results. Moreover, this morphophonological marking is needed independently for all lexical items in Thai since Thai tones are lexical but are constrained by the segmental properties and the structure of each syllable, and for loanwords, the stress patterns of both the donor and the borrowing languages as well, although the stress pattern of the borrowing language takes precedence.

Regarding syllable structure, the relevance of syllable weight in the operation of phonological rules is proven in the literature (For stress:-- Halle & Vergnaud 1987; Wong-opasi 1987, etc.) For tone, the light syllable weight allows the syllable more flexibility to carry any of the five tones, including contour tones. Because syllables closed with a stop segment involve glottalization, it creates extra weight on these syllables, and hence it restricts *heavy* syllables from carrying certain tones. Unless intervened by some special phonetic properties of the onset, heavy syllables are assigned L tone; thereby, excluding the default M tone (*M). The shortness of vowels in heavy syllables accounts for their inability to accommodate both the extra syllable weight, imposed by the Thai final stress, and a contour tone (i.e. *HL or *LH on stressed CVC syllables), except when the contour tone is intonationally derived or in some marginal lexical words. Further, postulation of the [-cont] feature as causing L tone explains the absence of rising tone (*LH) on all Thai heavy syllables, long or short, despite its presence in other languages. This is due to the fact that the resulting tone would have the L tone, never the H tone, at the end of the contour tones. Aside from morphophonological factors, psychological factors do influence tone assignment as well since Thai has special tone patterns to mark English, Chinese, and Japanese loanwords from Indic loanwords and Thai native words.

Notes

least, this version of the paper has included substantial changes since its presentation at the first annual meeting of SEALS.

2 The phonetic transcription in this study may be different from those employed in the papers being discussed. Specifically, off-glides are represented as [y, w] whereas on-glides are written as [i] and [u], respectively. All long vowels are transcribed as sequences of two identical vowels while short vowels are single vowels followed by a glottal stop except when eliminated by some phonological rule. All tones in the phonetic transcripiton are written on the first vowel irrespective of the gliding or vocalic properties of the high segment. Such tone values as M, L, H, HL, and LH on the examples are given as necessary.

3 Another example of Leben is *tɔ́ŋ kaan* -> *tɔ́ŋ kaan* 'want' is questionable since underlyingly, the first lexical item contains a long vowel and it is shorthened *tɔ́ɔŋ kaan* -> *tɔ́ŋ kaan*..

4 For more details, the reader is invited to read the full discussion in her paper.

5 The development of a high tone as in (12) is also attested in the evolution of Punjabi from Sanskrit (Bhatia 1975; Hock 1985).

6 Phoneticians are invited to check out the validity of this hypothesis from laboratory analyses of the actual Thai isolative speech style.

7 Along this line of hypotheses, David Strecker (in Comrie (1987: 753)) discusses the development from Proto-Tai to the modern Tai languages. He states that the Thai words for 'face' and 'mother's younger sibling' had the same tone but different initials, namely a voiceless vs. voiced nasal, respectively, whereas in modern Thai they have the same initial but different tones as falling vs. high tone, in that order.

8 As predicted, the bracket of the first tonal domain is erased in light syllables with devoiced aspirated onsets while the first tone is retained in light syllables with original aspirated onsets. This is due to the fact that tone is assigned in the first case before devoicing and aspiration apply while in the second case, it is assigned directly to the intrinsic [+spread] property of original aspirated onsets.

[9] These final vowels (plus an applicable nasal) are Indic declension endings. They were deleted in the majority of cases in the Thai adoption (Phanthumetha 1975: 26-47).

[10] This lexical word is given with a final [m̐] in HRH. Prince Kitiyakara Krommaphra Chandaburinarunath's dictionary. However, according to Phanthumetha (1975: 68), the ending for Pali is [ŋ] while it is [m̐] for Sanskrit.

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stops:	Mid [-vc, -spr]	High [-vc, +sprd]	[+vc, -sprd]	Low [+vc, +sprd]	[+nas]
Thai orthography:	ก	ข	ค	ฆ	ง
Indic velars:	k	k h	g	g h	ŋ
Thai velars:	k	k h		k h	ŋ
Thai orthography:	จ	ฉ	ช	ฌ	ญ
Indic palatals:	c	c h	j	j h	ñ
Thai palatals:	c	c h		c h	y
Thai orthography:	ฏ	ฐ	ฑ	ฒ	ณ
Indic retroflexes:	ṭ	ṭ h	ḍ	ḍ h	ṇ
Thai dentals:	t	t h		t h	n
Thai orthography:	ต	ถ	ท	ธ	น
Indic dentals:	t	t h	d	d h	n
Thai dentals:	t	t h		t h	n
Thai orthography:	ป	ผ	พ	ภ	ม
Indic labials:	p	p h	b	b h	m
Thai labials:	p	p h		p h	m

Fricatives:	[+strident]		[+glottal/laryngeal]		[+labiodental]	
	High	Low	High	Low	High	Low
Thai ortho.	ศ ษ ส	ซ	ห	ฮ	ฝ	ฟ
Indic	ś ṣ s	-	h	-	-	-
Thai	s	s	h	h	f	f

Glides:	Low		Liquids:	Low		
Thai ortho.	ย	ว		ร	ล	ฬ
Indic	y	v		r r̥ r̥h	l	ḷ
Thai	y	w		r		

Appendix: From Indic Consonant Inventory to Thai Tonal Consonants

Note: Thai inventions: ฎ ฑ (d) from Indic (ṭ), (t), respectively; บ (b) from

(p); and syllable initial อ (?)]