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## Languages and Peoples of the Eastern Himalayan Region (LPEHR)

*Syllable duration in Tai Phake: The interaction between vowel length and tone length*

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### ABSTRACT

Tai Phake (Tai Kadai/Southwestern Tai) has six lexical tones, and nine phonemic vowels plus a length distinction between /*a*/ and /*aː*/. Following Banchob Bandhumedha (1987), the long /*aː*/ is written as <*ā*>. The vowel length distinction is only found when there is a final nasal (/*m*/, /*n*/, /*ŋ*/), semivowel (/*i*/, /*u*/) or stop (/*p*/, /*t*/, /*k*/). Three of the six tones are mid falling tones, which are conventially notated as Tone 3, Tone 4 and Tone 5. Tone 3 is creaky and is primarily distinguished from the others by phonation. Tone 4 is mid falling and short, whereas Tone 5 is mid falling and longer. In the speech of the Tai Phake speakers presented here, the most salient distinction between these two mid falling tones is usually length, thus in citation /*nā*$^{4}$/ 'mother's sister' was half the length of /*nā*$^{5}$/ 'melt away'. This paper presents some preliminary findings on the interaction between vowel length and tone length, findings that we hope can lay the foundation for more detailed phonetic studies in the future.

### KEYWORDS

tone; vowel length; Tai languages

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# *Syllable duration in Tai Phake: The interaction between vowel length and tone length*[1]

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## 1 Introduction

Tai Phake is a language of the Southwestern branch of the Tai Kadai family spoken by somewhere around 2000 people in 9 villages in Assam State, North East India, see Banchob (1987); Morey (2005, 2014).

Tai Phake language has six contrastive lexical tones conventionally numbered 1 to 6 and shown by superscript numerals, following Banchob (1987). This convention is also in use in the Tai Phake community, for example in the Tai Phake Dictionary being developed by Mr. Ailot Hailowng. The six tones are realised by a bundle of features that may include one or more than one of pitch, contour, phonation and duration (see Section 2 below, and also Morey 2014). In some cases, it would appear that the contour (level, falling, rising &c) is a more salient feature of a tone than its pitch. For example, the tone numbered 1 in Tai Phake has generally been recorded as a mid or high level tone, but the most salient feature of this tone is that it is level.

There are nine contrastive vowels, /*i*/, /*e*/, /*ɛ*/, /*u*/, /*o*/, /*ɔ*/, /*a*/, /*ɯ*/ and /*ɤ*/, the last two of which (following Banchob 1987) are conventionally written as <*ü*> and <*ə*> when the language is written using Roman script. There is also a vowel length contrast between short /*a*/ and long /*aː*/, which, following Banchob (1987) will be written in this paper as <*a*> and <*ā*>, a convention also adopted by the Tai Phake community. This vowel length contrast, which is not marked in the

[1] My research on Tai Phake commenced as part of a PhD project undertaken at Monash University (1999-2002). Some of the recordings used in this article and the basic analysis of the Tai Phake phonology was undertaken at that time. Subsequently, further research on Tai Phake has been made possible during my time at La Trobe University by grants from the Endangered Languages Documentation Programme (ELDP) (2005-07) and the Dokumentation Bedrohter Sprachen (DoBeS) program of the Volkswagen Foundation (2007-10). Although my main focus of research since 2007 has been on the Tangsa (Naga) languages, supported by two Australian Research Council grants, a Future Fellowship FT100100614 from 2011-2014, and a Discovery Project DP160103061 from 2016-20, the field work undertaken as part of these projects has allowed me to keep in contact with the Tai Phake community on a regular basis for the last 20 years. I am very grateful to colleagues Jürgen Schöpf, Kellen Parker van Dam, Rikker Dockum, Pittayawat Pittayaporn, Poppy Gogoi, Anthony Diller who have given good advice on the study of different aspects of Tai languages. The anonymous reviewers of this paper, originally sent to a different publisher, provided many helpful comments that have allowed the paper to be improved for inclusion in this volume. My biggest debt is to my Phake consultants, particularly the late Aije Let Hailowng, Ee Ngyan Kheit and Ailot Hailowng, together with Am Chaw Khya, Ee Kya, Ai Lun Khong, Sam Thon Wingkyen, Ai Thownche Chakap and many others.

traditional script, is restricted to situations when the vowel is followed by a final nasal, stop or semivowel (written as final <-*i*> and <-*u*>), as in the case of /*kaŋ*$^3$/ 'to open (as an umbrella)' and /*kāŋ*$^3$/ 'wide', both written in the script as ꩡꩫ.

Tai Phake language is traditionally written with a script developed from the Shan script, an abugida with 16 consonants and a number of dependent vowel symbols. The script does not mark tone, and does not indicate all of the vowel constrasts, so that for example /*e*/ and /*ɛ*/ are in most cases written in the same way even though they are contrastive phonemes (see Morey 2005 for more discussion of the script). The Tai Phake script differs from Burmese and Shan in that the consonant symbols occur with 'little black dots' that are not present with the cognate Burmese or Shan letters. As at August 2020, the rendering of Tai Phake using Unicode is not yet fully implemented for all programs and applications. We will use the script in this paper, to affirm it's importance to the community, but whether the 'little black dots' will be visible or not, remains to be seen[2].

The main purpose of this paper is to discuss the relationship between vowel length and tone length. Given that length, or duration, can both distinguish tones (particularly Tone 4 and Tone 5) and distinguish the the vowel /*a*/ from /*ā*/, this paper will explore how length is realised at these different levels of the phonology of the language. This paper can only be an introduction to this topic, and a pointer to future research in which data can be collected from a range of speakers to establish the extent to which the findings here apply more widely. In essence, our hypothesis is that the Tone Bearing Unit is the whole coda – in the case of /*kaŋ*$^3$/ 'to open (as an umbrella)' and /*kāŋ*$^3$/ 'wide', this refers to the vowel and final /*-ŋ*/, whereas vowel length applies only to the nucleus, /*a*/ as distinct from /*ā*/

In the next section we will present an overview of tones in Tai Phake, followed by a more detail discussion of the relationship between tones and vowel length in section 3 .

## 2 The Tones of Tai Phake

Banchob (1987) was the first to analyse the Tai tones and to number them in the order that has become conventional and which is adopted in this paper. Banchob's analysis is discussed in Morey (2005: 157).

Figure 1 presents a chart showing the pitch and contour of the six tones. The tones were all pronounced on the syllable /*nā*/ as spoken by a by a female speaker, Mrs Ee Kya of Tipam village, Assam, who was around 35 at the time of recording in 2002. This recording[3] was made as an exemplar of how the six tones of Phake were distinguished, using the following six words. Note that these words were not pronounced in a sentence frame[4] but simply with three tokens of each word pronounced after the speaker gave the meaning of each word in Assamese.

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[2] Readers who are interested in the issues involved in Unicode can watch a video presented by Stephen Morey on 7th August 2020 on the topic of "Using Scripts in the 21st century", which discusses the issues involved. This is available on YouTube at https://www.youtube.com/watch?v=1oj39daSHkI. Accessed 20200811.

[3] The recording was named SDM01_2007_019 and is archived at the Pacfic and Regional Archive for the Documentation of Endangered Cultures, (PARADISEC) (http://www.paradisec.org.au/).

[4] Tai Phake speakers are very consistent in their pronunciation of the tones and recording the words in a frame was not considered necessary.

(1)

| | |
|---|---|
| *nā*[1] | 'to quarrel' |
| *nā*[2] | 'rice field' |
| *nā*[3] | 'face' |
| *nā*[4] | 'mother's younger sister' |
| *nā*[5] | 'melt away' |
| *nā*[6] | 'thick' |

In Figure 1, the pitch, contour and duration of the tones is shown, because we have not time-normalised the duration of these tones. This is important because we contend that duration is one of the key features for distinguishing tones. Each tone is represented by a different coloured line, the key for which is given in (2).

(2)

| | |
|---|---|
| Tone 1 | blue |
| Tone 2 | blue-green |
| Tone 3 | yellow-green |
| Tone 4 | yellow |
| Tone 5 | red |
| Tone 6 | violet |

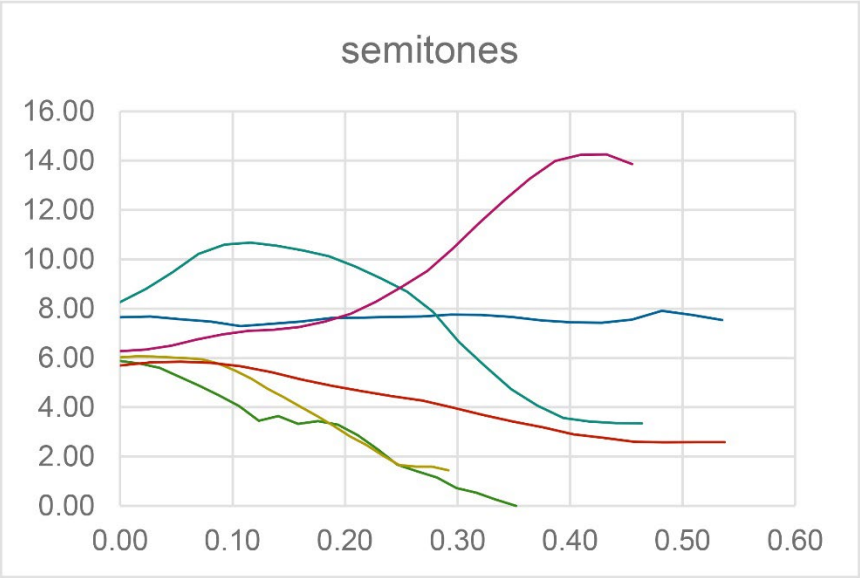


**Figure 1 The six tones of Tai Phake**

To produce Figure 1, each of the three tokens of the words listed in (1) were analysed in Praat, and the tone bearing unit (TBU) selected - from after the completion of the initial nasal up to the end of the vowel. An example of the selection of the TBU for the first token of Tone 1 is presented as Figure 2. This is a screen shot taken from Praat in order to show how the TBU was selected.

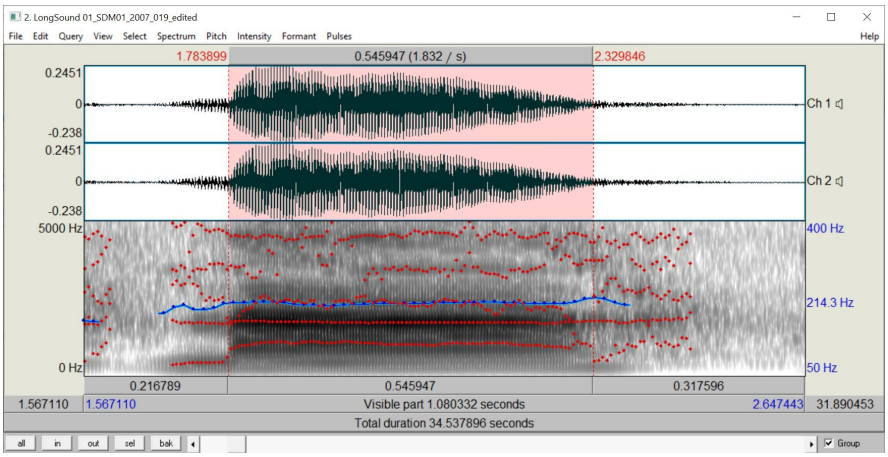


**Figure 2 The tone bearing unit (TBU) for a Tai Phake word, *nā*$^{1}$ 'quarrel'**

The pitch values produced by Praat were then entered into an Excel spread sheet and a semitone value created.[5] Each of the three tokens of each of the six tones were entered and then the chart in Figure 1 was produced.

| Tone No. | Pitch (Hz) | Pitch (Semitones) | Chao Numerals | TBU length (ms) | Phonation |
|---|---|---|---|---|---|
| 1 | 217-216 | 7.4-7.5 | 44 | 540 | Modal |
| 2 | 225-259-170 | 8.2-10.6-3.4 | 452 | 460 | Modal |
| 3 | 196-140 | 5.8-0.0 | 31 | 350 | Creaky |
| 4 | 198-152 | 6.0-1.4 | 31 | 290 | Final Breathiness |
| 5 | 194-162 | 5.7-2.5 | 31 | 540 | Modal |
| 6 | 201-219-312 | 6.3-7.5-13.8 | 335 | 460 | Modal |

**Table 1 The six tones of Tai Phake**

Table 1 presents raw Hertz values for pitch (F0) plus the duration in milliseconds for the average of each of the tones of Tai Phake recorded by Nang Ee Kya, together with the pitch reinterpreted into semitones and Chao numerals (see below).

Four of the tones in Table 1 had either very level pitch (Tone 1), or falling pitch lines (Tones 3, 4 and 5). In the case of token of Tone 3, because of the heavy creakiness, the Praat program was

[5] The process to convert Hz into Semitones was first to set the lowest pitch in the speaker's range in each of the tokens (3 tokens of each of 6 words) as 0 semitones and then appply the following formula and is "semitones = 12 x log2 (Hertz to be translated / Hertz reference)". In Excel this is created by the formula =12*LOG(X,2) (Sujinat Jitwiriyanont 2014), where x is the F0/lowest F0 value.

not able to record pitch accurately for the whole of the TBU but we expect that the pitch actually commenced at around the same level as Tones 4 and 5, namely around 195 Hz.

Tones 2 and 6 both had different pitch trajectories, which are shown by three Hz figures in Table 1. In the case of Tone 2, the pitch rises, then after remaining level for a short time, falls rapidly. In the case of Tone 6, the pitch rises gently through the first half of the tone, but then rises sharply in the last part of the tone.

We have also suggested Chao numerals for each of these tones (see Chao 1930, for a further discussion of the use of these, also van Dam 2018). Many tonal descriptions use the 1-5 scale of Chao's system, where 1 is the lowest pitch and 5 is the highest pitch, but in this paper, we propose to use these and offer a quantification for them based on the semitones shown in Table 1. To establish the target pitch for each of the five levels of the Chao system, we need to take the lowest and highest pitch of the speaker's range. Tone 6 rises very sharply up to over 300 Hz, and we felt that this was unusually high, creating a diapason of 14 semitones from the lowest to highest pitch, and so it was judged more appropriate to set the highest point at around half way in the rise, at 280, giving a diapason of 12 semitones.

This quantification for the Chao numbers is presented as Table 2:

| **Semitones** | **Chao Number** |
|---|---|
| 0 | 1 |
| 3 | 2 |
| 6 | 3 |
| 9 | 4 |
| 12 | 5 |

**Table 2 Quantification of Chao numbers for the tones of Tai Phake**

Thus Tone 1 which was around 7.4 semitones is rounded up to be 44 in the Chao system.

## 3 The relationship between vowel length and tone length

As we can see in Figure 1 and in Table 1, the tones numbered Tone 3, Tone 4 and Tone 5 are very similar in terms of pitch and contour, both falling from the mid range of the speaker's pitch space (3 in Chao numerals) to close to the lowest point. All three tones[6] have the Chao numerals 31. Tone 3 is quite distinct from the other two in being very creaky, but the most salient contrasting feature between Tone 4 and Tone 5 is duration. There is a breathiness at the end of Tone 4 in some tokens spoken by Ee Kya, and while this feature is probably significant, the length distinction appears to be much more so. An important question for future research will be to test a range of speakers to

[6] Note that in Ee Kya's pronunciation the pitch of Tone 5 does not fall quite as far as either Tone 3 or Tone 4 and some may therefore argue that it is best given a Chao numeral value of 32 and, having a different contour from Tone 4 which is clearly 31, that the key difference between the two tones is one of pitch. However, it is very clear to anyone listening to the recordings of these tones that the duration difference is far more salient than the pitch difference.

establish whether our hypothesis that duration is the main feature distinguishing Tone 4 and Tone 5 is in fact justified.

Over the past years, we have been able to record several speakers of Tai Phake, and in this paper we will present analysis of some recordings made of the late Aije Let Hailowng, one of the *pandits* of the Tai Phake language, and a well respect expert in many aspects of Tai Phake tradition. He was more than a generation older than Ee Kya, and some differences between their pronunciations of the tones may reflect generational differences. Table 3 presents some data comparing Ee Kya's pronuncation of *nā* on Tone 4 and Tone 5, with Aije Let's pronuncation of the same two tones on the syllable */hauŋ/*.

| **Tone number** | **TBU Length (ms)** | **Hz** | **Semitones** | **Tone numerals** |
|---|---|---|---|---|
| 4 (Ee Kya) | 290 | 198-152 | 6.0-1.4 | 31 |
| 4 (Aije Let) | 335 | 117-83 | 5.9-0 | 31 |
| 5 (Ee Kya) | 540 | 194-162 | 5.7-2.5 | 31 |
| 5 (Aije Let) | 480 | 105-87 | 4.0-0.9 | 31 |

**Table 3 Comparing Tone 4 and Tone 5 as spoken by Ee Kya on the syllable */nā/* and Aije Let on the syllable */hauŋ/***

As expected, both speakers pronounced tone 5 with a much longer TBU.

Later, Aije Let Hailowng pronounced two words, both verbs, that demonstrate how Tone 4 and Tone 5 interplay with the long and short */a/* vowels. These two words were pronounced both in isolation, and as part of a short phrase, or couplet, with a following noun object. These words are listed in ((3):

(3) *khāi*$^{4}$ 'move out, migrate'
(couplet: *khāi*$^{4}$ *hən*$^{2}$ 'move house')
*khai*$^{5}$ 'tell'
(couplet: *khai*$^{5}$ *khām* 'tell words')

The measurements of length and pitch from Praat are presented in Table 4:

| **Form** | **Length of coda /*ai*/ (ms)** | **Length of /*a*/ (ms)** | **Hz** |
|---|---|---|---|
| *khāi*$^{4}$ | 457 | 191 | 145-75 |
| *khai*$^{5}$ | 425 | 91 | 111-82 |
| *khāi*$^{4}$ in couplet | 286 | 124 | 120-83 |
| *khai*$^{5}$ in couplet | 259 | 53 | 120-104 |

**Table 4 Comparison of /*khāiꝟ* and /*khaiś*/ as spoken by Aije Let**

Both words had TBUs around the same length, and both words were significantly shorter when in the form of a couplet followed by the object[7]. The clear difference between them is in the length of the vowel /*a*/, which is much shorter in the case of the short vowel alternative /*khai*$^{5}$/ than with the long vowel alternative /*khāi*$^{4}$/. Thus, when there is a word that has a long vowel but shorter tone, the vowel takes up a higher proportion of the coda, but when the there is short vowel and long tone, the length of the coda is the same, but the vowel /*a*/ takes a much small proportion of the coda. It may be that a word like /*khai*/ should be analysed as having two morae in its nucleus /*a*/ + /*i*/, whereas /*khāi*/ has three morae /*a*/ + /*a*/ + /*i*/. In the case of /*khāi*$^{4}$/ we have three morae but a short tone, whereas with /*khai*$^{5}$/ we have two morae and a long tone, and that is why the TBU of these two words is similar. If this is the case, we might then predict that a word with a short vowel and a short tone would have a shorter TBU length. There is no recording of /*khai*$^{4}$/ but, as we shall see below in connection with the word /*kan*/, this prediction appears to be correct.

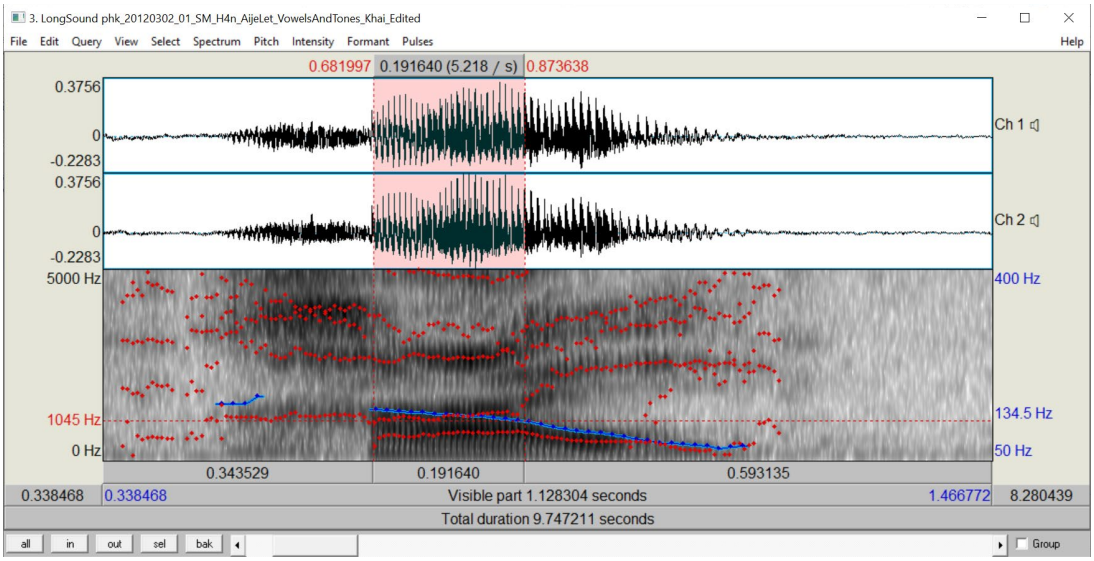


**Figure 3. Wave form, pitch trace and spectrogram for the word /*khāiꝟ* 'move out, migrate'**

Figure 3 is a screen shot[8] of Praat analysis of the isolated (non-couplet) token of the word /*khāi*$^{4}$/ 'move out, migrate', showing the vowel /*ā*/ shaded. Figure 4 presents the screen shot of the word /*khai*$^{5}$/ 'tell' with the /*a*/ shaded. This clearly demonstrates that the difference between these two words is largely conveyed by vowel length.

[7] This phenomenon, the shortening of a syllable when it is the first syllable of a compound, is one of the reasons why we have preferred to record words in isolation rather than in sentence frames, as the continuous speech in a sentence frame leads to much shorter codas.

[8] I am grateful to an anonymous reviewer for suggesting that a customized Praat picture is preferable to a screen shot, owing to the higher quality resolution that can be achieved from a Praat picture. I have chosen to use the screen shot (a) for pedogogical reasons, to show how the calculation of the length of the /*a*/ vowel was achieved and (b) because combining pitch, formant and wave form information into a Praat picture is not as effective as the screen shot.

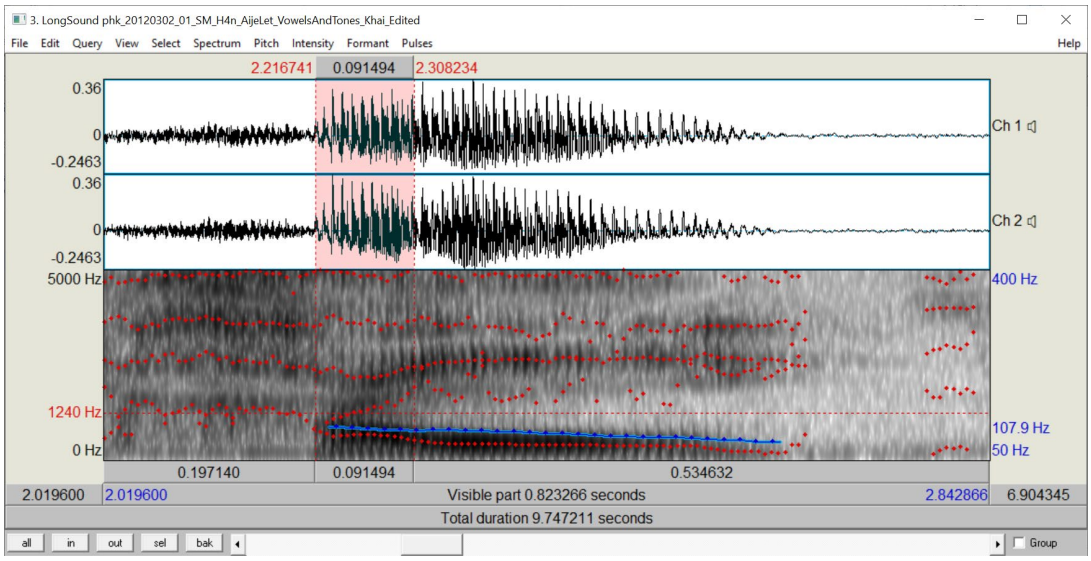


**Figure 4. Wave form, pitch trace and spectrogram for the word /*khaiŚ*/ 'tell'**

As already mentioned, we have established that with full minimal pairs, Tone 4 is significantly shorter in duration than Tone 5. The similarity in duration of the TBU in these two words is owing to the fact that the long /*ā*/ vowel adds a mora, and hence length to the TBU.

As part of the research into this question, we sought to try and find a full minimal set of four words distinguishing both the long and short tones (Tone 4 and Tone 5) and the long and short vowels, /*ā*/ and /*a*/[9]. Aije Let confirmed that /*khai*$^4$/ and /*khāi*$^5$/ have no meaning, as shown in ((4), and he did not pronounce those words for us.

(4) *khāi*$^4$ 'to move out, migrate'
*khai*$^4$ (no meaning)
*khāi*$^5$ (no meaning)
*khai*$^5$ 'to tell'

However, for many years Aije Let had been accustomed to pronounce all syllables in the order of the tones given in Table 1, when answering the question of which word belonged to which tone category, so we were able to record him pronouncing the syllables /*kan*/ and /*kān*/ on all six tones (even though some of the tokens did not carry meaning). A comparison of both words pronounced on tones 4 and 5 is presented in Table 5:

| **Form** | **Length of coda /*an*/ (ms)** | **Length of /a/ or /*ā*/ (ms)** | **Hz** |
|---|---|---|---|

[9] I am grateful to an anonymous reviewer for pointing out that a full minimal set would not be required but that multiple examples, with either different initials (any one of the 16 initial consonants of Tai Phake), or different finals (*-i*, *-u*, *-n*, *-ŋ* and *-m*) would be equally valuable. The suggestion was that a study of 8-12 speakers, each speaking 10 words from each of the four tone categories (Tone 4 with /*ã*/, Tone 4 with /*a*/, Tone 5 with /*ã*/, Tone 5 with /*a*/) would give a deeper understanding to this phenomenon in the language. It is to be hoped that this kind of phonetic study will indeed be undertaken in the future.

| | | | |
|---|---|---|---|
| *kan*$^{4}$ 'wrestle' | 394 | 51 | 127-79 |
| *kan*$^{5}$ 'direction' | 411 | 55 | 103-84 |
| *kān*$^{4}$ 'break off' | 449 | 191 | 108-74 |
| *kān*$^{5}$ (no meaning) | 707 | 230 | 109-94 |

**Table 5 Comparison of /*kan*/ and /*kān*/ as spoken by Aije Lett**

Note that /*kan*$^{4}$/ 'wrestle' and /*kan*$^{5}$/ 'direction' seem to be here distinguished more by the higher pitch and bigger fall in /*kan*$^{4}$/ than by length. However, Aije Let later discussed the meaning of each word in more detail, and when he did this, the words /*kan*$^{4}$/ 'wrestle' and /*kan*$^{5}$/ 'direction' were pronounced again. His overall pitch was higher at this point in the recording, although the relative pitch was the same, but, as shown in Table 6, a clear distinction in the length of the whole syllable was observed, while the length of the short vowel /*a*/ was constant. As with the forms in Table 5, the Tone 4 word /*kan*$^{4}$/ 'wrestle' also showed a higher pitch and sharper fall, suggesting that length may not be the only feature relied upon to distinguish these two words.

| **Form** | **Length of coda /*an*/ (ms)** | **Length of /*a*/ (ms)** | **Hz** |
|---|---|---|---|
| *kan*$^{4}$ 'wrestle' | 333 | 73 | 140-75 |
| *kan*$^{5}$ 'direction' | 588 | 77 | 120-99 |

**Table 6 Comparison of /*kan*Ꝝ and /*kan*Ś/ as spoken by Aije Let**

We have collected minimal sets from a third speaker, Mr. Ailot Hailowng, now in his early 60s who has been working for some years to produce a Tai Phake dictionary.

Ailot pronounced a number of minimal sets including the minimal triplet presented in Table 7. As with the words pronounced by Aije Let in Table 5 and Table 6, we see that the pitch of the mid falling tone for the short vowel on Tone 4, /*tau*$^{4}$/ 'support', is higher than for the two words carrying Tone 5. However, consistent with most other examples presented in this paper, the length of the TBU for Tone 4 is here less than half the length of those for Tone 5, but the vowel /*a*/ in both the Tone 4 and Tone 5 exemplars of /*tau*/, with short /*a*/ are of similar length, whereas both the whole TBU and the vowel /*ā*/ in the word /*tāu*$^{5}$/ 'turn' are significantly longer in duration.

| **Form** | **Length of TBU /*au*/** | **Length of /*a*/ or /*ā*/** | **Hz** |
|---|---|---|---|
| *tau*$^{4}$ 'support' | 250 | 56 | 128-84 |
| *tau*$^{5}$ 'ask' | 520 | 79 | 112-96 |
| *tāu*$^{5}$ 'turn' | 610 | 310 | 116-89 |

**Table 7 Comparison of /*tau*Ꝝ, /*tau*Ś/ and /*tāu*Ś/ as pronounced by Ailot Hailowng in a list**

Both Ailot Hailwong and Aije Let have become accustomed to pronouncing words in the order of Tone 1 to Tone 6 in order to (a) test out the tone category of a word, or (b) test whether there is a meaningful word carrying a particular tone. When Ailot Hailowng was searching for a meaningful word pronounced /*naŋ*$^{4}$/, he spoke, rather quickly, the first five tones in the order /*naŋ*$^{1}$/, /*naŋ*$^{2}$/, /*naŋ*$^{3}$/, /*naŋ*$^{4}$/ and /*naŋ*$^{5}$/. The measurements of pitch and TBU length and vowel length for /*a*/ for the last two of these are given in Table 9. Here we can see that there is no significant difference in the pitch between Tone 4 and Tone 5, and we therefore suggest that the higher pitch for Tone 4 that we see in Table 5, Table 6 and Table 7 is providing additional information to distinguish meaningful words, but when there is no meaning distinction, as between the first and second tokens in Table 9, this pitch distinction is also not present. Alternatively, the distinction created by the higher pitch for Tone 4 as distinct from Tone 5, as seen in the first pair of words in Table 4, may be a feature of older speakers and that for a younger generation of speakers duration is the principle distinguishing feature between Tone 4 and Tone 5.

| **Form** | **Length of TBU /*aŋ*/ (ms)** | **Length of /*a*/ (ms)** | **Hz** |
|---|---|---|---|
| *naŋ*$^{4}$ | 189 | 48 | 109-91 |
| *naŋ*$^{5}$ 'sit' | 299 | 58 | 107-96 |

**Table 8 Comparison of /*naŋ*Ḷ/ and /*naŋ*Ś/ as spoken by Ailot Hailowng in a list**

## 4 Conclusion

Tai Phake employs duration or length to mark both the distinction between Tone 4 and Tone 5, and a vowel length distinction between /*a*/ and /*a*ː/ (written as /*ā*/). This vowel length distinction is only found where there is a final nasal, glide or stop, and is expressed by lengthening the proportion of the vowel /*a*/ within the syllable (TBU), while the syllable length remains the same.

Thus, as we saw in Table 4 when there is a short vowel with the long tone (Tone 5) contrasting a long vowel with the short tone (Tone 4), the length of the syllable is very nearly similar but in the first case the vowel /*a*/ takes up a much shorter proportion of the syllable length. When there is a word having both long vowel and long tone (as with /*kān*$^{5}$/, in Table 6), the length of the syllable is extended.

Further research on the Tai Phake language, in the form of a study of multiple speakers pronouncing this tone distinction in multiple linguistic environments, such as word lists, 'couplets' (see above Table 4) and sentence frames will enable us to better understand how the interplay between vowel length and tone length is realised. A study that includes speakers from a range of ages may also help establish whether there has been any change in the way that these tones are realised over several generations.

### Abbreviations

| | | | |
|---|---|---|---|
| Hz | Hertz | TBU | Tone bearing unit |

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