Different Durations of Diphthongs in Thai: A New Finding
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Different Durations of Diphthongs in Thai: a New Finding

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1. Introduction

This paper presents the studies of the quantity and the quality of diphthongs in Thai. In a traditional Thai grammar, there are six diphthongs in Thai: short diphthongs /iaʔ, ɯaʔ, uaʔ/ (only with a final glottal stop) and long diphthongs /ia, ɯa, ua/ (without any final or with other finals than a glottal stop), as suggested by Praya Upprakitsilpasaan (1998), and Thonglor (1966).

Linguists (Abramson 1962, Naksakul 1998, and Rudaravanija 1965), on the other hand, pointed out that there are three phonological diphthongs in Thai /ia, ɯa, ua/. Short and long diphthongs are not phonemically distinctive. Naksakul (1998) added that diphthongs are shorter in unstressed positions but longer in stressed positions and that diphthongs are always short when followed by a final glottal stop.

2. Aim

The aim of this paper is to see (1) whether short and long diphthongs are different in quantity, (2) whether a final glottal stop is the main cue to distinguish short and long diphthongs in Thai, and (3) whether the three diphthongs in Thai are different in quality (trivially true, but specifically how?).

3. Study A. An Acoustic Study of Diphthongs in Thai

3.1. Aim

The aim is to study acoustically the quantity and the quality of the three diphthongs in Thai.

3.2. Tokens

The tokens, used in this study, had the structure of C1V(C2)T, where C1 was a voiceless unaspirated stop /p-/, a voiced stop /b-/, a voiceless fricative /f-/, a nasal

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/n-/, or a lateral /l-/; V was /ia/, /ɯa/, or /ua/; C2 was a voiceless unreleased velar stop /-k/, a glottal stop /-ʔ/, a dental nasal /-n/, a palatal glide /-j/, or a labial-velar glide /-w/; and T was a low tone. Some tokens were meaningful but some were nonsense words. All the tokens were in a sentence "*faŋ kham wâa* _____ *sŏɔŋ khráŋ*" 'Listen to the word _____ twice.'

3.3. Speakers

The speakers for this study were three native Standard Thai speakers: two males (Speaker 1 and Speaker 2) and one female (Speaker 3: the author). All of them were graduate students at the University of California at Berkeley. All of the speakers had normal speech and hearing.

3.4. Procedure

The three speakers read all the tokens twice. The tokens were recorded on analog tapes and were subsequently digitized at a sample rate of 16 kHz. with 16 bits per sample. All the tokens were categorized into 4 sets, as follows.

1. Diphthongs without final. There were 5 initial consonants*3 diphthongs* 2 times of each token * 3 speakers. There were 90 tokens for this set.
2. Diphthong /ia/ with finals. There were 5 initial consonants * 4 final consonants * 2 times of each token * 3 speakers. There were 120 tokens for this set.
3. Diphthong /ɯa/ with finals. There were 5 initial consonants* 5 final consonants *2 times of each token * 3 speakers. There were 150 tokens for this set.
4. Diphthong /ua/ with finals. There were 5 initial consonants *4 final consonants * 2 times of each token * 3 speakers. There were 120 tokens for this set.

There were a total of 480 tokens in this study.

To study diphthong quantity, all the tokens were measured[1] for the diphthong duration, the first vocalic element duration, the transition duration between the first and the second vocalic elements, and the second vocalic element duration.

To study diphthong quality, all the tokens were measured for the first and the second formants at 25%, 50%, and 75% points in diphthongs. This helps to ensure that the formant values obtained more a function of the diphthong and not the adjacent consonants.

[1] Any such demarcation of V1(the first vocalic element), transition, V2 (the second vocalic element) has some arbitrariness. One has to adopt one well-defined arbitrary measure and use it consistently.

3.5. Results

In previous literature (Naksakul 1998), there are three phonemic diphthongs in Thai /ia/, /ɯa/, and /ua/. That is, short diphthongs appear before a final glottal stop or in unstressed syllables. Short and long diphthongs are not phonologically distinctive in length.

The results of this study on diphthong quantity and quality are shown below.

3.5.1. Diphthong Quantity

The results of this study on diphthong quantity are presented in Figures 1-3.

Figure 1 shows the average duration of three diphthongs, which was measured for the first vocalic element duration, the transition duration, the second vocalic element duration, and the total diphthong duration, in all environments. From the figure, the average duration of the 1st vocalic element is 54% of the total diphthong duration, the transition, 17%, and the second vocalic element, 29%. This can be concluded that the 1st vocalic element of a diphthong is the most prominent part of the three phonemic diphthongs. Moreover, the data shows that the total duration of the three diphthongs are in the same range.

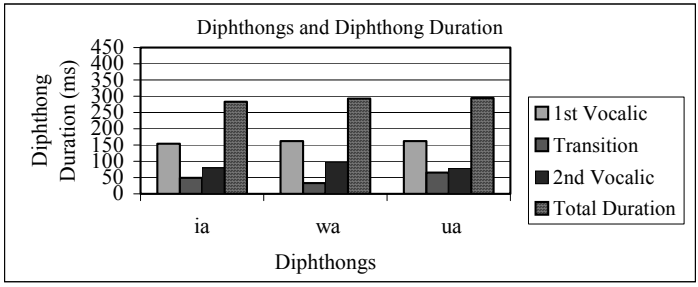

Figure 1. Duration of diphthongs in all environments (without any final, with final sonorants, with a final glottal stop, with final stops) of the three speakers.

Figure 2 presents the total durations of all three diphthongs after five initial consonants. The data shows that the durations of diphthongs after initial consonants are the same.

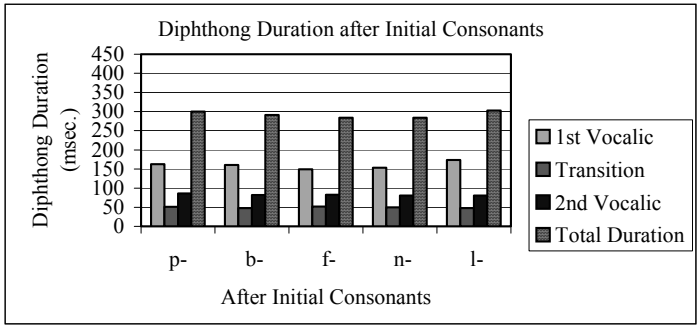

Figure 2. Duration of diphthongs and the different types of initial consonants.

The total durations of all three diphthongs before different types of final consonants are shown in Figure 3. It can be seen from the figure that diphthongs without any final (in open syllables) have the longest total diphthong duration (about 443 msec.). Diphthongs with a final (in closed syllables), regardless of whether it is a final glottal stop /-ʔ/, a final stop /-k/, a final nasal /-n/, a final glide /-w/, or a final glide /-j/, have shorter total diphthong duration (246-293 msec.).

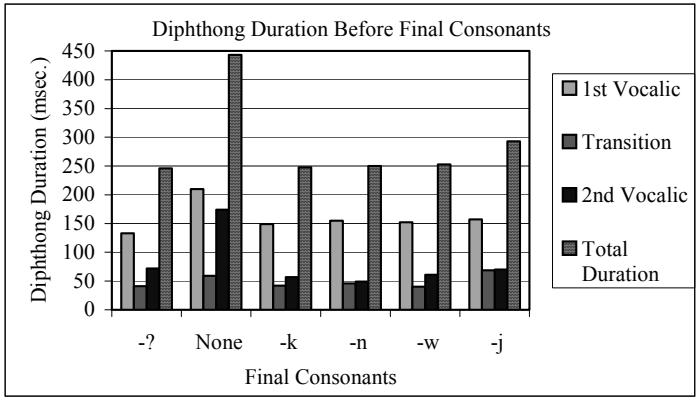

Figure 3. Duration of diphthongs and the different types of final consonants.

Moreover, diphthongs in open syllables are about 1.7 times as long as diphthongs in closed syllables. The shorter and longer duration of diphthongs is reflected by the shorter and longer duration of the first vocalic element, and, mainly, by the shorter and longer duration of the second vocalic element. The first vocalic element of diphthongs in open syllables is about 60 msec. longer than

the first vocalic element of diphthongs in closed syllables. The second vocalic element of diphthongs in open syllables is about 112 msec. longer than the second vocalic element of diphthongs in closed syllables.

3.5.2. Diphthong Quality

The results of this study on diphthong quality are shown in Figures 4-9.

Figures 4 and 5 below present the quality of three diphthongs at 25%, 50%, and 75% points in diphthongs[2], when diphthongs were not followed by glides /-w/ and /-j/. The data from Figures 4 and 5 show the diphthong quality after all initial consonants and before all final consonants. It was found that diphthong quality of shorter and longer diphthongs are in the same range**.** Moreover, there is no difference in diphthong quality after different types of initial consonants nor before different types of final consonants, except for final glides.

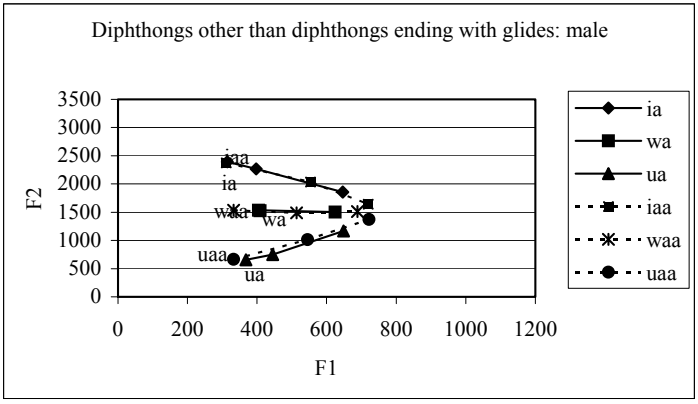

Figure 4. Diphthongs other than those ending with glides, from the tokens of male speakers.

[2] The diphthong quality at 25% point in diphthongs shows the value of the first vocalic element in diphthongs, the value at 50% point, the transition, and the value at 75% point, the second vocalic element.

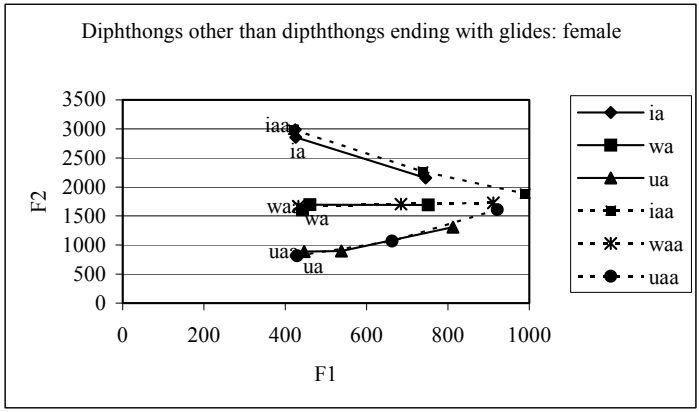

Figure 5. Diphthongs other than those ending with glides, from the tokens of female speakers.

The data show that the diphthong quality at 25% point in diphthongs, which reflects the quality of the first vocalic element in diphthongs, functions as the main cue to distinguish the three phonemic diphthongs /ia/, /ɯa/, and /ua/.

The diphthong quality at 50% and 75%points in diphthongs, however, is a less salient cue for differentiating the three phonemic diphthongs, as the three diphthongs share the same second vocalic element /a/ but it was found that the F2 height of the first vocalic element affects the F2 height of the second vocalic element in diphthongs. It can be seen that the F2 of the second vocalic element /a/ in diphthongs is the highest in the diphthong /ia/, higher in the diphthong /ɯa/, and the lowest in the diphthong /ua/.

Figures 6-7 and 8-9 show the diphthong quality before final glides /-w/ and /-j/, respectively. Figures 6-7 present the diphthong quality before a final glide /-w/ from the tokens of male and female speakers, respectively. The results show that the F2 decreases, especially at the 75% point of diphthongs, due to the coarticulation of final /-w/.

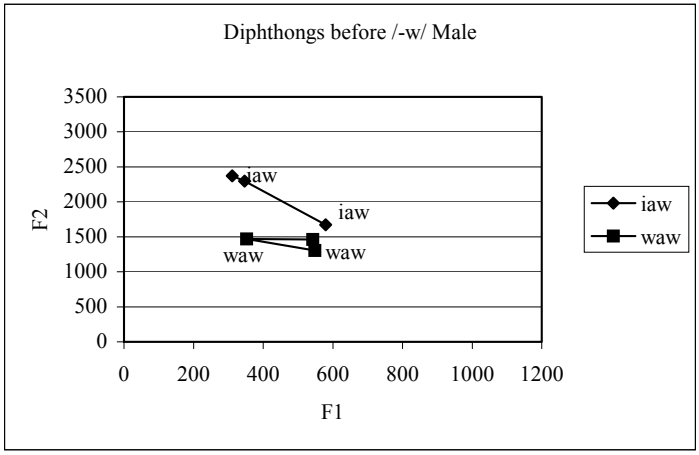

Figure 6. Diphthongs before a glide /-w/ for male at 25%, 50%, and 75% points in diphthongs.

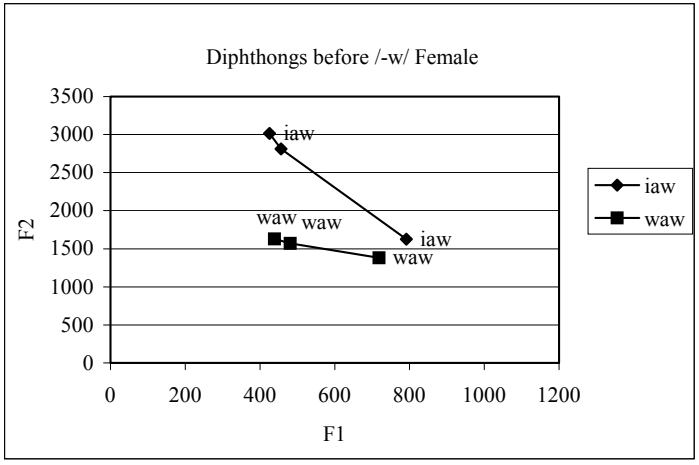

Figure 7. Diphthongs before a glide /-w/ for female at 25%, 50%, and 75% points in diphthongs.

Figures 8-9 present the diphthong quality before a final glide /-j/ from the tokens of male and female speakers, respectively. The results show that the F2 increases, especially at the 75% point of diphthongs, due to the coarticulation of final glide /-j/.

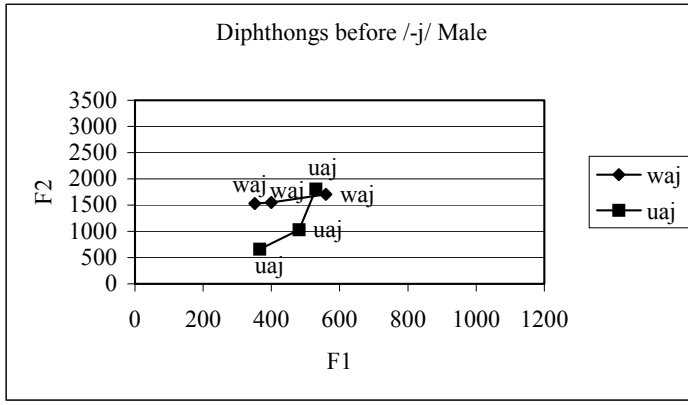

Figure 8. Diphthongs before a glide /-j/ for male at 25%, 50%, and 75% points in diphthongs.

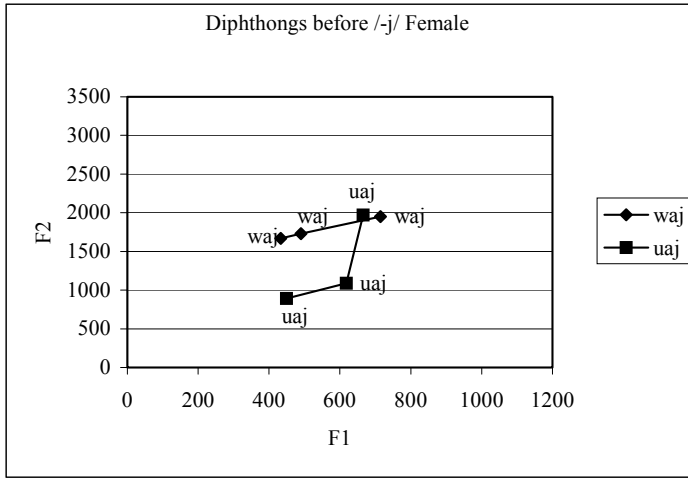

Figure 9. Diphthongs before a glide /-j/ for female at 25%, 50%, and 75% points in diphthongs.

3.6. Conclusion of Study A

From the results of study A, it can be concluded, as follows.

1. Diphthongs in Thai are not phonemically distinctive in length, as said by Abramson (1962) and Naksakul (1998).
2. In this study, it is found that diphthongs in open syllables or "longer allodiphthongs" are longer than diphthongs in closed syllables or "shorter allodiphthongs."
3. The cue to distinguish shorter and longer allodiphthongs is whether a diphthong has a final consonant (of all types) or not.
4. The cue to distinguish three phonemic diphthongs /ia, ɯa, ua/ is the diphthong quality of the first vocalic element.
5. Shorter and longer allodiphthongs do not have different diphthong quality.
6. Diphthong quality is not different when preceded by different types of initial or followed by different types of final consonants, except for final glides.
7. Final glides affect the diphthong quality at 75% point in diphthongs. Final glide /-w/ decreases the F2 value at 75% point in diphthongs. Final glide /-j/ increases the F2 value at 75% point in diphthongs.

4. Study B: A Perceptual Study of Diphthongs in Thai

4.1. Aim

The aim of this study is to see how Thai listeners perceive shorter and longer allodiphthongs in Thai and to see whether diphthong duration is the main perceptual cue to differentiate shorter and longer allodiphthongs in Thai.

4.2. Stimuli

A pair of nonsense words with shorter and longer allodiphthongs [pìaʔ] and [pìaa] was chosen for this study. A native-Thai female speaker (the author) read the words in the frame sentence "*faŋ kham wâa* _____ *sɔ̌ɔŋ khráŋ*" 'Listen to the word _____ twice.' Both tokens were recorded on an analog tape and were digitized at a sample rate of 16 kHz. with 16 bits per sample. Both tokens were measured for the diphthong duration.

The results from Table 1 show that the shorter allo-diphthong in [pìaʔ] had a shorter diphthong duration than did the longer allo-diphthong in [pìaa].

Table 1. Diphthong duration for a perceptual study of diphthongs.

Tokens	V1 duration /i/	transition	V2 duration /a/	Total duration
pìaʔ	180.94	89.88	71.75	342.57
pìaa	177.44	75.50	247.19	500.13

To avoid a glottal stop and creakiness after a shorter allo-diphthong [ia] being perceived as a cue for a shorter allo-diphthong in the token [pìaʔ], the glottal stop and the creakiness were spliced off and the second vowel was digitally lengthened to reach the same duration as the original one. Aspiration was found at the end of the token [pìaa]. To avoid any unexpected side effect from this aspiration, the aspiration was spliced off and the second vowel was digitally lengthened to reach the same duration as the original one.

The shorter allodiphthong [ia] in the token [pìaʔ]was lengthened only from the transition between the vowels /i/ and /a/ to the end of the second vowel /a/ at 20 msec steps until it reached the same duration as the original long allodiphthong. The longer allodiphthong [iaa] in the token [pìaa] was shortened only from the transition between the vowels /i/ and /a/ to the end of the end of the second vowel /a/ at 20msec steps until it reached the same duration as the original short allodiphthong.

All the tokens were resynthesized in the LPC analysis and resynthesis program, and were randomized. There were a total of 18 tokens for this study.

4.3. Listeners

Ten native-Thai listeners participated in this study. All the listeners were graduate students at the University of California at Berkeley. There were 8 males and 2 females with the age ranging from 22-38; the mean age was 26 years. All listeners grew up in Thailand and none had no hearing defects.

4.4. Task

The listeners were asked to listen to the processed tokens, to judge whether each token had a shorter or a longer allodiphthong, and to circle their answers on the answer sheets, provided in Thai. The listeners were told that the tokens they listened to carried no meaning.

The tokens were played by the ASPP program through a headphone for each listener, at a comfortable volume, in the Phonology Lab at the University of California at Berkeley.

4.5. Results

Figure 10 below presents the results of this study. In this figure, it can be seen that, for both tokens [pìaʔ] and [pìaa], the percentage of shorter-allodiphthong responses is higher when diphthongs have a shorter duration and the percentage of shorter-allodiphthong responses is lower when diphthongs have a longer duration.

Moreover, at mid range, for listeners to identify the shortened longer allodiphthongs as shorter allodiphthongs, the shortened longer allodiphthongs have to be shorter than the original shorter allodiphthongs.

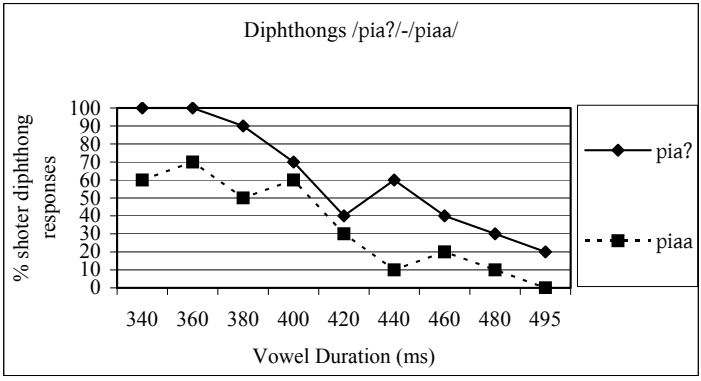

Figure 10. Diphthongs /pìa?/ and /pĭaa/ from Study 3 Diphthongs.

4.6. Conclusion of Study B

It can be concluded that the duration of the second vocalic element functions as a main perceptual cue to differentiate between shorter and longer allodiphthongs.

5. Conclusion of Studies A and B

From previous literature (Abramson 1962, Naksakul 1998), Thai has three phonemic diphthongs /ia/, /ɯa/ and /ua/. From the two studies in this paper, it is found that the main cue to distinguish the three diphthongs is the quality of the first vocalic element. Moreover, the results confirmed that three diphthongs have phonetic short and long differences. It was found from the data in the two studies that shorter allodiphthongs occur in closed syllables; whereas, longer allodiphthongs occur in open syllables. Furthermore, the main acoustic and perceptual cue for shorter and longer allodiphthongs is the duration of the second vocalic element of diphthongs. Shorter and longer allodiphthongs do not have differences in diphthong quality.

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