The Phonetic Realizations of the Khorat Thai Tones

Rungpat Roengpitya
College of Religious Studies, Mahidol University, Thailand
rungpat@gmail.com

Abstract

This paper investigates the behavior and variations of the five phonological tones in the Khorat Thai dialect, when they sit on different TBU duration. Shorter and longer Khorat Thai tones were digitally computed, extracted, and measured. After shorter and longer tones were plotted together in real time and aligned at the tone onset, five tonal processes were found. The first two processes, previously found in Swedish pitch accents, are truncation and F0 rate adjustment. The others, as reported for Standard Thai tones, are F0 range adjustment, plateau, and phase realignment.

1. Introduction

This paper examines the phonetic realizations of the five tones in "Khorat Thai", a dialect of the Thai language. This dialect is mainly spoken in the Khorat or Nakhorn Rachasiima province, situated in the Northeastern section of Thailand. In previous literature, it reports four to six phonological tones in Khorat Thai, depending on the descriptive or acoustic view of each linguist (Komoltha 1996; Rinphrom 1977).

However, according to the data gained from the elicitation with the native speakers for this research, it confirms that Khorat Thai has five phonological tones. The shapes of the five tones in Khorat Thai are presented in Figure 1.

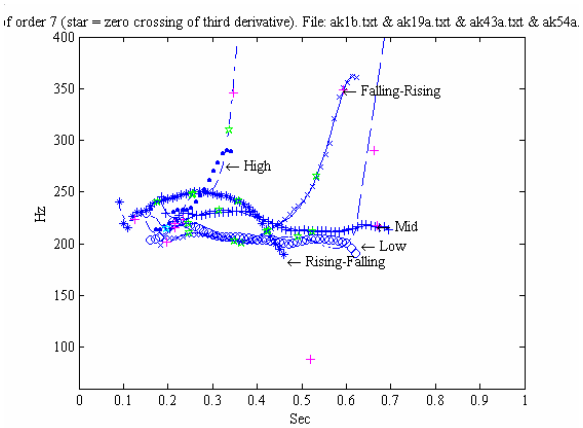

Figure 1: The five tones of Khorat Thai: mid, low, rising-falling, high, and falling-rising, plotted in real time, uttered by AK.

Figure 1 shows the F0 contours of the five words in Khorat Thai, representing its five phonological tones: /naa/ 'field' a mid tone (+), /nàa/ 'a face' a low tone (o), /nâa/ 'a horse' a rising-falling tone (*), /mǽk/ 'to marinate or to fertilize' a high tone (.), /nǎa/ 'thick' a falling-rising tone (X). It can be noted here that, though the five phonological tones in Khorat Thai have the same tone labels as the ones in Standard Thai: mid, low, rising-falling, high, and falling-rising, the five Khorat Thai tones have different shapes from the ones of the Standard Thai. For a comparison, the five tones in Standard Thai are shown in Figure 2 below.

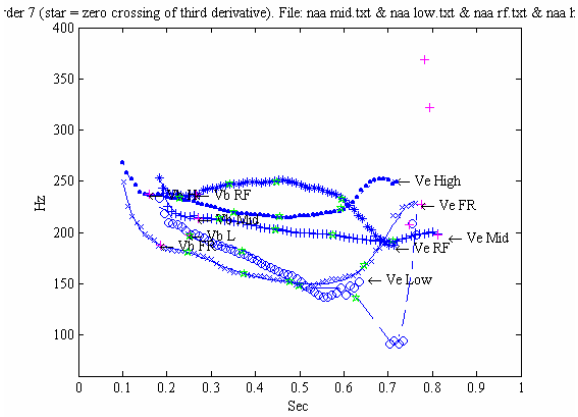

Figure 2: The five tones of Standard Thai: mid, low, rising-falling, high, and falling-rising, plotted in real time, uttered by RR..

Proceedings of the 11th Australian International Conference on Speech Science & Technology, ed. Paul Warren & Catherine I. Watson. ISBN 0 9581946 2 9
University of Auckland, New Zealand. December 6-8, 2006.

Accepted after abstract only review

Figure 2 presents the F0 contours of the five words in Standard Thai, representing its five phonological tones: /naa/ 'field' a mid tone (+), /nàa/ 'a custard apple' a low tone (o), /nâa/ 'a face' a rising-falling tone (*), /náa/ 'an aunt' a high tone (.), /nǎa/ 'thick' a falling-rising tone (X).

It can be seen from Figures 1 and 2 above that the tonal shapes of the five Khorat and Standard Thai tones appear differently. It is interesting to investigate how Khorat Thai tones would be phonetically realized, when they appear on short and long TBUs. This research was inspired by the works on Swedish pitch accents (Alstermark and Erikson 1971; Erikson and Alstermark 1972), which show that shortened F0 contours, when compared to the canonical F0 contours, can get end truncated or have F0 rate adjusted. Later, the works on short and long Standard Thai tones reported three additional tonal processes: F0 range adjustment, plateau, and phase realignment (Ohala and Roengpitya 2002; Roengpitya, in print). In this paper, the aim is to find out whether tones in Khorat-Thai would be modified on different TBUs. An acoustic study was conducted.

2. An Acoustic Study

2.1. Aim

The aim of this acoustic study is to investigate whether the five tones in Khorat Thai vary in shapes when they sit on shorter and longer TBUs.

2.2. Tokens

Sixteen meaningful native Khorat-Thai words were chosen for this acoustic study. Each word had a combination of the following syllable structure C1V(:) (C2)T; where C1 was a nasal /m/, /n/, or /ŋ/; V(:) was a short or long vowel /a/ or /a:/; C2 was a nasal /n/ or /ŋ/ or a stop /k/; and T was a mid, low, rising-falling, high, or falling-rising tone. All words are listed in Table 1.

All the words were put in six different contexts: in a word in citation form (WA), in a word in a sentence (WS), in a syllable in an unstressed position in a compound (UA), in a syllable in an unstressed position in a compound in a sentence (US), in a syllable in a stressed position in a compound (SA), and in a syllable in a stressed position in a compound in a sentence (SS). These combinations expressed shorter and longer TBUs, due to unstressed vs. stressed positions and connected speech vs. citation form (Tingsabadh and Deeprasert, 1997), on top of the phonemic short and long vowels (Roengpitya, 2001).

Table 1: Test words used in this acoustic study

	Mid	Low	RF	High	FR
CV:	/naa/ field	/nàa/ face	/mâa/ horse	-	/nǎa/ thick
CVN	/man/ it	/nàn/ name	/nân/ that	-	/mǎn/ 'sterili-se'
CVO	-	-	-	/mák/ always	-
CV:N	/maan/ evil	/ŋàaŋ/ sound of bells	/mâan/ a blind /nâan/ emph.	-	/mǎan/ name
CV:O	-	/màak/ gum	-	-	-

2.3. Speakers

Two native-Khorat Thai female speakers, with the age of 49 years (JS) and 48 years (AK), participated in this study. These two speakers grew up in Tambon Nongbunnak, Amphoe Nongbunnak, in Nakhorn Rachasiima province. These two native speakers had no defect in speaking, nor hearing.

2.4. Tasks

Two native speakers were asked to read all test words in six different contexts twice. All tokens were digitally recorded in the Praat sound analysis program at a sample rate of 16 kHz. There were a total of only 352 tokens in this study (([14 words x 6 contexts] + [1 word x 4 contexts]) x 2 speakers x 2 times).

2.5. Processing

In the Praat program (see http://www.praat.org), all 352 tokens were marked for the vowel onset and vowel offset. This is because, in this study, the tone onset is believed to be at the vowel onset, and the tone offset is at the vowel offset for CV:, CVO, and CV:O tokens, or at the nasal offset for CVN and CV:N tokens. Then, all tokens were extracted for the F0 values and the data were ported to the Matlab program.

In the Matlab program, in each graph, the 7th order of polynomial was fitted for each F0 contour. This is because, by trial and error, this order is best for F0 contours in Standard Thai, and, in this paper, for F0 contours in Khorat Thai. In each graph, one shorter contour was plotted together with one longer contour, in real time scale. The two contours were aligned at the tone onset (vowel onset or Vb), as to avoid the effects of tonal coarticulation of the previous tone on the initial portion of the targeted tone. It is noted here that all initial consonants of all tokens were nasals, as to avoid the effects of the possible pitch perturbation, which may occur for an initial stop.

Proceedings of the 11th Australian International Conference on Speech Science & Technology, ed. Paul Warren & Catherine I. Watson. ISBN 0 9581946 2 9
University of Auckland, New Zealand. December 6-8, 2006.

Accepted after abstract only review

All tokens were measured for vowel duration, nasal duration, and rhyme duration. All shorter-longer tonal pairs were analyzed for the possible five tonal processes: truncation, F0 rate adjustment, F0 range adjustment, phase realignment, and plateau. The results are discussed in the following section.

3. Results

As the focus of this paper is on the study of the behavior of short and long tones in Khorat-Thai, the first section (Section 3.1) presents the results of the different TBU duration, due to different syllable structures (whether they are in open syllables, closed syllables with final stops, or closed syllables with final nasals), as seen in Figure 3. Figure 4, however, shows the results of the different TBU duration due to the six different contexts.

After gaining the results of the different TBU duration, which implies that tones on short or long TBUs vary in (tonal) duration, the behavior of a short tone, plotted in the same figure as a long tone, might differ in tonal shape, rate of change of F0, and F0 range. This distinction leads to different tonal processes, as seen in details in Section 3.2.

3.1. The rhyme Duration of Khorat-Thai Tones

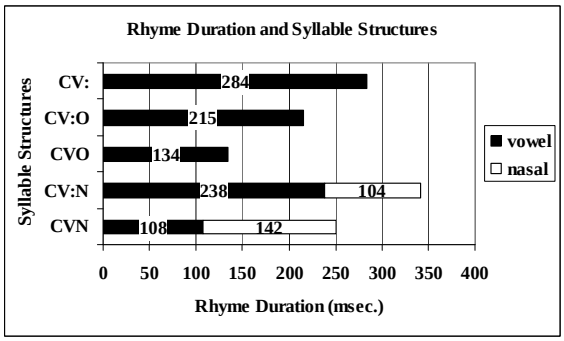

Figure 3: Rhyme duration and different syllable structures.

The results, as seen in Fig.3, revealed that the longest rhymes were in the structure of CVVN, shorter rhymes appeared in CVV, CVN, CVVO, and the shortest rhymes, in CVO. As for the vowel duration and nasal duration in CVVN and CVN structures, the results showed that short vowels in CVN were shorter than long vowels in CVVN, but final nasals after short vowels were longer than the ones after long vowels. This result followed the same way, as previously found in Standard-Thai tones (Abramson 1962; Roengpitya, 2001).

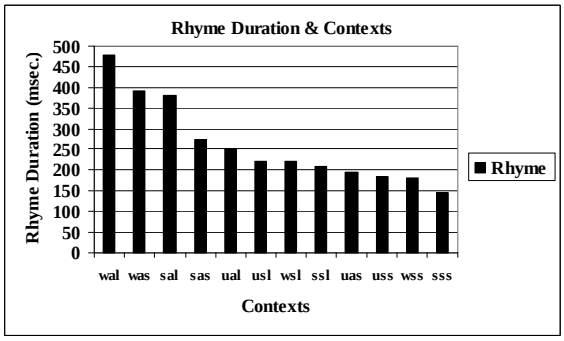

Figure 4: Rhyme duration and six contexts with short and long vowels.

In Figure 4, the six contexts are WA (the targeted word in citation form), WS (the targeted word in a sentence), UA (a syllable in an unstressed position in a compound alone), US (a syllable in an unstressed position in a compound in a sentence), SA (a syllable in a stressed position in a compound alone), and SS (a syllable in a stressed position in a compound in a sentence), and the letters '–s' and '–l' after each context stand for short or long vowels, respectively.

From the results in Figure 4, it can be seen that different contexts yield different duration of rhymes. The contexts for longer rhymes are word in citation form (WA) and the stressed position in a compound alone (SA), whereas shorter rhymes are in connected speech (WS, US, and SS). Moreover, in the same contexts, long-vowel rhymes are always longer than short-vowel rhymes.

The next section reports tonal processes, found for shorter and longer Khorat-Thai tones.

3.2. Tonal Processes in Khorat Thai

After a shorter tone in Khorat Thai was plotted with a longer tone of its pair, in real time, for all tokens, the shapes of the short and long contours, appearing in each graph, can be analyzed. The results show the first two tonal processes, first, found for short and long Khorat Thai tones: truncation and F0 rate adjustment, the same way as found for Swedish pitch accents (Alstermark and Erikson 1971; Erikson and Alstermark 1972) and for Standard-Thai tones (Ohala and Roengpitya, 2002; Roengpitya, 2001; Roengpitya, in press).

Moreover, three additional processes, which were previously reported for Standard-Thai (Ohala and Roengpitya, 2002; Roengpitya, 2001; Roengpitya, in press): F0 rate adjustment, plateau, and phase realignment, occurred in Khorat-Thai as well, as presented below.

Proceedings of the 11th Australian International Conference on Speech Science & Technology, ed. Paul Warren & Catherine I. Watson. ISBN 0 9581946 2 9
University of Auckland, New Zealand. December 6-8, 2006.

Accepted after abstract only review

3.2.1. Process 1: Truncation

This truncation process occurs with a shorter tone when compared to a longer tone. In this process, an end portion of the shorter tone gets truncated. In the below Figure, it can be seen that the end portion of the shorter RF tone in Khorat Thai is cut off.

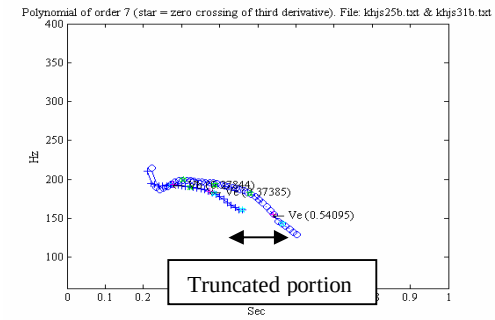

Figure 5: An example of end truncation of a shorter RF tone in the word /nân/ 'that', when compared to a longer RF tone in the word /mâan/ 'a blind', uttered by JS.

3.2.2. Process 2: F0 rate adjustment

This F0 rate adjustment occurs with a shorter tone, plotted with a longer tone. In this process, the shorter tone has a higher rate of change of F0 and has a steeper slope than does the longer tone in Khorat Thai. Figure 6 shows an example.

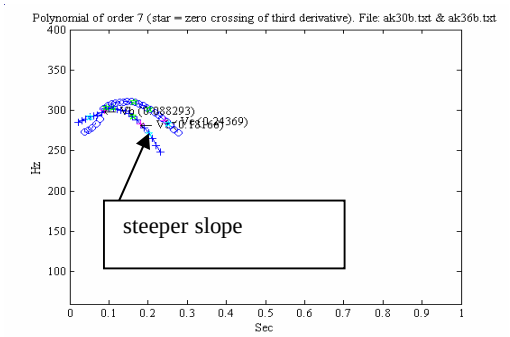

Figure 6: An example of F0 rate adjustment of a shorter RF tone in the word /nân/ 'that', when compared to a longer RF tone in the word /mâan/ 'a blind' in SA context uttered by AK.

3.2.3. Process 3: F0 range adjustment

In this process, the F0 range of shorter tones can be compressed or expanded, when compared to longer tones, as seen in Figures 7 and 8 below. A dashed arrow shows the F0 range of a short tone in Khorat Thai, while a solid arrow does for the long tone of the same pair.

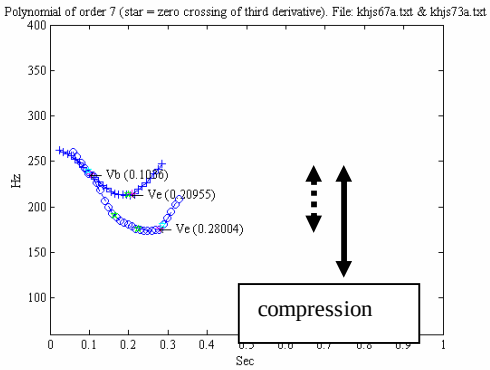

Figure 7: An example of F0 range adjustment (compression) of shorter and longer FR tones (JS).

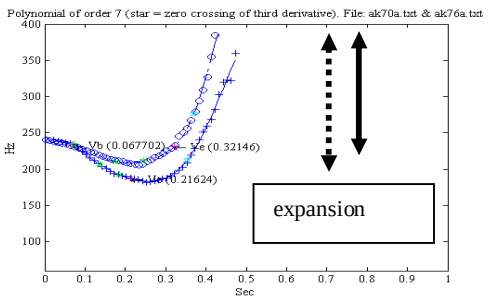

Figure 8: An example of F0 range adjustment (expansion) of shorter and longer FR tones, uttered by AK.

3.2.4. Process 4: Plateau

In this process, in the case of the two contour tones: rising-falling and falling-rising, what may be described as a plateau, i.e. a relatively flat portion, appears in between the more steeply sloped initial and terminal portions of the tone. It is found for Khorat-Thai tones that longer contours had longer plateau duration than did shorter contours, as presented in a dashed arrow for the shorter plateau duration and in a solid arrow for the longer plateau duration in Figure 9 below.

Proceedings of the 11th Australian International Conference on Speech Science & Technology, ed. Paul Warren & Catherine I. Watson. ISBN 0 9581946 2 9
University of Auckland, New Zealand. December 6-8, 2006.

Accepted after abstract only review

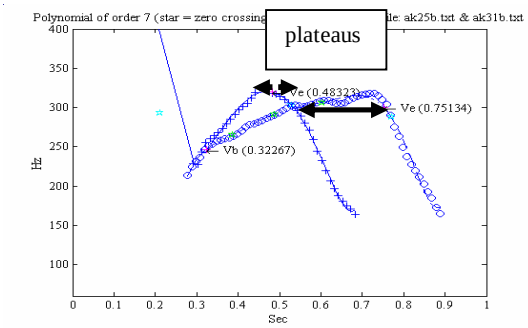

Figure 9: Shorter and longer plateaus for shorter and longer RF tones in Khorat Thai, respectively, uttered by AK.

3.2.5. Process 5: Phase realignment

As short vowels are followed by longer final nasals and long vowels, by shorter final nasals (Abramson 1962, and Roengpitya 2001), and as a tone is superimposed on a rhyme, the tone can sit on a short vowel plus a longer nasal, and vice versa. Thus this process is called 'phase realignment' (Ohala and Roengpitya 2002). An example of the phase realignment found for Khorat Thai tones is shown in Figure 10 below. The F0 curve for a shorter tone is in '+', and for a longer tone is in 'o'.

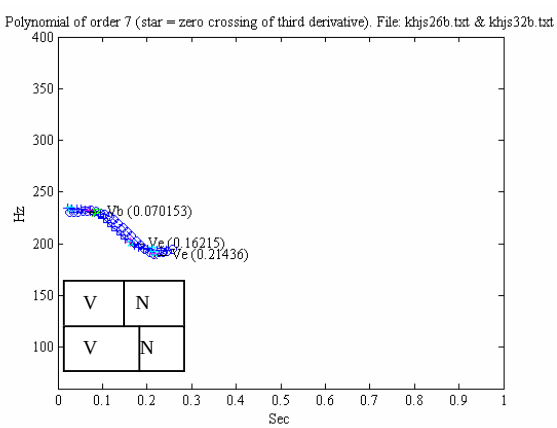

Figure 10: An example of phase realignment of shorter and longer RF tones in the word in a sentence (WS) context in Khorat Thai, uttered by JS.

In sum, the five tonal processes found in Khorat Thai are tonal truncation, F0 rate adjustment, F0 range adjustment, plateau, and phase realignment.

4. Discussion and Conclusion

The results in Section 3 show that the tonal shapes and behaviors of Khorat-Thai tones can vary due to the shorter and longer TBUs, as tones sit on the TBUs. It can be concluded from this acoustic study that the five tonal processes (truncation, F0 rate adjustment, F0 range adjustment, plateau, and phase realignment) that were previously found in Standard Thai (Roengpitya, in press), appear in the Khorat-Thai dialect as well.

However, the five processes do not occur for all tones. That means each tone has its 'preferred' processes, which later would help distinguish one tone from another.

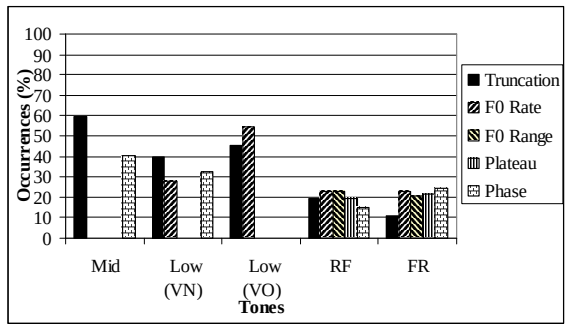

Figure 11: The percentage of occurrences of the five tonal processes found for tones in Khorat Thai.

Figure 11 presents the percentage of occurrences of each tonal process for a mid tone, a low tone (with a final nasal), a low tone (with a final stop), a rising-falling tone, and a falling-rising tone. It can be noted here that the results of a high tone were not included, as a high tone in Khorat Thai appears only in CVO (with a short vowel).

This Figure shows that a mid tone has the highest percentage of the truncation process. This means that when a mid tone gets shorter, its end portion gets truncated. A short low tone, however, has both its end portion truncated and has its F0 rate of change adjusted.

As for the two contours, all processes occur for both two contours: rising-falling and falling-rising. However, it can be noticed that the truncation process occurs in the rising-falling-tone cases, at a higher percentage than does in the falling-rising-tone cases. It can be noted also that the two processes, which are the F0 range adjustment and plateau, only occur in the contour cases, not in the level-tone cases.

To summarize, a high percentage of occurrences of the end-truncation process distinguishes level tones from the contour tones. Moreover, a high percentage of occurrences of the F0 range adjustment and the plateau separates the contour tones from the level tones. Within the group of the two level tones, a high percentage of occurrences of the F0 rate adjustment makes a low tone differ from a mid tone. As for the syllable structure, the phase realignment process occurs only for syllables with final nasals, but does not occur for syllables with final stops.

The results of the five processes found for the five tones in Khorat Thai, as stated above, correlate with the results

Proceedings of the 11th Australian International Conference on Speech Science & Technology, ed. Paul Warren & Catherine I. Watson. ISBN 0 9581946 2 9
University of Auckland, New Zealand. December 6-8, 2006. Copyright, Australian Speech Science & Technology Association Inc.

Accepted after abstract only review

found in Standard Thai (Roengpitya, in press). Then, it can be concluded that the results in this study may lead towards the way that these five tonal processes would be realized as the universal phonetic characteristics for distinguishing one tone from another in other tonal languages. However, this has yet to be explored further. It is hoped that this study will shed light on other phonetic and phonological studies of tones in the dialects of Thai and in the world's tonal languages.

5. Acknowledgements

The author deeply appreciates the guidance and comments from John Ohala. Many thanks to Ron Sprouse for the scripts, and to the two native-Khorat speakers JS and AK for their participation.

6. References

Abramson, A. (1962). *The vowels and tones of standard Thai: Acoustical measurements and experiments*. Bloomington: Indiana University Center in Anthropology, Folklore, and Linguistics, Pub. 20.

Alstermark, M., and Y. Erikson. (1971). Speech Analysis. A. Swedish word accent as a function of word length. *Speech Transmission Laboratory Quarterly Progress and Status Report (STL-QPSR)*, 1, 1-13.

Erikson, Y., and M. Alstermark. (1972). Speech Analysis. A. Fundamental Frequency correlates of the grave word accent in Swedish: the effect of vowel duration, *Speech Transmission Laboratory Quarterly Progress and Status Report (STL-QPSR)*, 44, 1-13.

Komoltha, M. (1996). *Khorat tones: an acoustic study*. MA. Thesis, Thammasat University. [in Thai].

Ohala, J. and Roengpitya, R. (2002). Duration Related Phase Realignment of Thai Tones. *Proceedings of the International Conference on Spoken Language Processing*, Denver, 2285-2288.

Rinphrom, C. (1977). *The Khorat sound system*. M.A. Thesis. Chulalongkorn University. [in Thai].

Roengpitya, R. (2001). *A study of vowels, diphthongs, and tones in Thai*. Ph.D. dissertation. University of California at Berkeley.

Roengpitya, R. (in press). The Variations, Quantification, and Generalizations of Standard Thai Tones. In M. Ohala, P. Beddor, and M. Solé (Eds.), *Experimental Approaches to Phonology in Honor of John Ohala*. Oxford University Press.

Tingsabadh, K., and Deeprasert, D. (1997). Tones in Standard Thai Connected Speech. In A. Abramson (Ed.), *Southeast Asian Linguistic Studies in Honour of Vichin Panupong*, Chulalongkorn University Press. 297-307.

Proceedings of the 11th Australian International Conference on Speech Science & Technology, ed. Paul Warren & Catherine I. Watson. ISBN 0 9581946 2 9
University of Auckland, New Zealand. December 6-8, 2006.

Accepted after abstract only review