Phonetic sources of sound change: The influence of Thai on nasality in Pwo Karen

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PHONETIC SOURCES OF SOUND CHANGE: THE INFLUENCE OF THAI ON NASALITY IN PWO KAREN[1]

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บทคัดย่อ

สัทสมบัติของสระนาสิกของผู้บอกภาษาชาวกะเหรี่ยงโปซึ่งมีอายุต่างกันมีความหลากหลาย งานวิจัยนี้จึงศึกษาสระนาสิกซึ่งเป็นสระกลางและสระต่ำของผู้บอกภาษากะเหรี่ยงโปซึ่งอาศัยอยู่ที่จังหวัดแม่ฮ่องสอน ประเทศไทย เนื่องจากผู้บอกภาษาที่มีอายุน้อยกว่ามีแนวโน้มที่จะมีการสัมผัสภาษากับภาษาไทยมากกว่าผู้บอกภาษาที่มีอายุมากกว่า งานวิจัยนี้จึงสันนิษฐานว่าสระนาสิกของผู้บอกภาษาที่มีอายุน้อยกว่าจะสูญเสียการออกเสียงขึ้นจมูกไปมากกว่าผู้บอกภาษาที่มีอายุมากกว่า นอกจากนี้ ยังคาดว่าจะพบพยัญชนะท้ายนาสิกซึ่งเกิดขึ้นมาใหม่ในข้อมูลของผู้บอกภาษาที่มีอายุน้อยกว่าด้วย ทั้งนี้ งานวิจัยนี้ได้วิเคราะห์ค่าระยะเวลาของการออกเสียงขึ้นจมูกและค่าระยะเวลาของพยัญชนะท้ายนาสิก ผลการศึกษาพบว่าสระนาสิกซึ่งเป็นสระกลางของผู้บอกภาษาทั้งที่มีอายุมากและน้อยบางคนมีพยัญชนะท้ายนาสิก ในขณะที่สระนาสิกซึ่งเป็นสระต่ำของผู้บอกภาษาทุกคนไม่มีพยัญชนะท้ายนาสิก ยิ่งไปกว่านั้น ผู้บอกภาษาที่มีอายุมากกว่ามีค่าระยะเวลาของการออกเสียงขึ้นจมูกและค่าระยะเวลาของพยัญชนะท้ายนาสิกมากกว่าผู้บอกภาษาที่มีอายุน้อยกว่า แสดงว่าผู้บอกภาษาที่มีอายุมากกว่ามีแนวโน้มที่จะรักษาการออกเสียงขึ้นจมูกของสระไว้มากกว่า ตรงกันข้ามกับผู้บอกภาษาที่มีอายุน้อยกว่าซึ่งมีค่าระยะเวลาของการออกเสียงขึ้นจมูกและค่าระยะเวลาของพยัญชนะท้ายนาสิกน้อยกว่า แสดงให้เห็นว่าการออกเสียงขึ้นจมูกในสระนาสิกของผู้บอกภาษากลุ่มนี้ลดน้อยลงโดยไม่มีพยัญชนะท้ายนาสิกเกิดขึ้นมาทดแทนการออกเสียงขึ้นจมูกของสระที่หายไป การเปลี่ยนแปลงนี้อาจเกิดจากปัจจัยด้านคุณสมบัติสระ กล่าวคือ สระนาสิกซึ่งเป็นสระสูงได้สูญเสียการออกเสียงขึ้นจมูกของสระทั้งหมดโดยที่ไม่มีพยัญชนะท้ายนาสิกเกิดขึ้นมาทดแทนการออกเสียงขึ้นจมูกของสระ ส่วนสระนาสิกซึ่งเป็นสระกลางยังคงมีการออกเสียงขึ้นจมูกโดยมีพยัญชนะท้ายนาสิกเกิดขึ้นมาด้วย และสระนาสิกซึ่งเป็นสระต่ำยังคงการออกเสียงขึ้นจมูกของสระไว้โดยที่ยังไม่มีพยัญชนะท้ายนาสิกเกิดขึ้นมา อย่างไรก็ตาม งานวิจัยนี้ไม่สามารถยืนยันได้ว่าพยัญชนะท้ายนาสิกซึ่งเกิดขึ้นมาใหม่

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[1] **ที่มาทางสัทศาสตร์ของการเปลี่ยนแปลงทางเสียง: อิทธิพลของภาษาไทยต่อการออกเสียงขึ้นจมูกของสระในภาษากะเหรี่ยงโป**

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เป็นผลมาจากการสัมผัสภาษากับภาษาไทยเนื่องจากพบพยัญชนะท้ายนาสิกทั้งในข้อมูลของผู้บอกภาษาที่มีอายุมากและน้อย ดังนั้น การที่ข้อมูลของผู้บอกภาษาที่มีอายุน้อยมีพยัญชนะท้ายนาสิกจึงไม่อาจใช้เป็นหลักฐานในการพิสูจน์อิทธิพลของการสัมผัสภาษากับภาษาไทยต่อการเปลี่ยนแปลงของสัทสมบัติของสระนาสิกในภาษากะเหรี่ยงโปได้

Abstract

The phonetic realization of nasal vowels produced by Pwo speakers of different ages can vary. The present study investigated mid and low nasal vowels of Pwo speakers from Mae Hong Son province, Thailand. Due to the higher tendency of language contact with Thai, the younger group's nasal vowels were expected to lose more nasality than the older group. The emergence of final nasal consonants was also expected in the younger group. The nasalization duration and consonant duration of both groups were analyzed. The results showed that, regardless of age, mid nasal vowels of some speakers had final nasal consonants, while low nasal vowels of all speakers did not. Furthermore, the older group had both longer nasalization duration and consonant duration than the younger group, suggesting their higher tendency to preserve nasality. The younger group had shorter nasalization duration and consonant duration, indicating the loss of nasality in vowels without compensatory final nasal consonants. The change might be due to the vowel quality. High vowels were fully denasalized with no compensatory final nasal consonants. Mid vowels were nasalized with the emergence of final nasal consonants. Low vowels remained nasalized without final nasal consonants. We could not confirm that the emergence of final nasal consonants was induced by Thai because it occurred in both groups. The existence of final nasal consonants in the younger group could not be used as evidence of an effect of contact.

1. Introduction

The present study investigated the phonetic realization of Pwo nasal vowels of different age speakers from Mae Phae Luang village, Kong Koi subdistrict, Sop Moei district, Mae Hong Son province in Thailand. Due to a higher degree of language contact with Thai, we hypothesized that the younger group's nasal vowels would show traces of Thai influence in the emergence of final nasal consonants. To test the hypothesis, the nasalization duration (the nasalized portion of nasal vowels) and consonant duration (the final nasal consonant) of older and younger groups were acoustically compared.

When speakers produce speech, the airstream typically flows through the oropharyngeal cavity. The resulting sounds are oral. However, when the velum is lowered, the oral and nasal cavities are coupled through the velopharyngeal port. The airstream then flows out through two articulatory channels: oral and nasal. The resulting sounds are nasalized and nasal

vowels[5]. So apart from resonance in the oral cavity which has an influence on the vowel quality, resonance and anti-resonance in the nasal cavity additionally contribute. Resonances in the nasal cavity can be seen as additional peaks in the spectrum when compared to the spectrum of oral vowels. The anti-resonance, caused by sound energy absorption in the nasal cavity, results in so called 'antiformants'. Antiformants may affect vowel formants, especially in the F1 vicinity. As a consequence, the F1 amplitude is lowered and its bandwidth is wider (House and Stevens 1956, Ohala 1975, Sampson 1999). These characteristics have been shown to be perceptually salient in terms of vowel nasalization (Delattre 1954 cited in Sampson 1999, House and Stevens 1956, Huffman 1990). Moreover, according to Ohala (1975: 294), formant frequencies are shifted but there are no consistent patterns. In addition, when oral vowels occur in non-nasal contexts, for example, in the contexts of high airflow sounds, e.g. voiceless fricatives or glottal consonants, vowel nasalization can be perceived. Ohala and Amador (1981) (as cited in Ohala 2007) state that the high airflow consonants require a larger opening of the glottis than other voiceless sounds. Via assimilation between vowels and such consonants, the large glottal opening couples the supra-glottal and tracheal cavities. The coupling of the cavities leads to higher damping, resulting in wider formant bandwidths. This again, is perceptually salient in terms of vowel nasalization.

Moreover, vowel nasalization differs across vowels. Nevertheless, it is difficult to draw conclusive generalizations since results from different studies conflict. First, it has been proposed that the velopharyngeal opening of low vowels is greater than that of high vowels which also means the velum is lower for low vowels (Ruhlen 1973, Delvaux, Metens and Soquet 2002, Rossato, Badin and Bouaouni 2003). The greater velopharyngeal opening implies more nasalization. Additionally, perception studies found that low vowels are perceived as more nasalized than mid and high vowels (Ali, Gallagher, Goldstein and Daniloff 1971, Lintz and Sherman 1961). However, there are counterexamples from cross-linguistic studies showing that the velopharyngeal port does not relate to vowel heights in a systematic way. In these studies, results from languages like French and English show the inverse relationship between vowel heights and velopharyngeal ports, where low vowels have the larger port. However, a few languages do not show such a relationship (Clumeck 1976, Al-Bamerni 1983 cited in Hajek and Maeda 2000). Hajek and Maeda (2000) have argued against the inverse relationship of vowel heights and nasalization. Instead, they propose two universals regarding nasalization, in which only one relates directly to vowel heights. In the first universal, nasalization of high vowels is preferred since they can be perceived as nasalized when acoustic

[5] *Nasalized vowel* refers to vowels which are phonetically nasalized through the context of nasal consonants. *Nasal vowel* refers to phonemically distinctive vowels.

distortion is low. As nasal coupling increases, high vowels are perceived as nasalized sooner than low vowels. This is because the effect of nasalization on the acoustic property is more susceptible in high vowels. The small degree of nasality can cause more acoustic changes to high vowels than low vowels which means that nasality preferably occurs in high vowels. The second universal is the relationship between duration and nasalization. With an increase in vowel duration, the perceptual salience of nasalization increases as well (Delattre and Monnot 1968, Whalen and Beddor 1989). Hajek and Maeda (2000) suggest that the relationship between nasality and low vowels might not be directly related to vowel heights. Instead, they propose vowel duration as the driving factor for increased nasalization in low vowels. Low vowels are intrinsically longer than other vowels; therefore they are more likely to become nasalized. In the present paper we found support for the view that low vowels remain nasalized without final velar nasal consonants, while mid vowels are nasalized with the emergence of final nasal consonants in Pwo spoken in the Mae Phae Luang village.

The Karen are a large ethnic minority group in Thailand and Myanmar. The approximate population in Thailand is 500,000 (with another estimated 5 million people in Myanmar). Luangthongkum (2014: 86) states that there are six Karen groups living in Thailand, namely, Sgaw, Pa-O, Pwo, Kayaw, Kayan and Kayah. Most of them live in provinces along the northern and western borders between Thailand and Myanmar. As a result, Thai, a Tai-Kadai language, influences Karenic languages, members of the Tibeto-Burman group of the Sino-Tibetan language family, in various aspects. This study examined the possible influence of Thai on nasality in Pwo. Thai and Pwo have different sound systems. Thai has vowel length contrasts, but Pwo does not. Phonemically Thai possesses oral vowels only, but Pwo has both oral and nasal vowels. Furthermore, Thai (both the standard and northern varieties) has nine final consonants which are /p, t, k, m, n, ŋ, w, j, ʔ/, but Pwo does not have any final consonants. This is, however, different from Proto-Karen which is believed to have had only oral vowels and final consonants, including nasal consonants, namely, *m, *n and *ŋ (Jones 1961, Manson 2009, Luangthongkum 2014). Proto-Pwo is reconstructed as having nasal vowels as is also the case in Modern Pwo (Jones 1961: 100-107; Jones does not mention final nasals; presumably there were no final nasals at the time). Below is the Proto-Karen reconstruction proposed by Jones (1961) which is presented here to show the hierarchy of Proto-Karen, Proto Pwo and Modern Pwo (Moulmein Pwo and Bassein Pwo).[6]

[6] Note that Proto-Karen reconstruction from Jones (1961) has been disproved by later studies (Burling 1969, Shintani 2002) which find that Pwo and Sgaw are closely related and Pa-O is the most distant Karenic language within the family.

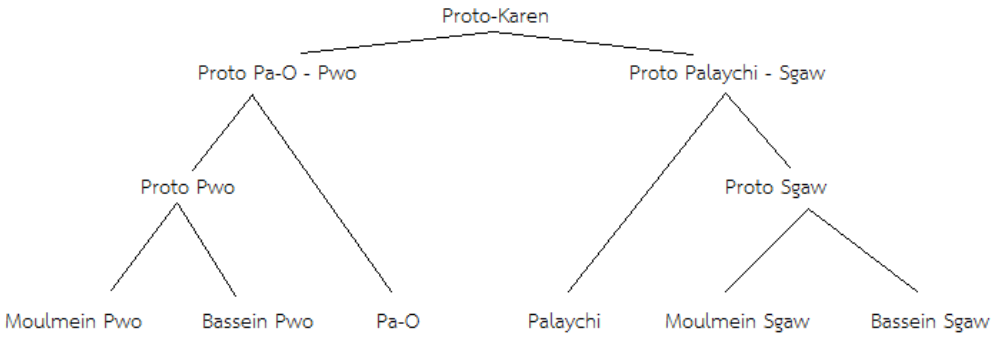


Figure 1 Genetic relationship of Karenic languages (adapted from Jones 1961).

In addition, at least in the Mae Phae Luang dialect of Pwo (henceforth MPL Pwo), there is, for some speakers, sporadic occurrence of final velar nasal consonants after the nasal vowels. The explanation for the emergence of nasal vowels in Proto-Pwo would be that nasal vowels were developed through extensive coarticulation of oral vowels with the following lowering of the velum to provide a velopharyngeal port for acoustic coupling of the oral and nasal cavities for final nasal consonants. In addition, the articulatory closure of the old final nasal consonant was lost, thus retaining the nasal characteristics only in the vowel. (see details in Sampson 1999, 25-28). As a result, nasality gained a contrastive role in the vowel system. The phonetic realization of nasal vowels can vary according to the vowel quality and speakers' age. The nasal vowels are expected to be nasalized with no final nasal consonants once the nasal vowel evolution is completed. However, phonetic final nasal consonants can later emerge in some contexts. The vowels may then change back to oral vowels. This means that the possible phonetic realizations of nasal vowels are [ṽ], [ṽ$^{\eta}$] and [vŋ].

In preliminary listening experiments, we perceived final nasal consonants in words containing nasal vowels in the speech of a young Pwo speaker who was originally from the Mae Phae Luang village, Mae Hong Son, but had been living in Bangkok for more than four years. This seemed to reflect the influence of Thai on this young Pwo speaker's speech. So it is possible that the language contact with Thai may also induce final nasal consonants to occur in other Pwo speakers' speech. Moreover, nasal vowels of Pwo speakers who differ in age are expected to be different. The older people tend to have less contact with Thai so they are expected to still preserve the full nasal vowels. On the other hand, younger speakers are more likely to come into contact with Thai so they might tend toward Thai rhyme construction of vowels plus final consonants, turning vowels more oral and adding final nasal consonants.

The fact that Pwo speech might be influenced by Thai should not be surprising. It is in line with studies on other aspects of the language which show the effect of language contact on Karenic languages. For

example, while in other Tibeto-Burman languages the basic word order is APV[7], the Karenic languages have AVP like most Southeast Asian languages in other families (Tai-Kadai and Mon-Khmer; Benedict 1972, Matisoff 2003, Dryer 2008). This suggests their tendency to change as a result of language contact.

The present study was conducted in Mae Phae Luang village, Kong Koi subdistrict, Sop Moei district, Mae Hong Son province in the north of Thailand. Located at about 1,000 meters above sea level, the village is quite isolated from the outside community. There are about 330 households and 1,000 people in the village. According to the villagers, the village is about 200-300 years old. There is no electricity. The water supply is from the mountain. Roads and the elementary school in the village as well as the secondary school in a nearby village in the same subdistrict were built in the early 90s. People still preserve their culture and traditional way of life. Especially older women still make and wear traditional clothes. The older generation normally has never been to school because Thai education was not available for the villagers until early 90s. Only people who are now in their 30s and younger, have had access to schooling and as a result have been exposed to Standard Thai. Most of the villagers are farmers. Some younger people also go to other provinces to work for a short period of time, while older people are less likely to travel to other provinces.

Apart from Standard Thai, some Pwo speakers in the Mae Phae Luang village can also speak Northern Thai and Sgaw. Along with Standard Thai, Northern Thai is spoken in northern provinces of Thailand, for example, Chiang Rai, Chiang Mai, Mae Hong Son, Lam Pang and Phrae. Thus Pwo people who go to work in towns in provinces like Chiang Rai, Chiang Mai and Mae Hong Son become familiar with Northern Thai. Both Standard Thai and Northern Thai have oral vowels and final nasal consonants. Vowels in Standard Thai and Northern Thai - the main contact languages of MPL Pwo - are phonetically nasalized in some contexts (Haas 1964, Noss 1964, Katsura 1969). In contrast to Pwo, nasalization in Thai varieties is weaker and less audible, and does not have phonological value. Some Pwo people from Mae Phae Luang village have social relations with Sgaw speakers in Sgaw villages in a nearby subdistrict of 'Pa Pong'. Some learn Sgaw from working with Sgaw people in other provinces. As a result, some Pwo people can communicate in Sgaw. Sgaw, like most Karenic languages, only has oral vowels and does not have final consonants. Phonetic vowel nasalization is found when oral vowels follow initial nasal consonants.

Our hypothesis is that the high degree of contact between Pwo and Thai influenced the phonetic realization of nasalization in the vocalic parts of the vowels. Because younger speakers are exposed to Thai to a drastically higher degree (typically they are fully bilingual), they are expected to show the results of a change in nasalization more clearly compared to older speakers. This means that younger speakers' nasal vowels should (a) contain a proportionately shorter

[7] APV are the abbreviations for Agent, Patient and Verb.

nasalization duration and (b) have a higher number of nasal consonants following the vowel. This was tested in the following experiment in which we examined mid and low nasal vowels of older and younger Pwo speakers. Both the absolute and proportional vowel nasalization and consonant duration were calculated and compared between the two groups. Since we compared segment durations between different age groups, such durations were influenced by the overall articulation rate of a speaker which typically decreases with age. For this reason, processing of proportional segment durations within a syllable was found to be essential.

2. Methods

Nasalization duration corresponded to the nasality present in the vowel portion of nasal vowels. Consonant duration corresponded to the final nasal consonant. Unlike nasalization duration, it was not present in every occurrence of nasal vowels. Final nasal consonants were expected only in the speech of younger speakers but we also found them in the older ones. For this reason, we also compared consonant duration between the two groups.

2.1 Participants

Data from 19 male speakers were analyzed and they could be divided into 2 groups based on their age. The 10 speakers aged between 50 to 75 are named the 'old' group. The 9 speakers aged between 24 and 35 were named the 'young' group. They all had Pwo parents and they typically had knowledge of Standard Thai, Northern Thai and Sgaw, but the level of proficiency varied.

2.2 Corpus

Every test word containing a monophthongal nasal vowel in our word list was monosyllabic and had an initial unaspirated stop as shown in Table 1. These four nasal vowels formed the only group of nasal vowels which were monophthongal. The tone was not controlled because it was previously reported that it does not affect nasalization (Onsuwan 2005). Words were recorded in isolation. The number of tokens analyzed were 223 containing /ə̃/, 333 containing /õ/, 274 containing /ã/ and 434 containing /ɔ̃/.

For the recording, two microphones were used. The main microphone was an omnidirectional microphone that was part of our Laryngograph equipment. A second microphone was unidirectional and was used as a backup. The recording software was SPEAD3 which was used with the Laryngograph microphone and Audacity with the backup microphone. The recording was mono at a sampling rate of 32 kHz. Both microphones were placed about six inches from the speakers' lips. Before making the recording, we first checked with each participant if he knew the Pwo words for the given Thai meanings. Every participant was able to provide Pwo words for the equivalent Thai meanings. To record the data, the participant was asked to pronounce each Pwo word at his natural speech rate after hearing the Thai meaning given by the first author.

Vowel	Word	Meaning
/ə̃/	/kə̃33/	lazy
/õ/	/tõ33/	to scoop water up
	/dõ42/	drum
	/kõ33/	lamp
	/kõ44/	slingshot
/ã/	/bã33/	bamboo shoot
	/bã42/	yellow
	/tã33/	thick
/ɔ̃/	/bɔ̃33/	fat
	/bɔ̃42/	to pour
	/dɔ̃33/	to be related by marriage
	/dɔ̃42/	to put a pot on the stove
	/tɔ̃42/	to poke

Table 1 Nasal vowel test words in Pwo.

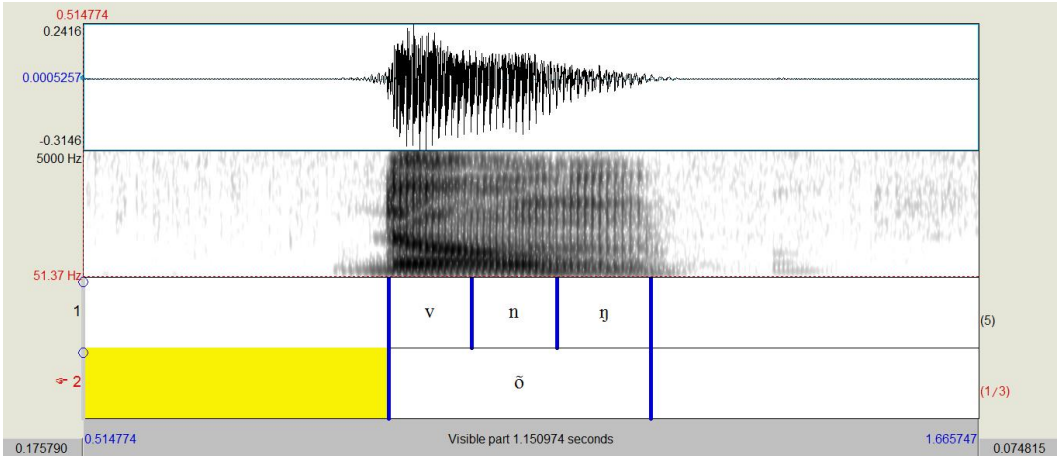


Figure 2 An example of boundary placement among the oral and nasalized parts of the vowel and the final nasal consonant in the word /dõ42/.

2.3 Acoustic analysis

The recorded data were processed with Praat version 5.3.80. The phonemically nasal vowels were segmented into the oral portion (v), nasalized portion (n) and final consonant (ŋ) where applicable. The oral duration (o.d.), nasalization duration (n.d.) and consonant duration (c.d.) were then measured. Apart from the vowel onset, the acoustic criteria for the detection of the boundaries (oral to nasalized portions, nasalized portion to final consonants, consonant or vowel offset) are highly arbitrary as the articulators produce subtle and smooth articulatory movements that result in continuous acoustic changes with a high level of co-articulation. As such, boundary detection based on acoustic criteria can only be an indicator which requires auditory evaluation. For this reason, we first applied boundary detection based on acoustic criteria and second, an auditory correction procedure. Both steps are described in the following:

Acoustic boundary detection: Onsuwan (2005) formulated a number of criteria to obtain the boundaries of nasalized vocalic portions through the inspection of FFT (Fast Fourier Transform) plots and spectrogram. For the FFT analysis, she inspected each spectral frame to determine where the nasal formant - arising from the resonance in the nasal cavity - first appeared. The boundary was put at the place where the first spectral frame which showed the nasal formant was located (based on nasal formant peak, F1 bandwidth and F1 amplitude lowering). This method, however, is only applicable when the two lower formants are well separated which is typically not the case in back vowels. For this reason, we could not apply the FFT analysis in this study. For the spectrographic analysis, antiformants were examined (low amplitude gaps between formants). Because our data was recorded under fieldwork conditions in a room with some reverberation, such low amplitude regions were typically difficult to detect. A helpful cue was an overall drop in energy between the oral and the nasalized part of the vowel (in particular F1 and F2 energy). Boundary detection between the nasalized vocalic part and nasal consonant could typically be observed by a further drop in energy above F1 and by the formation of nasal formants. Figure 2 shows an example where some of the acoustic criteria can be observed (a drop in energy between oral and nasal vocalic part and formation of nasal formant between nasalized vowel and consonant). Vowel onset was at the first zero crossing of the first period in the waveform. Vowel offset was determined to be the last zero crossing of the period in the waveform that resulted in a prominent visible pulse in the spectrogram.

Figure 2 shows an example of segmentation. The phonemically nasal vowel /õ/ was divided into 3 intervals. The oral portion of vowel was labeled ‘v’, the nasalized portion of the vowel was labeled ‘n’, and the final velar nasal consonant was labeled ‘ŋ’.

Auditory boundary correction: As stated above, the visible spectral cues could only serve as rough indicators of the location of the respective boundaries. For this reason boundary placement underwent an auditory correction. The first author of the paper repeatedly listened to the segments and adjusted the boundary to the place that

differentiated vocalic and consonantal parts best. We also had two other labelers, who segmented part of the data using the same method. Because this procedure was highly subjective we calculated an average disagreement between different labelers. This was done in the following way:

- We chose all mid vowel tokens (N = 57) from two randomly selected speakers who had final nasal consonants in the mid vowels (one young and one old). Only mid vowels were selected because they allowed us to check both nasalization duration and consonant duration across different labelers.
- We let two additional labelers label the 57 tokens according to the auditory method described above.
- For each token, we calculated differences between all possible labeler pairs.
- We calculated the average of the absolute labeler-pair differences (labeler error). This average resulted in 14 ms.
- Where applicable (see results), we moved the distributions closer together by adding/subtracting the labeler error for each sample.
- We carried out hypothesis testing (Wilcoxon test[8]) before and after the labeler error was applied. The non-parametric Wilcoxon test was chosen because our data was unimodally distributed as seen in Figure 3, but visible inspection let us assume that the data were not perfectly normally distributed.

Calculation of proportional nasalization duration: In the results section (below) we carried out comparisons between the young and old groups in which syllables were either mixed (with and without final consonant) or unison (all syllables either with or without final consonant). When syllables were mixed, the proportional nasalization duration (%nasalization) was calculated based on the vowel duration only (i.e. excluding the final consonant; % nasalization = nasalization duration*100/vowel duration). In the unison condition, the percentage was calculated based on the entire rhyme duration including the final consonant.

3. Results

3.1 Nasalization duration

The old group had significantly longer nasalization duration, both absolute and proportional (%), than the young group as shown in Figure 4, top and bottom respectively. The old group's average nasalization duration was 176 ms, while that of the young group was 136 ms ($W = 288462$, $p < 0.01$). The average percentage values of nasalization duration were 45% for the old group and 43% for the young group ($W = 224986$, $p < 0.01$). We introduced the labeler error (see 2.3) to the data by subtracting 7 ms. from each token of the old group and adding 7 ms. to each token of the

[8] The Wilcoxon test or Wilcoxon rank-sum test is a non-parametric test which is suitable for data that are not normally distributed. It is used to compare two independent groups of data. Its calculation is based on the sum of ranks of the observed data. (Triola 2004)

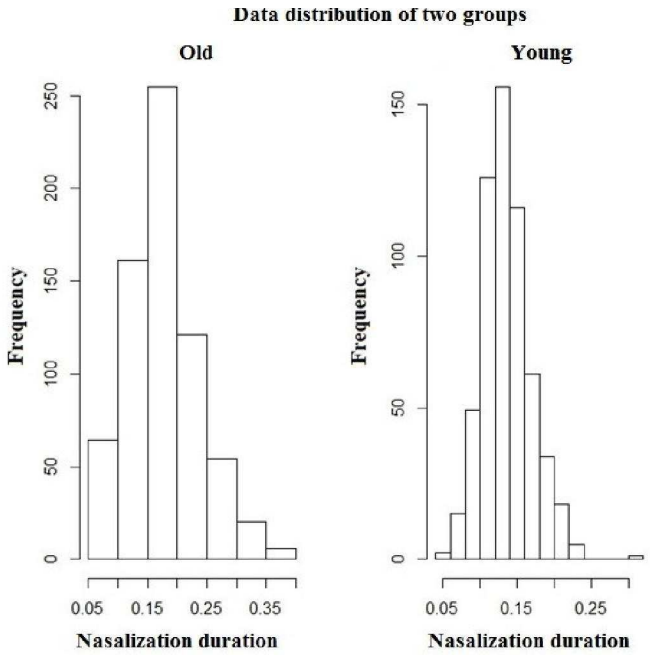
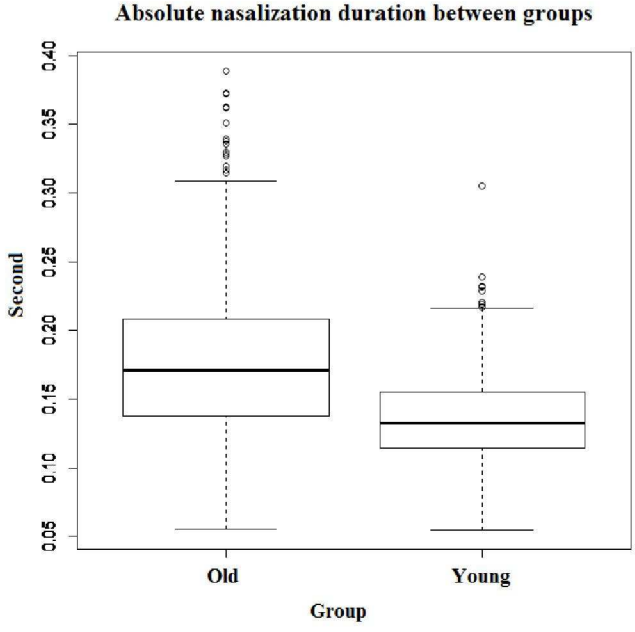


Figure 3 Distribution of nasalization duration in the old (left) and young (right) groups.



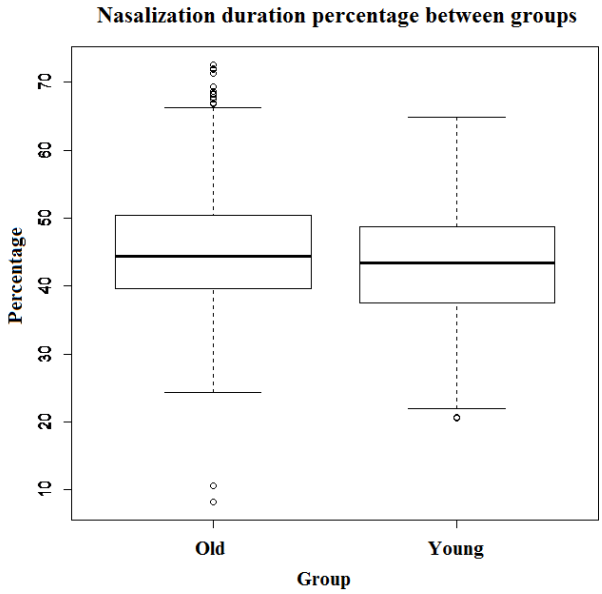


Figure 4 Distribution of the absolute (top) and proportional nasalization duration (bottom) between the old and young groups.

Group / Vowel	Old (%)	Young (%)	Significance
/ə̃/	42.27	41.62	-
/õ/	51.81	45.74	$p < 0.0125$
/ã/	43.2	42.28	-
/ɔ̃/	43.7	42.14	-

Table 2 Percentages of nasalization duration between two age groups.

young group. We then ran the Wilcoxon test on the data containing the labeler error. Comparing results on absolute nasalization duration, we found the same results from the two sets of data: original data and data with introduced labeler error. The old group had significantly longer nasalization than the young group at $p < 0.01$ ($W = 288462$ for data without labeler error and $W = 257626$ for data with labeler error). Therefore, the results supported the hypothesis that the older group had longer nasalization duration than the younger group.

The results on the proportional values of nasalization duration of each vowel between the two age groups revealed that only /õ/ had a significant effect as shown in Table 2 (W

= 19362, p < 0.0125). However, the relational patterns still remained the same across vowels. The old group had longer percentages of nasalization duration than the young group.

3.2 Consonant duration

Only mid nasal vowels /ə̃/ and /õ/ had final nasal consonants which were always velar. Furthermore, final nasal consonants were found in both speaker groups. The assumption that only younger speakers had final nasal consonants because of a possible contact with Thai is thus not supported. In addition, we hypothesized that the consonant duration of the older group would be shorter than that of the younger group. The opposite, however, was the case. The old group had significantly longer absolute consonant duration than the young group (Figure 5, top; W = 13530, p < 0.01). The old group's average consonant duration was 112 ms., while that of the young group was 100 ms.. The old group also had a higher proportional consonant duration compared to the young (Figure 5, bottom); however, this effect was not significant (W = 199302, p = 0.8696). The average proportional consonant duration pooled from the two mid vowels was 29% for the old group and 27% for the young group. The proportional values of consonant duration of each vowel between the two age groups are shown in Table 3. These results are not in line with our hypothesis that consonant duration should be longer in younger speakers.

Furthermore, proportional durations of speakers with and without final nasal consonants were compared in Figures 6 and 7. As shown in Figure 6 (top) for /ə̃/ for 11 speakers with final nasal consonants, the proportional nasalization duration of the young group was longer than that of the old group. The effect, however, was not significant (W = 1848, p = 0.3061). The consonant duration of the old group was longer than that of the young group, but, again, there was no significant effect (W = 2550, p = 0.219). This contradicted our hypothesis that the older group would have shorter consonant duration than the younger group. This may mean that the old group tried to preserve nasality via the final nasal consonant. Figure 6 (bottom) shows the proportional durations for the 8 speakers that did not have final nasal consonants for the vowel /ə̃/. It can be seen that the old group had longer nasalization duration than the younger group. Again the effect was not significant (W = 1167, p = 0.6379). Thus only a descriptive tendency in favor of our hypothesis that young speakers showed shorter nasalization duration could be observed.

Figure 7 shows the equivalent data for /õ/ that was presented in Figure 6 for /ə̃/. The 10 speakers of the old group had longer nasalization duration (n.d.) than that of the young group (Figure 7, top). This effect was significant (W = 4485, p < 0.01). The final nasal consonant duration (c.d.) of the old group was also longer than that of the young group, but not significantly so (W = 3712, p = 0.6219). Overall, the nasalization of the older group was better preserved than the younger group. They managed to maintain more nasality in the vocalic portion and a longer final nasal consonant. Figure 7 (bottom) reveals that for the 9 speakers without final consonants, the old group had longer nasalization duration than the young

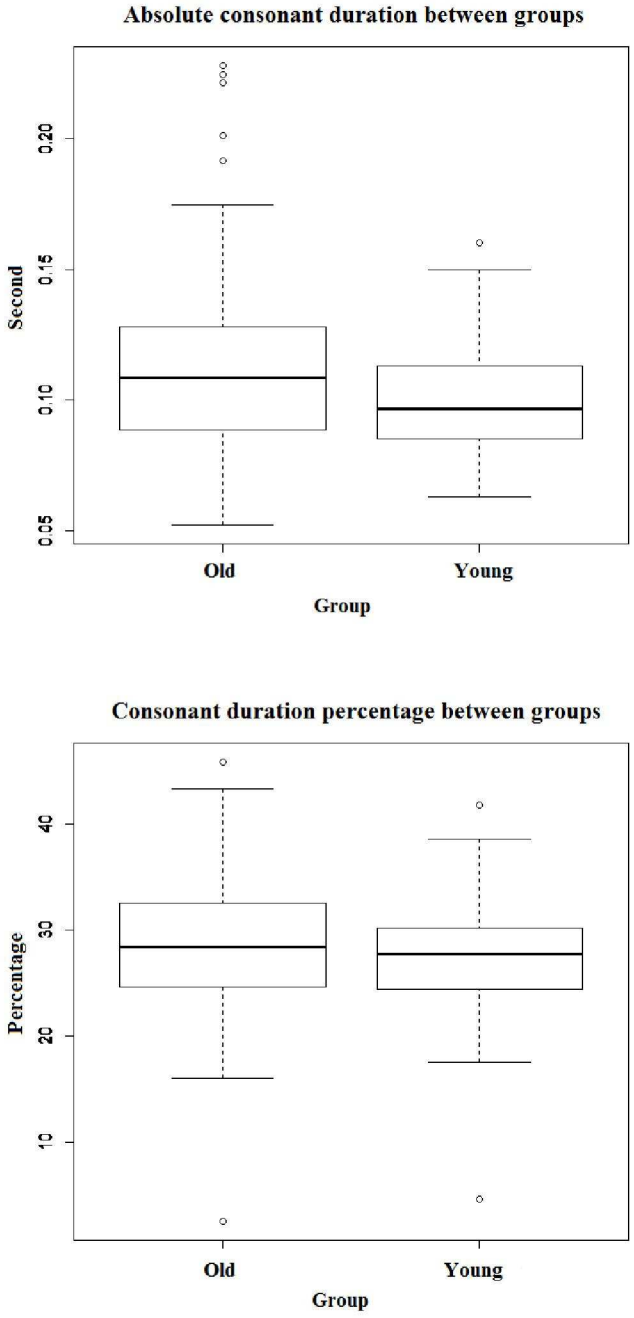


Figure 5 Distribution of the absolute (top) and proportional (bottom) final consonant duration between the old and young groups.

Group / Vowel	Old (%)	Young (%)
/ə̃/	28.37	25.9
/õ/	29.3	28.61

Table 3 Percentages of consonant duration between two age groups.

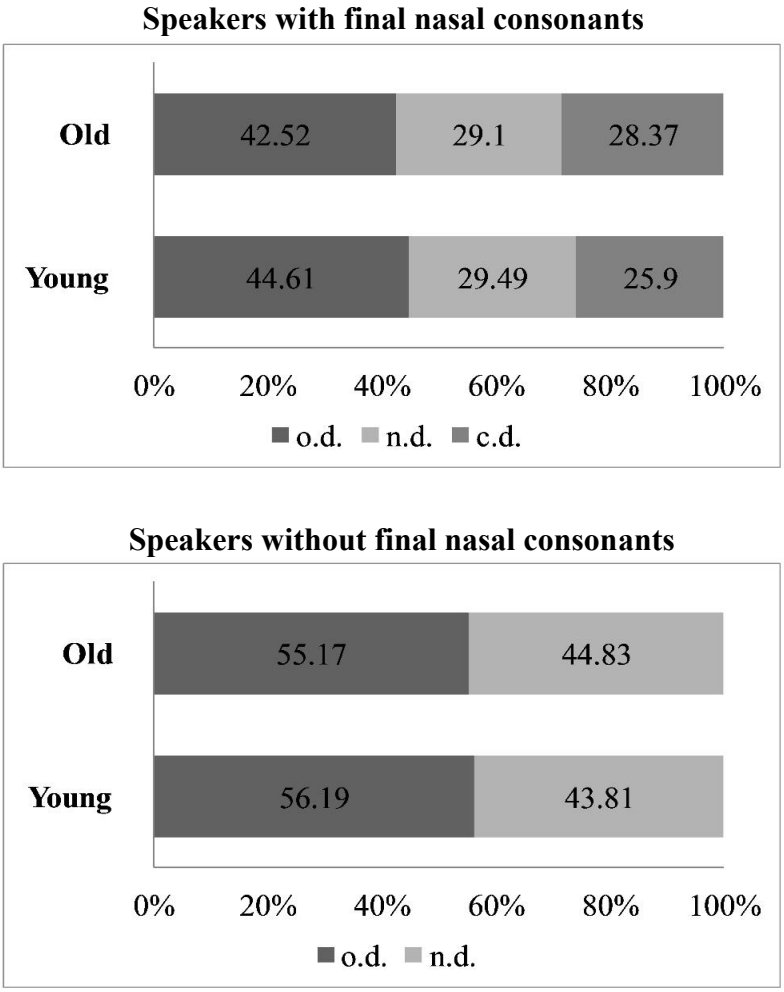


Figure 6 Proportional oral duration (o.d.), nasalization duration (n.d.) and consonant duration (c.d.) of /ə̃/ for the two age groups old and young, divided into speakers who had final nasal consonants (N=11, top) and who did not have final nasal consonants (N=8, bottom)

group. The effect was significant ($W = 4897$, $p < 0.01$) and is well in support of our hypothesis that young speakers showed shorter nasalization duration.

3.3 Nasality and vowel duration

In this section, we present average values of absolute durations of nasalization duration, vowel duration, consonant duration and rhyme duration. In the low vowels (Table 4), the nasalization duration of the old group was longer than that of the young group (significant at $p < 0.01$). The vowel duration was also significantly longer for the old group ($p < 0.01$). The durations for mid vowels are shown in separate tables. Table 5 shows data of those speakers who did not have final nasal consonants (non-C group), and Table 6 shows data of those speakers who did have final nasal consonants (C group). As can be seen in Table 5, both the nasalization duration and the vowel duration of the old group in mid vowels were significantly longer than those of the young group ($p<0.01$).

Table 6 shows that, for /ə̃/, the nasalization duration of the old group was longer than that of the young group; however, the effect was not significant ($W = 1875$, $p = 0.3703$). The vowel duration, in contrast, was shorter for the old group, but also not significantly so ($W = 2070$, $p = 0.983$). The consonant duration was significantly longer for the old group ($W = 2622$, $p < 0.01$). The rhyme duration was longer for the old group, but not significantly so ($W = 2245$, $p = 0.3961$). The mid vowel, /ə̃/, presented the only case of an inverse relationship in which the nasalization duration was longer when the vowel duration was shorter.

In Table 6, for /õ/, the nasalization duration of the old group was significantly longer than that of the young group ($W = 4461$, $p < 0.01$). The vowel duration was longer for the old group, but not significantly so ($W = 4118$, $p = 0.07633$). The consonant duration was longer for the old group, but not significantly so ($W = 4268$, $p = 0.02477$). The rhyme duration was longer for the old group, also not significantly so ($W = 4250$, $p = 0.02865$).

4. Discussion and conclusion

In the present study, we found that the phonetic realization of nasal vowels between two age groups of Pwo speakers varied in many respects. However, the differences did not always meet our expectations. In the introduction, we argued that younger speakers of Pwo are exposed to Thai to a drastically higher degree (typically they are fully bilingual) and that, as a result of this, we expected them to show the results of a change in nasalization more clearly, compared to older speakers. This means that hypothetically they should (a) reveal a proportionately shorter nasalization duration and (b) have a higher number of nasal consonants following the vowel. The results of the nasalization duration generally supported (a); however, the finding of final nasal consonants in the older group was not in line with (b). In other words, the older group had more overall nasality. They preserved nasality by maintaining it in vowels and also using final nasal consonants. The younger group had shorter overall vowel duration and also showed less nasalization. We did not find any evidence for the view that this decreased nasalization

Vowel	Group	Nasalization duration	Vowel duration
/ã/	old	177	413
	young	143	346
/ɔ̃/	old	177	407
	young	140	338

Table 4 Average absolute durations (ms) of low nasal vowels between two age groups.

Vowel	Group	Nasalization duration	Vowel duration
/ə̃/	old	214	474
	young	152	358
/õ/	old	238	465
	young	145	313

Table 5 Average absolute durations (ms) of mid nasal vowels between two age groups (non-C group).

Vowel	Group	Nasalization duration	Vowel duration	Consonant duration	Rhyme duration
/ə̃/	old	115	283	110	393
	young	114	285	99	385
/õ/	old	139	273	113	421
	young	111	248	100	373

Table 6 Average absolute durations (ms) of mid nasal vowels between two age groups (C group).

These results possibly shed some light on sound change. Proto-Karen supposedly had oral vowels and final nasal consonants *m, *n and *ŋ (Jones 1961, Manson 2009, Luangthongkum 2014). Jones (1961) also proposes that Proto-Pwo had nasal vowels. Then in Modern Pwo in Mae Phae Luang village, mid and low nasal vowels were found. The phonetic realization of mid and low nasal vowels was different. The phonetic final nasal consonant [ŋ] was found only in mid nasal vowels of some Pwo speakers, not in low nasal vowels. The place of articulation of the emergent final nasal consonants is not related to the places of articulation of the final nasal consonants of Proto-Karen, but is rather the nasal consonant that needs the least adjustment in vocal tract configuration. In this stage, it was probably a change due to a language internal factor: the vowel quality. From our results, the mid nasal vowels had final nasal consonants for some speakers while retaining nasality. The low nasal vowels remained nasalized without the emergence of final nasal consonants. This is in accordance with the received relationship between nasality and vowel quality according to which low vowels are more prone to nasality. Some studies have found that the velopharyngeal opening of low vowels is greater than that of high vowels. In other words, the velum is lower for low vowels (Ruhlen 1973, Delvaux et al. 2002, Rossato et al. 2003), thus implying the higher tendency for low vowels to become nasal vowels. Therefore, the results of our study support the notion of vowel height and nasality since only the low vowels remained nasalized without the final nasal consonants, suggesting its higher compatibility with nasality. Moreover, we found indirect evidence which reflects the denasalization of high nasal vowels. From mapping some reconstructed words of Proto-Karen from Luangthongkum (2013) to corresponding words in MPL Pwo, we found that words whose rhyme consists of high oral vowels and final nasal consonants in Proto-Karen became words whose rhyme contains only oral vowels and no final nasal consonants in MPL Pwo. So we hypothesized that Proto-Karen rhyme of high oral vowels and final nasal consonants became high nasal vowels in Proto-Pwo. These nasal vowels were then denasalized later. This evidence, nevertheless, needs to be treated with caution since we could not be certain what changes occurred during Proto-Pwo. The proposed development of high nasal vowels in Pwo is, thus, only our speculation. If we believe such a development has occurred, then we would have supporting evidence for the relationship between nasality and vowel quality in which high nasal vowels were fully denasalized with no compensatory final nasal consonants, mid nasal vowels had final nasal consonants for some speakers while maintaining nasality, and low nasal vowels remained nasalized without final nasal consonant emergence.

However, Hajek and Maeda (2000) suggest that results of cross-linguistic studies showing that nasalization prefers low vowels might not directly relate to vowel heights. It is, instead, the relationship between vowel duration and nasality that plays a role. Long vowels are more likely to become nasalized than short vowels. Low vowels are intrinsically longer than other vowels so they are more likely to become nasalized. And, as explained in the introduction, long vowels are more prone to be perceived as

nasalized compared to short ones. Our results contain support for the view of a relationship between nasalization duration and vowel duration. We found that when the average values of vowel duration of the older group are longer than those of the younger group, the average values of nasalization duration are also longer (except for /ə̃/ of speakers who have final nasal consonants). However, the vowel duration between two age groups differs significantly ($p < 0.01$) only for low vowels and mid vowels of those speakers who do not have final nasal consonants. When they do, the nasalization duration of the older group is also significantly longer than that of the younger group. So our results also seem to be in favor of the relationship between vowel duration and nasalization to a certain degree.

In addition, the results of this study can be viewed as supporting progresses of the possible nasal vowel evolution's path. Ruhlen (1973) proposes that nasalization from low vowels to high vowels. In contrast, denasalization is believed to start from high vowels before spreading to mid and low vowels, respectively. So our findings on phonetic realization seem to reflect the denasalization since the high nasal vowels are already denasalized, the mid nasal vowels are losing nasality and the low nasal vowels still maintain full nasality without the emergence of final nasal consonants.

Furthermore, we could not firmly confirm that the emergence of final nasal consonants in mid nasal vowels was a result of Thai influence, either Standard Thai or Northern Thai, on Pwo Karen speakers. The results showed that both younger and older speakers had final nasal consonants in mid nasal vowels. Thus, the existence of final nasal consonants in the younger group could not prove that it was the effect of language contact. At the same time, low vowels did not have final nasal consonants, pointing to vowel quality as the internal factor. However, it is possible to interpret that the final velar nasal consonant emergence was a change due to vowel quality which was induced by language contact with Thai, whose phonological system includes the final velar nasal, in both speaker groups. Both groups of MPL Pwo speakers came into contact with Thai language, but to different degrees. This might be why final nasal consonants were found in the speech of some speakers in both groups.

Moreover, if nasal vowels are lost, there are two possible developments. The first one is the compensation of nasality through final nasal consonants. Here the vowel becomes oral, and nasality is shifted to final nasal consonants. This would be a likely effect from the contact with Thai, which has VN structure. The second possibility is dropping nasality all together. What remains are oral vowels with possible change of vowel quality (Sampson 1999). MPL Pwo seems to head in the direction of the second possibility since in the younger group, the nasality of vowels decreases with no emergence of compensatory final nasal consonants. This indicates that the development of nasal vowels is in line with other Karenic languages. Apart from Pa-O which preserves all three original final nasal consonants, m, n and ŋ, and Kayan which has final velar nasal consonant (Manson 2007: 13), all Karenic languages drop proto final nasal consonants. This results in open

syllable structure with oral vowels. So the acoustic characteristics of mid nasal vowels of younger speakers, shorter nasalization duration corresponding to nasality loss in vowels and shorter consonant duration corresponding to the lack of nasality compensation via final nasal consonants, might reflect its tendency towards oral vowels only in the future.

For future work, the next step of the study is to look at other Pwo varieties in Thailand and Myanmar. Preliminary analysis of Pwo data from Kanchanaburi province suggests that final nasal consonants appeared regularly in close juncture and sporadically in other contexts in both older and younger speakers, but nasality appears to be decreasing generally in the younger generation.

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