

# PHONETIC REALIZATION OF NASAL VOWELS IN PWO

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## ABSTRACT

The relationship between vowel nasalization and vowel quality has been examined in many studies, yet results are conflicting. This study examined nasal vowels in Pwo language. The result showed that low nasal vowels had more nasalization than mid nasal vowels. A high correlation between nasalization and vowel duration was also found. Additionally, percentages of the total nasal duration were roughly similar across vowels. Possible explanations were offered for the observed patterns.

**Keywords:** nasal vowel, vowel nasalization, Karenic language, Pwo, acoustic study

## 1. INTRODUCTION

Vowel nasalization has been studied extensively in various fields of research: articulatory, acoustic and perceptual. However, the link between vowel quality and nasalization is not conclusive since many studies show conflicting results. A number of studies find a relationship between vowel heights and nasalization, where nasalization prefers low vowels over high vowels. For example, [3] finds that the velopharyngeal opening (VPO) is greater for French low vowels than non-low vowels. A greater lowering of the velum suggests more nasalization. However, [1] cited in [4] offers contrasting results. In this cross-linguistic study, [1] reports that the greater VPO occurs in mid-high and high back vowels in Gujarati and Hindi. In addition, [4] gives great details on studies where high vowels are preferred. In short, high vowels require a lesser degree of nasal coupling to be perceived as nasalized, and they are judged as nasalized sooner than low vowels. This is because a small degree of VPO can distort acoustic characteristics of high vowels more than low vowels.

[4] then propose that nasalization preferring low vowels is due to the longer duration of these vowels. Long vowels are more likely to become nasalized than short vowels. Since low vowels are intrinsically longer, they are more likely to become nasalized. Perceptual tests provide supporting evidence for this claim [2][10]. For instance, [2] finds that French speakers perceive shorter stimuli as oral vowels and longer stimuli as nasal vowels.

The present study then investigated the relationship between vowel quality and nasalization in Pwo, in which vowels contrast in nasality, to offer additional data to the issue. Pwo, which is an understudied language, belongs to the Karenic subgroup in the Tibeto-Burman group of the Sino-Tibetan family [6]. Pwo speakers in Thailand live mostly in provinces along the northern and western borders to Myanmar. Unlike other Karenic languages, Pwo possesses two sets of vowels: oral and nasal, with no length contrast. The nasal vowels develop from oral vowels before final nasal consonants in Proto-Karen. Three proto final nasals are reconstructed as \*m, \*n and \*ŋ [5][7]. Over time the final nasals weaken and eventually drop, nasality then has a contrastive role. [5] has reconstructed nasal vowels in Proto-Pwo. In Modern Pwo, however, the presence of final velar nasals could be perceived in the speech of young Pwo speakers. The three possible phonetic realizations of nasal vowels in the language then are [ṽ], [ṽ<sup>h</sup>] and [vŋ]. The emergence of final velar nasals was suspected to arise from language contact with Thai.

The research was conducted in Mae Phae Luang village, Sop Moei district, Mae Hong Son province, which is situated in Northern Thailand and shares borders with Myanmar to the west. The village of about 1,000 inhabitants is located on the mountains, isolated from other communities. People still preserve their culture and way of life.

The goal was to examine the phonetic realization of Pwo nasal vowels with a focus on the relationship between nasalization and vowel heights. The hypothesis was that low nasal vowels had more nasalization than mid nasal vowels. To test the hypothesis, various durations, namely, nasalization duration, consonant duration (if applicable), vowel duration and rhyme duration were compared among four nasal vowels. The different values were also statistically analyzed.

## 2. METHODS

### 2.1. Participants

Data from 19 male speakers aged between 24 to 75 were analyzed. Ten of them were 50-75 years old. The other nine were 24-35 years old. They were

native speakers of Pwo. Most of them also knew Standard Thai, Northern Thai and Sgaw, but the level of proficiency varied.

## 2.2. Corpus and setup

Monosyllabic test words consisted of one of four monophthongal nasal vowels, namely, /ɔ̃, ɔ̄, ɔ̆, ɔ̈/ and an unaspirated stop initial as shown in Table 1. The tone was not controlled since [8] finds that it does not affect nasalization. Test words were recorded in isolation. Two microphones were used: Laryngograph's omnidirectional and Sony's unidirectional (ECM-719) microphones. This was to have backup data. The recording software were SPEAD3 and Audacity for each microphone respectively. The recording was made in mono at a sampling rate of 32,000 kHz. The microphone was placed about 6" from speakers' lips. The number of test tokens were 222 for /ɔ̃/, 335 for /ɔ̄/, 433 for /ɔ̆/, and 274 for /ɔ̈/, thus, in total 1,264 tokens.

**Table 1:** Nasal vowel test words in Pwo.

Vowel	Word	Meaning
/ɔ̃/	kɔ̃33	lazy
/ɔ̄/	tɔ̄33	to scoop water up
	dɔ̄42	drum
	kɔ̄33	lamp
	kɔ̄44	slingshot
/ɔ̆/	bɔ̆33	fat
	bɔ̆42	to pour
	dɔ̆33	to be related by marriage
	dɔ̆42	to put a pot on the stove
	tɔ̆42	to poke
/ɔ̈/	bɔ̈33	bamboo shoot
	bɔ̈42	yellow
	tɔ̈33	thick

## 2.3. Acoustic analysis

The data were acoustically analyzed with Praat. The nasal vowels were segmented into the vowel's oral portion, the vowel's nasalized portion and a final nasal consonant where applicable. The vowel onset began at the first zero crossing of the first period in the waveform. The vowel offset ended at the last zero crossing of the period in the waveform that resulted in a prominent visible pulse in the

spectrogram. The vowel/nasalization and vowel/final nasal boundaries were based on spectrographic cues and auditory judgement. Cues to vowel nasalization on spectrogram were lowered energy especially in lower formants and nasal formant presence. The level of energy was relatively lower in final consonants compared to vowels.

The measurements are made in: 1) oral portion of the vowel/oral duration (OD), 2) nasalization portion of the vowel/nasalization duration (ND), 3) final consonant/consonant duration (CD), 4) vowel duration (VD), 5) total nasal duration (N), combining ND and CD and 6) rhyme duration (RD). These values, except RD, were converted to percentages. Note that the percentage of nasalization duration (%ND) was divided by the vowel duration, while other percentages were divided by the rhyme duration, for example, %ND/R = (nasalization duration\*100/rhyme duration).

## 2.4. Statistical analysis

A non-parametric Kruskal-Wallis test was used to test the differences among the four nasal vowels. Then Wilcoxon rank sum test was applied to test the differences between each vowel pair. The significance level was  $p < 0.01$ .

## 3. RESULTS

### 3.1 Phonetic nasalization of nasal vowels

The phonetic realization of the four nasal vowels differed. The difference could be divided into two groups along the vowel height dimension. Firstly, the mid vowels, /ɔ̃/ and /ɔ̄/, were nasalized with the emerged final velar nasals for some speakers, 11 out of 19 speakers. Within each speaker group who had and did not have final nasals, the age of speakers varied. Secondly, the low vowels, /ɔ̆/ and /ɔ̈/, remained nasalized without final velar nasals for every speaker.

### 3.2. Nasalization duration and vowel duration

Data pooled across speakers in Table 2 showed consistent patterns of nasalization duration and vowel duration. The low nasal vowels had significantly longer nasalization duration than mid vowels in both absolute (ms) and percentage values. Moreover, VD and %VD were significantly longer in low vowels. Spearman's correlation revealed a highly significant correlation between absolute values of nasalization duration and vowel duration ( $r = .95, p < 0.01$ ). Those vowels of longer duration tended to have longer nasalization. Comparing

differences between vowels of the same height, ND and %ND differed significantly only within low vowels. /ã/ had significantly longer nasalization than /õ/. However, their absolute vowel duration did not appear to differ significantly ( $p = 0.39$ ).

**Table 2:** Mean values of ND, %ND, VD, %VD pooled across speakers.

Vowel	ND	%ND	VD	%VD
ẽ	234.88	71.47	321.57	80.28
õ	213	70.63	292.68	79.18
ẽ	280.27	74.48	371.72	100
ã	301.52	77.93	383.48	100

### 3.3. Consonant duration

To study the relationship between CD and other durations, the percentage data in mid vowels of those who had final velar nasals (C group) were investigated as shown in Table 3. Among these values, %ND/R, %CD and %VD of /ẽ/ and /õ/ differed significantly. /ẽ/ had longer %ND/R and %VD but shorter %CD than /õ/. In addition, each vowel showed the inverse relationship between %ND/R to %CD and %VD to %CD. When one was long, the other was short. Moreover, when the vowel duration was longer, the nasalization was also longer, suggesting a correlation between vowel duration and nasalization. Interestingly, the mean %N of both vowels were close with no statistically significant difference between the vowels ( $p = 1$ ).

**Table 3:** Mean values of %OD, %ND/R, %CD, %VD of C group.

Vowel	%OD	%ND/R	%CD	%N	%VD
ẽ	20.41	45.39	34.20	79.59	65.80
õ	20.34	42.16	37.04	79.20	62.5

### 3.4. Total nasal duration

From data pooled across speakers in Table 4, the total nasal duration (N) of 3 vowel pairs differed significantly. They were /ẽ/ - /õ/, /ẽ/ - /ĩ/ and /ã/ - /ĩ/. However, only %N of /ĩ/ differed from the others significantly. While the mean %N of the others were close, approximately 77%, the mean %N of /ĩ/ was significantly shorter. Despite the difference, %N of all 4 nasal vowels were strikingly close, ranging from 74 to 77%

**Table 4:** Mean values of N and %N pooled across speakers.

Vowel	N	%N
ẽ	311.40	77.72
õ	288.63	77.29
ẽ	280.27	74.48
ã	301.52	77.93

## 4. DISCUSSION

Results from the study reveal the differences in phonetic realization between mid and low nasal vowels. While low vowels remain nasalized without final velar nasals, mid vowels show sporadic occurrence of the final nasal consonants among speakers of different ages. This different pattern between two vowel heights supports the nasal vowels' evolution proposed by [9] that nasalization starts from low to high vowels, and denasalization goes in the reverse order. So nasal vowels of Pwo spoken in Mae Phae Luang village seem to undergo denasalization where high vowels are fully denasalized, mid vowels are in process of losing vowel nasalization and low vowels maintain nasalization without final nasal consonants.

Initially it seems that the results support the relationship between nasalization and vowel heights where low vowels are more prone to nasalization, thus confirming the hypothesis. However, the alternative explanation for such pattern lies in the correlation between nasalization and vowel duration. When nasalization, both absolute and percentage values, is longer in low vowels, vowel duration is also longer. In other words, low vowels are longer and therefore have more nasalization than mid vowels. This relationship is confirmed by the high correlation coefficient between the two durations. Thus, this provides further supporting evidence to [4].

The examination of %CD in relation to other durations shows interesting, yet not surprising patterns. The first is the inverse relationship between %VD and %CD. When vowels are long, consonants are short. This is in line with results from other studies on the temporal relations between vowels and consonants [8]. The second is the inverse relationship between %ND and %CD. When vowel nasalization is long, the consonant is short. Moreover, when combining the two durations, the mean duration between /ẽ/ and /õ/ of the total nasal duration is similar.

This brings us to the total nasal duration (N). Regarding the absolute values, the total nasal

duration differs along the front-back dimension. The front vowels have longer N than the back vowels. However, the mean percentages of total nasal duration (%N) among the three vowels, namely, /ĩ/, /õ/ and /ã/ are roughly the same. In contrast, /ẽ/ has significantly lower %N than the other three vowels. This presents us with two interesting aspects. Firstly, that the %N among all three vowels are similar suggests that velum gesture remains stable across vowels. Thus when we see that nasalization of low vowels in Pwo are longer than mid vowels, that might be due to the fact that the whole velum gesture is present in the vowel. As for mid vowels, the velum gesture covers two parts: vowel nasalization and the following final velar nasal. Therefore, the nasalization present in the vowel appears shorter. From comparing absolute duration of total nasalization, [8] also finds roughly constant velum gesture in short/long vowels before final nasal consonants in Thai.

Secondly, the smaller %N found in /ĩ/ may be explained with a physiological constraint. From comparing MRI results among four nasal vowels, /ẽ/, /œ/, /ã/ and /ĩ/ in French, [3] finds that the velum lowers the least for /ĩ/. Its MRI frame displays the median part of the velum touching the back part of the tongue, and consequently, it could not go any lower. If this is also the case in Pwo, it suggests that to maintain vowel-like quality and avoid producing a final velar nasal, the velum lowers later and possibly lesser in /ĩ/. However, /ĩ/ found in Pwo might not be produced with the back of the tongue as high as the one in French. Therefore, other factors might be involved.

In conclusion, vowel nasalization in Pwo spoken in Mae Phae Luang village, Mae Hong Son, Thailand differs among nasal vowels. The low nasal vowels have more nasalization than the mid nasal vowels. This can be explained by its relationship to the vowel duration. The longer vowels have more nasalization than the shorter ones. Thus, low vowels whose vowel durations are greater have longer nasalization than mid vowels. Moreover, the overall nasal duration is similar across vowels. The only nasal vowel which is significantly different from the others is /ĩ/. Its difference could potentially be explained by physiology.

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