PRENASALISED VOICELESS STOPS IN NGKOLMPU

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ABSTRACT

Ngkolmpu (Yam, Papuan) has phonetic prenasalised voiceless stops as phonemic segments. Phonetically, these are characterised by a period of nasalisation which ceases before the release of the consonant. This is followed by a period of clear voicelessness before the commencement of voicing again in the following segment. The voice onset time of prenasalised stops is comparable to those of standard voiceless stops. Phonemically, these are single segments which contrast with voiceless stops at each place of articulation. We can see from phonotactic evidence that these are single segments. Segments of this type are a typological rarity in the worlds languages which is expected given the complexity of the articulatory gestures required to produce.

Keywords: Papuan languages, Yam languages, prenasalisation, voicing

1. INTRODUCTION

Prenasalised voiceless stops are phonetically complex segments involving a period of nasalisation and a voiceless stop. More specifically they involve a voiced nasalised onset which ceases before the release of the stop. Following the release there is a period of voicelessness before voicing commences again in the following segment. A more precise phonetic characterisation is presented in Section 2.

These segments are something of a rarity in the world's languages attested in just 1.77% of languages in the The UCLA Phonological Segment Inventory Database [10] and 3% of those found in the World phonotactics database [3]. This, in many ways, is unsurprising given the complexity of the articulatory gestures in producing these segments.

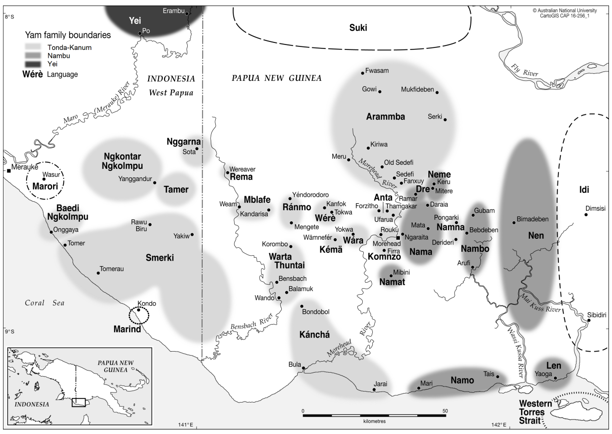
1.1. The Ngkolmpu language

Ngkolmpu is language of the Yam family spoken almost entirely in the village of Yanggandur in the extreme south-east of the Indonesian province of Papua. The primary description is [1].

The variety described here is known as Ngkontar Ngkolmpu which is the variety traditionally spoken in and around Yanggandur. The other variety, Baedi Ngkolmpu, which was spoken in the coastal village of Onggaya is no longer a spoken language. However, there are still six elderly individuals who remember the language but no longer use it as a language of communication. Ngkontar Ngkolmpu is spoken by around 150 people, all over the age of 30 who use it as a day-to-day means of communication alongside the local variety of Indonesian. Children are no longer learning the language and as such it should be classified as endangered. All data in this paper was taken from speakers of Ngkontar Ngkolmpu who have lived in Yanggandur their entire lives.

A map showing the location of the language family is shown in Figure 1. Ngkolmpu is the westernmost language of the family and belongs to the Tonda-Kanum branch. The family is one of the primary languages families of New Guinea and is not considered related to any other language family in New Guinea or elsewhere [4]. As with other aspects of their grammar, the Yam languages display rather unusual phonetic and phonological characteristics compared to the broader New Guinea region. Previous phonetic work on languages of the family is fairly limited, the most significant being Evans and Miller's [5] illustration of the IPA article on Nen.

Figure 1: The Yam Family Languages



1.2. The stop inventory

Ngkolmpu has phonemic stops at three places of articulation: bilabial, alveolar and velar. At each of these places, there is both a voiceless stop and a prenasalised stop. Additionally, there is a voiced bilabial stop. This system is summarised in Table 1.

Table 1: Basic stop inventory of Ngkolmpu

Bilabial	Alveolar	Velar
p	t	k
b		
ᵐp	ⁿt	ᵑk

In some ways this is quite similar to a fairly *typical* Papuan system which involves the primary phonemic contrast for stops being between voiceless stops and prenasalised voiced stops [6] [7]. Phonemically, the major aberration in Ngkolmpu is the presence of a voiced bilabial stop. Phonetically, however, Ngkolmpu is especially remarkable as the prenasalised stops are phonetically voiceless, i.e. they display a period of voicelessness and a positive voice onset time comparable to other voiceless consonants in all phonological environments.

1.3. Methods

All data in this study is taken from recordings made in the field using a Rode HS2 headset microphone connected to a Zoom H4N-pro recorder with a sample rate of 44.1 KHz and a depth of 16 bits. For this particular study, all tokens were taken from wordlist data in which the speaker was asked to translate a list of 398 words from Indonesian. These were all from a single female speaker in her late 40s. This is presented in milliseconds to one decimal place. Though the sample size is small, given the endangered nature of the language, the small speech community, the remoteness and difficultly working in the region along with the paucity of phonetic studies in Papuan languages, this study represents a significant contribution.

2. PHONETIC CHARACTERISTICS OF PRENASALISED VOICELESS STOPS

Phonetically, prenasalised voiceless stops are a combination of a nasal followed by a voiceless oral stop at the same place of articulation. As a continuous segment these involve a full oral occlusion at the place of articulation with the soft palate lowered and the velum open for a period of nasal voicing. Before the stop is released the velum rises, stopping the nasalisation. There is a very short period of non-nasal voicing before the voicing stops. There is a long unvoiced closure and once the consonant is then released there is a period of time before the voicing begins for the following vowel; this period of time is known the voice onset time (VOT).

In Ngkolmpu, prenasalised voiceless stops occur at the bilabial, alveolar and velar places of articulation. Spectrograms of examples of each of the three places of articulation in intervocalic position are provided in Figures 2 to 4. The phonetic characteristics described in the previous paragraph can be seen in each of these spectrograms. The relevant segments are in the middle of each spectrogram and the period of nasalisation, the non-nasalised voicing and the voiceless closure and release are all clearly visible.

The voiceless character of these stops can be measured in terms of VOT. A sample of 60 tokens of prenasalised voiceless stops were randomly selected across three distinct phonemic sites totalling 20 from each site. Tokens were selected from three positions: word initial, intervocalic and syllable initial following a consonant. In non-initial position, these were measured preceding a vowel to ensure the salience of the VOT. VOT of each token was measured from the moment of release to the steady voicing of the following vowel. The mean length of the voice onset time of each of the prenasalised voiceless stops is summarised in Table 2. All means show a positive VOT of well over 20ms in the word initial and intervocalic positions. Stops following another consonant have a reduced VOT closer to zero. However, no token displays a negative VOT and as such are strictly voiceless. We do see that the length of the VOT is dependent on the place of articulation with anterior consonants displaying shorter VOT as is typical cross-linguistically [8, 9].

Table 2: Mean VOT (*ms*) of prenasalised voiceless stops for a single female speaker over 20 tokens of each environment

	#_	V_V	C_V
/ᵐp/	22.4	29.3	15.9
/ⁿt/	24.6	26.8	17.3
/ᵑk/	36.7	34.7	25.9

The same measurement was performed on the non-prenasalised voiceless stops for the same speaker selected in the same manner. This is presented in Table 3. We see longer VOTs in the non-prenasalised voiceless stops compared to the prenasalised ones.

Figure 2: Spectrogram of *baempr* ‘snake’

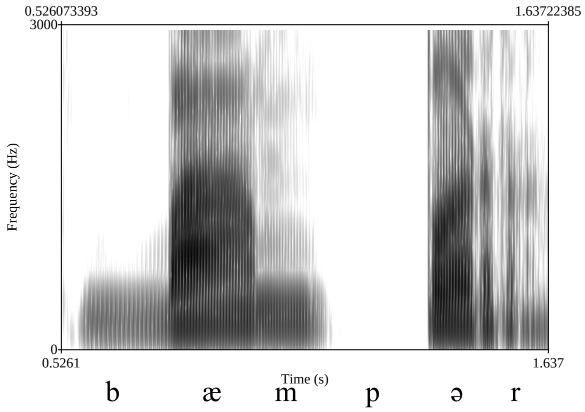


Figure 3: Spectrogram of *sento* ‘bird’

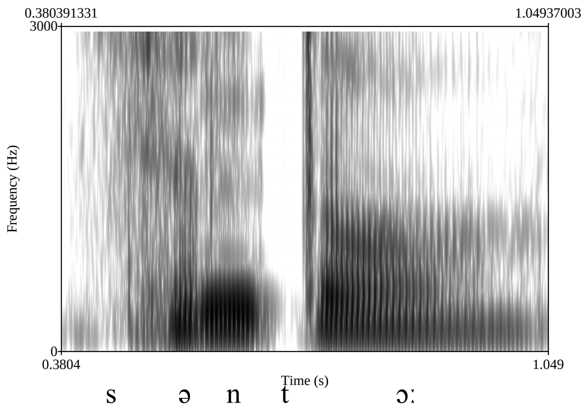


Figure 4: Spectrogram of *kongko* ‘sun’

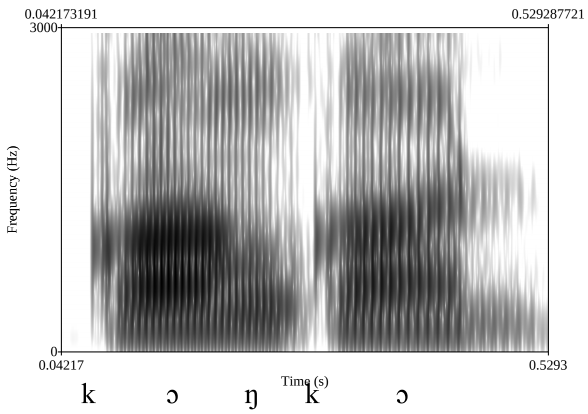


Table 3: Mean VOT (*ms*) of voiceless stops for a single speaker (ML) over 20 tokens of each environment

	#_	V_V	C_V
/p/	28.7	31.8	18.1
/t/	30.5	37.9	21.2
/k/	45.0	41.4	23.4

The absolute differences are summarised in Table 4 which range from 2ms to 16ms depending on place of articulation. However, the differences are not significant as shown by the *p* values.

Table 4: Mean VOT (*ms*) of intervocalic stops and their difference

	Oral	Prenasalised	Diff.	*p*
bilabial	31.8	29.3	02.5	0.7825
alveolar	37.9	26.8	11.1	0.9897
velar	41.4	34.7	06.7	0.8519

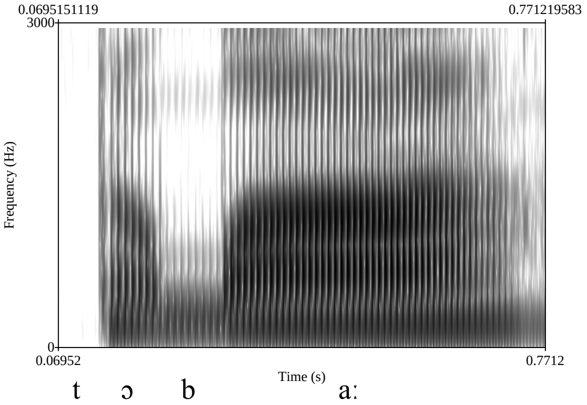
The voiceless characteristic of prenasalised stops is especially clear when compared to the single voiced stop. This stop is voiced for its entire duration, i.e. it has a negative VOT. This can be seen clearly in the spectrogram of the word [tɔbaː] ‘many’ in Figure 5, where there is no break in first formant across the entire articulation. This can also be seen in initial position in [bæ^{m}pər] ‘snake’ Figure 2.

We have established that phonetically these elements involve homorganic place of articulation with a nasal onset and a voiceless oral closure and release. The mean VOT of prenasalised stops are comparable to the oral stops. Both the prenasalised and plain oral stops have a positive VOT and hence voiceless. In addition, the length of prenasalised stops was measured compared to standard oral stops and sequences of nasal plus stop. This was measured for 60 tokens of both prenasalised stops and oral stops; only 20 tokens of sequences were measured as these are much rarer. We can see in Table 5 that although prenasalised stops are longer in duration than oral stops, the difference between them is not significant. Regardless, we would expect some tendency toward longer prenasalised stops due to increased complexity of articulation.

Table 5: Mean total length (*s*) of stops vs. sequences

Oral	Prenasalised	*p*	Sequence
89.6	97.4	0.248	167.2

Figure 5: Spectrogram of *toba* ‘many’



3. SEGMENTAL STATUS OF PRENASALISED VOICELESS STOPS

The remarkable aspect of these elements is that they combine both a period of nasal voicing and a period of voicelessness within a single phonological segment. In the previous section, we established the phonetic characteristics; in this section these will be demonstrated to be individual segments and not sequences. Already, we have seen these are shorter in duration than nasal plus stop sequences. In the remainder of this section, we will see evidence that phototactically these must be single segments as they occur where they would otherwise violate the sonority requirements of consonant clusters in Ngkolmpu.

Consonant clusters within a syllable in Ngkolmpu are fairly rare; ignoring for now prenasalised stops, clusters only occur syllable initially or word finally and always involve increasing sonority closer to the nucleus. The presence of word initial prenasalised stops would violate this otherwise consistent constraint in the phonology of Ngkolmpu. Indeed, when such sequences would arise from morphological operations these are always separated by an epenthetic schwa. Consider (1) in which the verb stem /tinpitr/ ‘cover’ is prefixed with the second singular default object prefix /n-/ which is obligatorily realised with a schwa separating the nasal and the oral stop as represented in the phonetic realisation. However, words commencing with a prenasalised stop are common; consider (2) in which the verb stem hang /iritr/ is prefixed the second singular object hortative marker /^{n}t-/ in which the nasal and stop are never separated by epenthesis.

(1) /n-tinpitr/ → [nə̆.ti.nə̆.pi.tə̆r]
2SG.O-cover

(2) /^{n}t-iritr/ → [^{n}ti.ri.tə̆r]
2SG.O:HOR-hang

Additionally, the phonotactics of Ngkolmpu never allow three consonants to occur sequentially without a vowel intervening, yet we do find prenasalised stops occurring in clusters which would otherwise be impossible if they were sequences. For example (3) has a velar nasal and stop followed by the alveolar trill. If we assume that these are two segments, the only time one would find sequences of three segments would involve nasal plus stop clusters which suggests analysing these as single segments. Additionally, in (3) we see the velar nasal which otherwise is not a phoneme of the language, only occurring as part of the onset of the velar prenasalised stop. Together these points clearly demonstrate that these segments are indeed a single phonological segment rather than sequences.

(3) [^{ŋ}krɛ.mun] ‘sago w. meat’

Finally, phonotactic evidence supports the analysis of these segments as prenasalised stops as opposed to post-stopped nasals as has been proposed for some languages[1] [11, 2]. The conceptual distinction here is whether the segment is underlying a plosive or a nasal. In this case, these are treated as plosives by the phonotactics and participate in onset clusters (3) unlike the basic nasals which do not (4). Hence, these are phonologically plosives rather than nasals.

(4) /n-rar/ → [nə̆.rar]
2SG.O-copula.PL

4. DISCUSSION

This paper has shown that Ngkolmpu has single phonological segments that phonetically display a nasalised onset followed by a voiceless closure and release. Phonetically, the voiceless characteristic of these segments is comparable with the standard voiceless oral stops in the language. Additionally, it is clear that these must be single segments as they display a range of distributions that would otherwise be impossible if they were sequences. Prenasalised voiceless segments are a rarity in the World’s languages with the largest estimates at 3% [3] and this study represents one of the few concentrated phonetic and phonological treatments of prenasalised voiceless stops adding to the typology of this rare phenomenon with data from an area largely overlooked in the phonetic literature.

5. REFERENCES

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