VARIABILITY IN THE PRODUCTION OF GLOTTALIZED SONORANTS: DATA FROM YAPESE

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ABSTRACT

Phonetic variation in the realization of segments is increasingly recognized to have functional value in signalling matters such as constituency, but patterns of variation of rarer segment types are not as well known as those of common types such as plosives. This paper presents data on variation in production of glottalized sonorants in the Austronesian language Yapese. Initial glottalized sonorants are typically but not invariably pre-glottalized. Final ones are post-glottalized. Medial ones are the most variable and may have very attenuated glottalization. Initial ones display greater variation in the degree of glottal constriction than final ones. These positional differences would have potential value in parsing strings of segments into words in Yapese, and may contribute to an asymmetry in the inventories of sonorant consonants in initial and final positions.

1. INTRODUCTION

All the consonants and vowels in the segmental inventory of a language vary in their production. In traditional-style phonemic descriptions such variation is usually reported in terms of a set of conditioned or free allophones. Although only the most salient kinds of variation get noted in this way, such accounts provide a good idea of the most important parameters along which different classes of segments tend to vary. Thus, for plosives we know to look for variation in the degree and duration of the articulatory constriction, in the salience of the burst, and in the relative timing of onsets and offsets of voicing, among other things. Detailed phonetic studies have provided much information on such variations in a variety of languages. Increasing appreciation of the role these play in encoding aspects of the structure of utterances, such as the prosodic grouping of their constituents, gives theoretical importance to these studies.

However, for many of the classes of segments found in the world’s languages, particularly those which do not occur in the better-known or economically-important languages, there is little information on the major ways that they vary in production. This paper will make a small contribution to filling one such gap by describing some of the variation in one class of little-studied consonants, glottalized sonorants. Consonants of this type do not occur in many languages, only being reported in 28 of 563 languages in a segmental database currently being developed by the first author. The majority of the languages in which they occur are indigenous languages of the Americas, and a good proportion of them are spoken by small and dwindling populations.

The data to be reported here are from Yapese, an Austronesian language spoken by around 8000 people on the island group of Yap, which forms part of the State of Yap in the Federated States of Micronesia. The position of Yapese within the large Austronesian family is uncertain [1], but it is not closely related to its geographical neighbors in the Micronesian group. Yapese is the only Austronesian language with ejective stops, glottalized fricatives and glottalized sonorants [2]. These distinctive characteristics attracted attention in early descriptions of the language [3, 4].

The glottalized sonorants of Yapese (transcribed, as often, with the IPA diacritic for ejective consonants) are the three nasals /m’, n’, ŋ'/, the lateral /l'/ and the two vocalic approximants /w’, j’/. The nasals /m’, n’/ and the lateral occur in initial, medial and final positions in words; /ŋ’/ is only known in medial and final positions but since this segment is very rare it is not possible to say if its absence from initial position is principled or accidental. The approximants /w’, j’/ only occur in word-final position. All these segments are broadly described as involving a constriction of the vocal folds co-produced with the gestures in the oral cavity.

Von Lörrach[4], Hsu [5] and Jensen [6] all comment on variation in production of the glottalized nasals and lateral, mainly in relation to position of the segment in the word. They broadly agree that in initial position the glottal constriction is released before the oral articulation is, but finally the glottal constriction is formed later than the oral articulation. Hsu writes “in intervocalic position the glottal stoppage is usually achieved first”. Hsu notes that the vocal fold constriction is a complete glottal closure in careful speech but “in normal speech” only involves a partial closure.

Below we present our analysis of the relative timing of oral and laryngeal events, and of the degree of vocal fold constriction — the two parameters of variation mentioned in the prior literature — in Yapese glottalized nasals and laterals. Realizations in word-initial, -medial and -final positions in isolated words will be compared.

2. DATA AND METHODS

The results presented are based on acoustic analysis of recorded wordlists collected with two groups of speakers in Yap. The speakers came from two districts, 6 from Tomil and 9 from Gagil. No noticeable difference of dialect was expected or found between these two groups. The assistance of John Tharngan in making these recordings possible is gratefully acknowledged. The speakers were seated in a circle and repeated each word twice in turn following Mr Tharngan.

The list was compiled to exemplify all the consonants and vowels of Yapese, but to keep the list to a suitable length not all segments were represented in all the positions in which
they can occur. The words selected to illustrate glottalized nasals and laterals for this paper are given in Table 1, together with some words with modally-voiced nasals and laterals used for comparison.

<table>
<thead>
<tr>
<th>segment</th>
<th>word</th>
<th>gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>initial l’</td>
<td>l’aaw</td>
<td>moss</td>
</tr>
<tr>
<td>initial m’</td>
<td>m’aar</td>
<td>sick</td>
</tr>
<tr>
<td>initial m</td>
<td>maap’</td>
<td>Maap (island)</td>
</tr>
<tr>
<td>final l’</td>
<td>maal’</td>
<td>barracuda</td>
</tr>
<tr>
<td>final m’</td>
<td>jaam’</td>
<td>death</td>
</tr>
<tr>
<td>final m</td>
<td>tsaam</td>
<td>fight</td>
</tr>
<tr>
<td>final n’</td>
<td>naam</td>
<td>landmass</td>
</tr>
<tr>
<td>final n</td>
<td>raan</td>
<td>water</td>
</tr>
<tr>
<td>final n’</td>
<td>kaan</td>
<td>spirit</td>
</tr>
<tr>
<td>final n</td>
<td>manaŋ’</td>
<td>swollen lymph nodes</td>
</tr>
<tr>
<td>final n</td>
<td>f’aaŋ</td>
<td>eel</td>
</tr>
<tr>
<td>medial l’</td>
<td>f’aaw</td>
<td>moss</td>
</tr>
<tr>
<td>medial m’</td>
<td>p’eeŋoon</td>
<td>in front of</td>
</tr>
<tr>
<td>medial n’</td>
<td>wun’ag</td>
<td>my feeling</td>
</tr>
</tbody>
</table>

*Table 1*: Words used in the analysis

The recordings were made in the open air, and there are inevitable intrusions of wind noise and bird calls. At times speakers’ voices overlap. As a result a number of recorded tokens could not be analyzed. Furthermore the lists recorded at the two locations were not identical and sometimes speakers did not recall a word or pronounced a variant. Consequently the numbers of tokens of the words in the list that are available for analysis ranges between 8 and 30.

The recordings were digitized at 20 kHz and examined using simultaneous waveform and spectrogram displays. Salient landmarks in the timing patterns of the segments of interest were marked and the values entered into a spreadsheet for subsequent statistical analysis. Qualitative aspects of the signal indicative of such aspects as the degree of laryngeal constriction and the ordering of events were also noted and written into a commentary field. The results therefore have both quantitative and qualitative aspects.

## 3. RESULTS

### 2.1. Initial glottalized sonorants

The words chosen to represent initial glottalized sonorants are /l’aaw/ “moss” and /m’aar/ “sick”. Speakers in the Gagil group produced the reduplicated variant of the “moss’ word /lal’aaw/. In this form the initial consonant is not initiating a stressed syllable. Position relative to stress may also be a factor which correlates with variation in production.

The most common pattern seen in the production of utterance-initial /m’, l’/ is for a complete glottal closure to be formed, which is then released into a voiced nasal or lateral portion with a fairly abrupt onset. This is illustrated by the spectrogram in Figure 1 for a token with initial /m’/. 11 of 30 tokens of /m’/ and 26 of 30 tokens of /l’/ show this pattern. When phonation begins it is usually with modal voicing with no detectable laryngealization. In a minority of cases, a glottal closure is released into laryngealized phonation which covers the first part of the audible nasal or lateral portion.

![Figure 1](image1.png)

Neither a full glottal closure nor this ordering of events is always present in these initial segments, however. The glottal constriction may be incomplete, even in the relatively careful speech style represented in this data. Incomplete glottal closures produce laryngealized phonation with no abrupt onset. There are two fairly distinct timing patterns in the tokens with incomplete closure. In one the glottal constriction is co-produced with the lateral or nasal portion and the following vowel has modal voicing; two tokens with /l’/ and three with /m’/ showed this pattern. In the other the nasal or lateral portion is modally-voiced but the first portion of the vowel has laryngealized voicing; two tokens with /m’/ had this pattern.

![Figure 2](image2.png)

The second of these patterns can be seen as the reduction of another variant production, one in which a complete glottal constriction follows a voiced nasal or lateral onset to the word. Two tokens with /l’/ and 4 with /m’/ quite clearly show this alternative ordering of events. It is illustrated by the spectrogram in Figure 2. The patterns in Figures 1 and 2 might be distinguished by being labeled pre-glottalized and post-glottalized respectively. The two patterns with incomplete glottal closures can be viewed as reduced versions of...
pre- and post-glottalized types.

The final variant noted among the initial glottalized sonorants is one where complete glottal constriction covers any nasal or lateral closure gestures which are present in the segment. There is therefore no portion of the acoustic signal which is a consonantal nasal or lateral. Six tokens of /m'/ showed this pattern. A token of this type is illustrated in Figure 3. The main sign of the presence of more than a simple glottal stop onset in such a case is the nasalization of the vowel onset; there are also some minimal consonantal transitions at vowel onset indicating a labial constriction must have been present.

The acoustic contrast between modal and glottalized initial sonorants lies in the absence of abrupt onsets or laryngealized voicing. In addition the acoustic duration of the voiced sonorant portion in the modal case is considerably longer than that usually present in laryngealized sonorants. A representative token of initial /m/ is shown in Figure 4. In tokens with pre-glottalized /m'/ the nasal portion has a mean duration of 56 ms (n= 15), whereas in modal nasals the voiced consonantal portion is over twice this long.

2.2. Final glottalized sonorants

Hsu’s [5] and Jensen’s [6] descriptions of final glottalized sonorants agree that the oral articulatory position is achieved before glottal constriction occurs. The audible nasal or lateral portion of the segment is thus cut short. The final glottalized lateral in Figure 5 can be compared with the final modally-voiced lateral in Figure 5. There is only about 55 ms of modal voicing in the lateral in Figure 4, compared to about 90 in the token in Figure 5, which is shorter than average.

The mean duration of the voiced portions of final sonorants was measured in all available tokens of the words in Table 1. Numbers of tokens range from 8 for /l/ to 28 for /l', n', η'/. The overall mean for glottalized sonorants is 82 ms of voiced portion (n = 118), whereas modally-voiced sonorants have a mean voicing duration of 164 ms (n= 199). This is a very robust distinction between the two classes of consonants, exceeding the .0001 significance level in a one-way ANOVA.

In the utterance-final position there is a more consistent ordering of the onset of the oral and laryngeal gestures than was found in the initial position. There is also less variation in the degree of the glottal constriction, which almost always is a complete closure. The major observable variation is between cases in which a clear release of the glottal closure is detectable, as in Figure 4, and those in which no audible release is heard or detected in the waveform. Hsu’s remark that “Final glottalized continuants, as opposed to final glottalized stops [i.e. ejective stops] and fricatives, need not be released. although if they are it is the glottal closure that is released first” reflects his observation of this variation, but seems to imply that the nasal or lateral articulatory position continues to be held after a glottal release. This is nowhere the case in our data. The oral articulation is clearly terminated while the glottal constriction is held, and the glottal release, which often occurs after a considerable time lag, shows no sign of a continuing oral constriction or closure.

2.3. Medial glottalized sonorants

In medial glottalized sonorants the degree of glottal constriction and its timing with respect to the oral articulatory gestures both vary greatly. Glottal constriction may be complete, as in Figure 6; sufficient to create noticeably laryngealized voicing, as in Figures 7 and 8; or so light that only a diminution of amplitude signals the presence of any laryngeal gesture. The constriction may occur clearly at the consonant onset (Figures 6, 8); at its release (Figure 7); or cover the entire consonant duration or be mainly present during one of the adjoining vowels (not illustrated). In the largest proportion of tokens, glottalization was mainly apparent from a greater than expected amplitude drop during the con-
sonant (cf [8]).

3. DISCUSSION

Since the most typical initial glottalized sonorant of Yapese is realized with the glottalization covering the first part of the oral gestures, and final glottalized sonorants are produced with the glottalization covering the final part of the oral gestures, these variations can be of use in parsing a string of segments into words. Word onsets can be recognized as typically pre-glottalized, word-final codas as typically post-glottalized. The existence of post-glottalized initial sonorants, however, means that this parsing information is only probabilistic, not absolute. Segments with very attenuated glottalization can be identified as probably word-medial.

We note that the set of glottalized sonorants in Yapese is more extensive in the final position than in the initial position, as /w', j'/. do not occur in the initial position, and possibly /ŋ/ is also systematically absent. Insofar as the origin of the glottalized segments of Yapese can be traced by comparison with other Austronesian languages, it seems likely that their origin is in the fusion of two separate segments that had come to be adjacent following loss of an intervening vowel [1]. We do not know enough of the phonological history of Yapese to determine if /w', j'/ developed in initial position and were subsequently lost or if they never developed in this position. In final position these segments are pronounced as simple glottal stops by some speakers [6], suggesting they are undergoing a process which will result in loss of distinctiveness in this position. This may well have happened at an earlier stage in initial position, perhaps facilitated by a greater variability in production.

The difference in the degree and type of variability observed between initial and final glottalized sonorant consonants in Yapese is quite striking. In a number of the Native American languages in which glottalized sonorants occur, for example the Pomoan language Kashaya [8], they are limited to final position. If a more stable phonetic form in final position is characteristic of this class of segments in general their restriction to this position may be favored by this fact.

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5. REFERENCES