SOME ACOUSTIC OBSERVATIONS ON HALF NASALS IN SINHALESE

MASATAKE DAN-TSUJI

Dept. of Linguistics
Kyoto University
Kyoto 606 JAPAN

ABSTRACT

Sinhalese is one of the Indic languages and is spoken in Sri Lanka. The present study is intended to explore the phonetic characteristics of half nasals in Sinhalese. From the examinations of the acoustic analysis making use of a minicomputer and a linear prediction algorithm, some phonetic properties can be clarified as follows. It appears that a half nasal consists of a nasal murmur portion, a voiced oral murmur portion, a burst and a transition portion to the following vowel. From the spectrum analysis, it can be examined that frequencies of the first formant (F1) of the nasal murmur portion are slightly higher than those of the oral murmur portion. It has been able to distinguish places of articulation by making use of spectrum features of the nasal murmur portion.

INTRODUCTION

Sinhalese is a national language of Sri Lanka, and is spoken by about 11 million people, or 75 percent of the population, living mainly in the southern and western two-thirds of the Island of Ceylon [1]. It is said that Sinhalese is an Indo-European language descended from Sanskrit, and this language was brought to the island by settlers from northern India in the 5th century B.C. [1]. There have been pointed out several problems connected with Sinhalese which arouse the interest of the linguists, e.g. Sinhalese is notable among the major Indo-Aryan languages of the past and present in having no aspirate stop phonemes nor clusters [2], literary Sinhalese is very different from spoken Sinhalese [3], etc. One of them is the phenomenon of "half nasals". In the intervocalic positions, there occur medial clusters composed of nasal plus voiced stop. There are two types of the first nasal element. One is often referred to as the single nasal and the other is referred to as the doubled nasal. The two types present a contrast, e.g., /kandə/ 'trunk' : /kanndə/ 'mountain'. In regard to voiceless stops, there are no such oppositions in the same position, only the normal type of cluster with doubled nasal occurs. In such cases, however, the doubled nasal is written with a single letter according to the convention. The length of the nasal in a cluster of single nasal plus voiced stop varies from normal to very short [2]. It has been customary in Sinhalese studies to treat the single nasal in these clusters as a special class of sounds to which was given the name "half nasal" and this is in accord with the traditional Sinhalese orthography, which uses special signs for the "half nasals" and the regular nasal letters for the "full (doubled) nasals" in the same position. From a synchronic point of view, there can be two different phonological interpretations. Some linguists regard them as independent phonemes. For example, Jones [4] treats them as separate independent phonemes. On the other hand, others regard them as consonant clusters. For example, Coates and De Silva [2] criticize Jones' view as it is an unnecessary complication of the phonemic system, increasing the number of consonant phoneme by nearly 20 percent, and treat them as consonant clusters with a single nasal, contrasting with a doubled nasal in similar clusters. However, the literature on the phonetic detail of half nasals is quite limited in quantity and quality. The present study is intended to explore the phonetic characteristics of half nasals through acoustic investigation. One of our main concerns is to confirm if the articulator is already ready for the place of articulation during the first nasal element.

ACOUSTIC ANALYSIS

Material

Lists of words were prepared, which contained four types of half nasals { mb, ng, nd, gg } in the intervocalic
I, as V; the list includes meaningless were sampled 'manuall . mur P°rt1°n the latter portion (means and standard are reported as follows ( > = higher e...,.,se::.

E1 and followed by 5 vowels / i. e.pa. o. u 32::ion:nf:::he Ezgandzdpss 2f lurmur Table 1. Analysis frequency values (in articulation ( bilabial, dental and velar 11 / leading to five different V.CV2 the 3500 samples of data ( :g; orm. From Hz) and standard deviations of the first ) are presented in Table 2. The

21' COUbinatlon, where v, is the same vowel waveforms including both murmur formant for the former portion and for properties of murmur of ordinary nasals

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digital m terances were Input from a Pred'er~ transform ( FFT ) and linear} 'h the nasal murmur portion of a half nasal first formant were used as variables. for 1

Sampling ) .microsecond ( 18.5 kHz burst 63% which precedes the release next vowel. These observations indicate total are 73 x. This shows tolerably high

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for aboutisc of 2—negabyte in real-time In a§§9t9f this portion is 13 ~ 43 msec. . prenasalized voiced plosive. . A resolution. all of the first, the second, é

U_200 Iinicom twas connected to a .FACOM that thi or a P10sion. This indicates nasal is sub—segmented into a nasal represents source, and the uppermost row

4-microsecond . A/D .converter of Periodic V In the energy. The quasi below 3500 Hz and anti-formant. It was assumed that the former portion is the the percent of correct classifications of

Acoustic anal 36 ~ 141 m e duration of this portion is Significant ( p < 0.01 ). This closer to the third and higher formants), . . . . h

portions are defined by acoustic aspects. Dental

Acoustic Analysis

Acoustic analyses were made at Dubois Laboratory, of the Information Science of Kyoto University. Speech waveforms were prepared from

sampling period were used gradual d waveforms of this portion show assumed that the former portion is a burst of the plosive. The fluctuation portion intensity lasted by as formant as the of bilabial half nasals, dental half

Portion has rather steady first formant of both portions are defined by acoustic aspects. Dental

portions are defined by acoustic aspects. Dental

A subset of the words including half nasals is 138 Hz. Those of bilabial half nasals, velar half nasals are 1010 Hz and 1054 Hz. There is a tendency for F2 of dental nasals to be slightly lower than those of nasal nasals. Both [g] > [m] and [g] > [n] are statistically significant ( p < 0.01 ). In the framework of Jakobson, Fant and Hall (8), distinctive features of nasal nasals have an "acute" feature and those of dental nasals have an "acute" feature and, when

nasals at the intervocalic position and Portlon'; a Porti°n 0f periodic repeated ' than those of dental and velar half

This indicates nasal is sub—segmented into a nasal represents source, and the uppermost row

Science if apartment. of Information than ct o {the latter portion is less only very low frequency energy. This we tried to distinguish dental h§1f h

Table 1. Analysis frequency values (in Hz) for the nasal murmur portion of half nasals for each place of articulation (means and standard deviations).

Table 2. Analysis frequency values (in Hz) for the nasal murmur portion of half nasals for each place of articulation (means and standard deviations).

Bilabial Dental Velar Mean (S.D.) Mean (S.D.) Mean (S.D.)

F1 256 (26) 294 (43) 339 (55)
F2 1009 (139) 1328 (169) 1051 (92)
F3 2607 (225) 2787 (129) 2700 (104)

F1 112 (42) 151 (51) 175 (39)

falls off rapidly after the first formant and is very weak in the middle- and higher frequencies. This is one of the characteristics of voiced plosives. On the other hand, the nasal

fluctuation portion intensity lasted by as formant as the of bilabial half nasals, dental half

nasals at the intervocalic position and Portlon'; a Porti°n 0f periodic repeated ' than those of dental and velar half

This indicates nasal is sub—segmented into a nasal represents source, and the uppermost row

This indicates nasal is sub—segmented into a nasal represents source, and the uppermost row

This indicates nasal is sub—segmented into a nasal represents source, and the uppermost row
Table 3. Classification matrix
(Variables: F1,F2,F3,B1)

<table>
<thead>
<tr>
<th></th>
<th>[mb]</th>
<th>[ng]</th>
<th>[gs]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[mb]</td>
<td>19</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>[ng]</td>
<td>0</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>[gs]</td>
<td>1</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>TOTAL</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

Group of the place of articulation is effectively discriminated. These results indicate that the nasal murmur portion of the half nasal includes necessary information to distinguish place of articulation. This confirms the view that the articulator is already ready for the place of articulation during the murmur portion of the first nasal element.

SUMMARY AND CONCLUSIONS

So far as our informant is concerned, the properties of half nasals in Sinhalese have been clarified as follows. A half nasal is sub-segmented into a nasal murmur portion, a voiced oral murmur portion, a burst and a transition portion to the next vowel. The plosive element keeps voicing before release of the consonantal constriction. These results indicate that a half nasal is a kind of prenasalized voiced plosives. Bilabial half nasals, dental nasals and velar half nasals could be distinguished by means of a step-wise discriminant analysis utilizing the value of F1, F2, F3 and B1 of the nasal murmur portion, and this confirms the view that the articulator is ready for the place of articulation during the first nasal element.

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REFERENCES