THE ACOUSTIC AND ARTICULATORY PROPERTIES OF THE PRENASALISED CORONAL TRILL IN TWO OCEANIC LANGUAGES

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ABSTRACT

A few Austronesian languages have a prenasalised coronal trill with a plosive-like release (hereinafter NDR), whose exact place and manner of articulation are rarely discussed in detail; the existing impressionistic descriptions vary. This paper adds to our knowledge about this rare complex segment by offering a detailed acoustic and articulatory description of NDR in two Oceanic languages spoken in Vanuatu – Ahamb and Farsaf. The description includes measurements of the nasal portion, the frequency of vibration, and the exact place and manner of contact between the articulators, and is based on audio recordings of citation forms, linguograms and palatograms.

Both languages contrast NDR with a plain coronal trill /r/. Perceptually, both prenasalisation and the plosive-like release in NDR appear to be salient cues for contrast. The results suggest that trilling is the main phonetic characteristic, and the plosive-like release is an effect of trilling being initiated following an oral closure.

Keywords: trills, prenasalisation, plosive release, Oceanic, Austronesian

1. INTRODUCTION

A voiced prenasalised coronal trill has been documented in a number of languages, most notably languages of the Austronesian family. There are different reports about the exact place and manner of articulation of such sounds. The more general designation “coronal” can refer to what have been claimed to be alveolar/apical [1, 2, 3, 4] or post-alveolar/retroflex [5, 6, 7, 8] articulations. The designation “prenasalised trill” is debatable as well – such sounds are also sometimes called “plosives with a trilled release” [9] since they normally feature a perceptually salient plosive-like release, followed by the period in trilling.

Phonological evidence from the languages where prenasalised coronal trills have been described, shows that we have one complex segment at hand here, rather than a sequence of more than one segment, e.g. [ndr]. Because of the perceptual salience of all three phases – prenasalisation, plosive-like release and trilling – this complex segment is often denoted in orthographies with the trigraph <ndr> or the digraph <dr> (as prenasalisation is often not marked in the orthographies of languages where it is distinctive; languages with a prenasalised coronal trill often also have other prenasalised sounds, mostly plosives, but also affricates or bilabial trills). Hereinafter I refer to the prenasalised coronal trill as NDR (to refer to the three portions of this complex segment) for the sake of clarity and brevity. In phonemic transcriptions, I use /D/.

To our knowledge, no detailed articulatory and acoustic studies of NDR exist. This study aims to partially fill this gap by offering an articulatory and acoustic analysis of NDR in two languages of Vanuatu – Ahamb (ISO 639-3 code: ahb, Glottocode: axam1237) and Farsaf (ISO 639-3 code: nrg, Glottocode: nara1263). Ahamb is spoken on the small Ahamb Island off the south coast of Malekula, the second largest island of Vanuatu. Farsaf (also known as Narango) is spoken in a few villages (the main one being Narango) near the south coast of Espiritu Santo, Vanuatu’s largest island. Both languages fall within the North-Central Vanuatu (NCV) group of Oceanic languages, but are members of different subgroups of NCV, see Glottolog [10] for a genealogical tree.

A number of other NCV languages have NDR; these are some of the other 80 or so languages of Malekula and Espiritu Santo [11], as well as Nafsan, another NCV language spoken on Efate Island further south [3, 11]. Outside of Vanuatu, within the Oceanic group, NDR has been reported in Fijian [4, 12], a few languages of the Admiralties group, (Manus Island, Papua New Guinea) [1], Sa’a (Solomon Islands) [1], as well as in the non-Oceanic Austronesian languages Nias (Sumatra, Indonesia) [5, 13] and Malagasy [8]. NDR has been reconstructed for Proto Oceanic [14]. Maddieson [15] suggests that a similar sound can be reconstructed for Proto Austronesian. Outside of Austronesian, prenasalised coronal trills have been reported in some languages of Africa [16, 17, 18].

NDR has two main phases: a closure period and a period in trilling. The closure period can be divided into *nasal closure* (nasal airflow is present, oral airflow is absent), followed by a *total closure* (absence of both nasal and oral airflow). This is then normally followed by the plosive-like release and the trilling phase.

In Ahamb, NDR contrasts with the plain alveolar trill /r/, the prenasalised alveolar plosive /ⁿd/ (a marginal phoneme found in only two words), and the prenasalised and plain bilabial trills /^{m}ʙ, ʙ̥/ [7, 19]. Prenasalisation is the main contrast in Ahamb's plosives and bilabial trills [7, 19]. Farsaf lacks proper phonological analysis and description. However, newly collected data suggest that in this language, NDR contrasts with a plain trill /r/. Farsaf appears to lack a coronal plosive, but there is a prenasalisation contrast in the bilabial and velar plosives.

A morphophonological process in Ahamb, which is relevant to this study, is that /nr/ clusters are produced by younger speakers similarly to NDR, with a perceptually salient plosive-like release. /nr/ clusters in Ahamb are almost exclusively found in word-initial position in nouns, across a morpheme boundary, where /n/ is a common noun marker, a reflex of a former article *na, and the noun stem begins with /r/, e.g. /n-ran/ 'ground', /n-ras/ 'sea', and borrowings such as /n-rum/ 'room' [7]. Older speakers of Ahamb lack such "intrusive" plosives in /nr/ clusters, and in some cases appear to retain the historical vowel as an extra short schwa.

This paper adds to our knowledge about NDR, whose phonetic properties have received little in-depth attention. More specifically, it aims to establish the acoustic and articulatory characteristics of NDR in Ahamb and Farsaf, including measurements of the duration of the nasal and oral closures and the frequency rate of trilling. Linguography and palatography data give evidence of the exact place and manner of articulation of NDR. Furthermore, I attempt to rank the importance of the different phonetic characteristics of NDR, in terms of their role in distinguishing it from other sounds in the consonant inventories of Ahamb and Farsaf.

2. DATA AND METHODOLOGY

2.1. Recording procedures

The analysis presented in this paper is based on controlled wordlist audio data, as well as linguograms and palatograms. All data were collected in late 2022 in Vanuatu by the author.

One speaker of each language was recorded, a 30-year-old male speaker of Ahamb and a 32-year-old male speaker of Farsaf. Both speakers were born, raised and currently reside in their respective communities. Ahamb and Farsaf were their respective first languages, which they use at home, when socialising with other members of their communities, and in other domains. The Ahamb wordlist was compiled in collaboration with Ahamb speakers, based on previously available Ahamb data [7, 19]. The Farsaf wordlist was compiled in Narango, in collaboration with Farsaf speakers, by extracting items from a list of over 500 words previously collected by the first author. In both cases, the wordlists contain items in which NDR appears in different positions, both in syllable onset and coda position, word-initially, word-finally, between vowels and preceding another consonant.

The Ahamb list contains 19 items with NDR, five items with word-initial /nr/ clusters (the recorded Ahamb speaker normally produces these with the "intrusive" plosive), four items with /r/ in other environments, and two items with /^{n}d/. The Farsaf list includes 19 items with NDR and eight items with /r/ in different environments.

The audio data for each speaker were recorded in two sessions. In a first session, each word was recorded at 24-bit/48kHz using an Audix HT5 headset microphone and a ZOOM H5 audio recorder. In a second session, a recording was made for the purpose of analysing nasality, using a method described by Bruil & Stewart [20] (a modified version of Stewart & Kohlberger's [21] method), which allows for easy and affordable recordings for nasality analysis in remote settings. With this method, earbud headphones are plugged into the microphone input of the recording device. The speakers insert the two earbuds in their nostrils, with the signal from both earbuds being recorded in one channel, while another microphone is placed in front of the mouth and feeds the other channel. After normalisation, the nasal channel of the resulting stereo recording clearly shows the cut-off points and duration of nasal gestures, see [20, 21] for more details. I used unbranded earbuds and the Audix HT5 headset microphone, and the ZOOM H5 device at the 24-bit/48kHz setting. In all cases, speakers were prompted in Bislama, the national language of Vanuatu, and were asked to repeat each word three times. The second repetition was used for analysis, unless it was judged unnatural or spoilt by noise, in which case the first or third repetition was used.

It was only logistically possible to perform linguograms and palatograms for the Ahamb speaker. These were made on Ahamb Island with the same speaker who provided the audio data.

Speakers provided informed consent to their participation. Strict hygiene procedures were followed.

2.2. Data processing and analysis

Waveforms and spectrograms were inspected in Praat [22]. The recordings from the first (non-earbud) sessions were used to measure the duration of the period in trilling and the number of oscillations, in examples with NDR and /r/.

The earbud recordings were used to measure closure durations. Nasal closure was measured as the period from the onset of high amplitude in the nasal channel when NDR is in initial position, or from a change in the nasal waveform with a simultaneous drop in energy in the oral channel, when NDR is after a vowel, until a significant drop in energy in both channels, more clearly visible on the spectrogram. This drop in energy signals the onset of the total closure period, which ends with a sudden burst of energy, corresponding to the release. Figure 1 shows an example of a spectrogram and waveform of a Farsaf word recorded with this method.

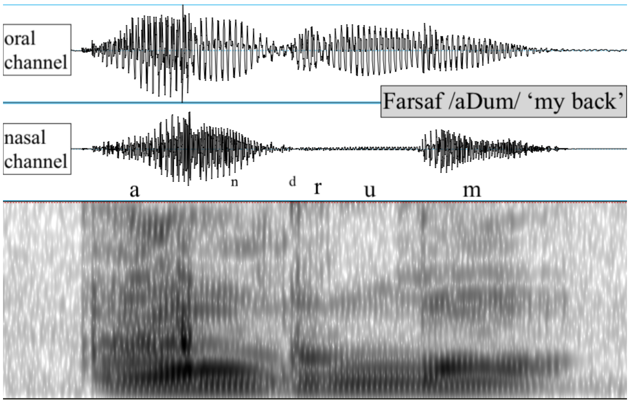

Figure 1: A spectrogram and waveform for Farsaf /aDum/ ‘my back’, recorded using the earbud method

3. RESULTS

3.1. The articulators

The linguogram and palatogram for the Ahamb speaker (target word /Daᵑg/ ‘strong’) in Figure 2 show that the articulation involves the apex of the tongue, which comes into contact with the alveolar ridge at the base of the upper teeth and immediately behind them. This means that, at least in Ahamb, NDR is an apical alveolar consonant without any major change of the place or manner of articulation throughout its different stages. Palatograms and linguograms for the same speaker for /n, r/ (the targets were /a**n**aᵑg/ ‘my mother’ and /**r**aŋ/ ‘to cry’; the figures are not included here in the interest of space), show a very similar place of contact between the articulators. The Farsaf speaker reported a similar place and manner of articulation when asked.

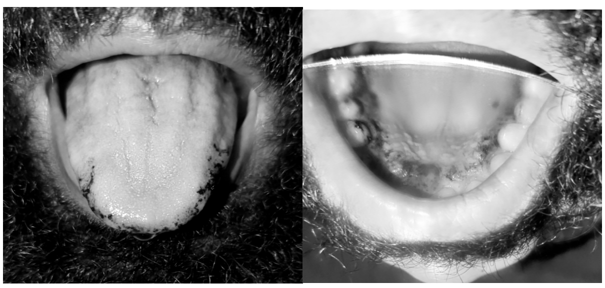

Figure 2: Linguogram and palatogram for Ahamb /Daᵑg/ ‘strong’

3.2. Prenasalisation

The mean duration of the entire closure phase for NDR was 120 ms (s.d. = 29) for Ahamb and 102 ms (s.d. = 28) for Farsaf. Of this, the nasal closure (prenasalisation) was on average 94 ms for Ahamb and 85 ms for Farsaf, corresponding to 78% (Ahamb) and 82% (Farsaf) of the entire closure phase. The differences in closure duration between the two speakers are small enough to be attributed to speech rate effects or individual characteristics, especially considering that the proportion of prenasalisation is less significantly different.

The substantial proportion of the nasal closure suggests that prenasalisation is a major cue for contrast between NDR and /r/ in both languages. This is not surprising, considering that prenasalisation is the main contrast in plosives in both languages and also between the two bilabial trills in Ahamb [19].

3.3. Trilling

Between one and four trill periods were observed during spectrogram and waveform analysis, most commonly one or two. Figure 3 demonstrates a realisation of NDR with two trill periods.

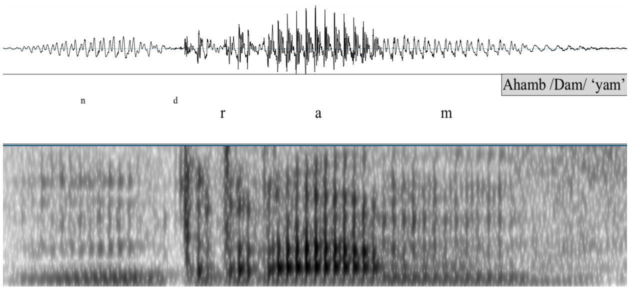

Figure 3: A spectrogram and waveform for Ahamb /Dam/ ‘yam’, showing two complete oscillations

The duration of the period in trilling varied substantially based on the number of complete oscillations recorded. The mean duration of each oscillation was 41 ms for Ahamb and 39 ms for Farsaf. This corresponds to a frequency rate of trilling of 24 Hz and 26 Hz respectively. These numbers are within the normal rates observed in trills cross-linguistically [9]. The frequency rates of trilling in items with /r/ for the two languages were very similar – 25 Hz for Ahamb and 28 Hz for Farsaf. This means that there are no substantial differences in terms of trilling between NDR and /r/.

Trills are generally known to easily fail to be realised properly, since they are “very sensitive to small variations in the articulatory and aerodynamic conditions” [9]. For example, the bilabial trills of Ahamb are often realised as plosives or fricatives [19]. In our data, in some cases where NDR was realised with only one oscillation of the tongue, trilling was perceptually available but was not as clearly distinguishable on the waveform and spectrogram as, for example, in the clear oscillations in Figure 3 above. (This allophonic realisation of the trill should be more precisely referred as a tap, rather than a trill.) However, in all such cases there was a clear drop in amplitude/airflow, following the initial release (see Figure 4 below), which cannot be observed in instances of a regular plosive release with /^{n}d/, as in Figure 5. This suggests that this drop in amplitude/airflow is an important articulatory and perceptual aspect of NDR.

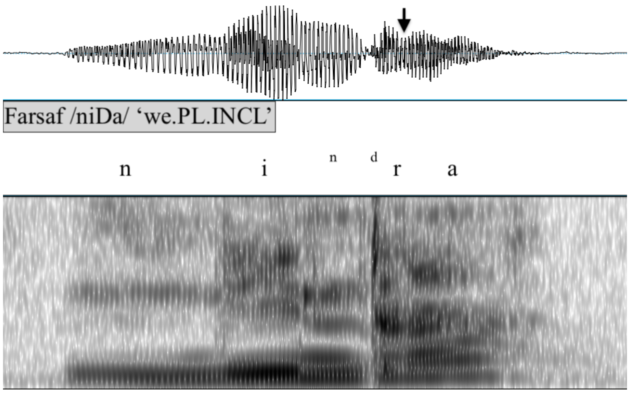

Figure 4: A spectrogram and waveform for Farsaf /niDa/ 'we.PL.INCL', showing a drop in amplitude after the initial release (indicated by an arrow) in a realisation of NDR with one oscillation of the tongue

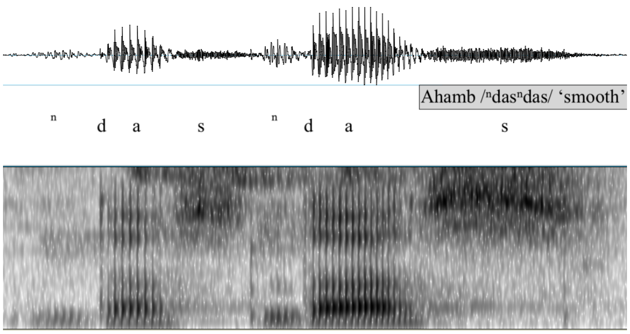

Figure 5: A spectrogram and waveform for Ahamb /^{n}das^{n}das/ 'smooth', showing a constant rise in amplitude following the initial release in both instances of /^{n}d/

3.4. /nr/ clusters in Ahamb

For the examples of /nr/ clusters in Ahamb, which the recorded speaker produced with the plosive-like release, the frequency rate of trilling was 25 Hz, which is similar to the values for NDR and /r/. The duration of the entire closure was 132 ms and the nasal closure duration was 111 ms (84% if the entire closure duration). These numbers are somewhat higher than those for NDR, albeit not substantially so. A possible explanation is the presumably recent origin of this prenasalisation as a full /n/ segment.

4. DISCUSSION AND CONCLUSIONS

This study of NDR has allowed to establish more precisely the phonetic properties of this rare sound in two small indigenous languages of Vanuatu. The results show that prenasalisation is the main strategy for contrast between NDR and plain alveolar trills. Trilling rates are similar to those for /r/. In all cases, a drop in airflow following the initial release of the articulators, appears to be an important characteristic.

In Farsaf, a prenasalised plosive is absent and in Ahamb it is only a marginal sound, but we do not see NDR changing to /^{n}d/ in order to occupy this gap in these two languages' phonological systems. In fact, our data suggest that trilling (or at least a partial closure following the initial release) is more important than the plosive-like release in the production and perception of NDR. In fact, from an aerodynamic point of view, the plosive-like release can be viewed as a product of the build-up of intraoral pressure during the total closure period. Even though this pressure likely does not have the chance to rise significantly (since air is escaping through the nose during most of the closure phase, as in bilabial trills [15]), it likely rises enough to cause a sudden and energetic first release, similar to that of plosives. The same process has been observed with prenasalised bilabial trills (which have a very similar manner of articulation as NDR [23]), where the first release is usually more sudden than the following releases during the trilling phase [19]. Furthermore, Ahamb's /nr/ clusters' surfacing as NDR also suggests that the plosive-like release is a bi-product of the articulation.

Based on these results, we can now establish that NDR is a *prenasalised apico-alveolar trill* – [^{n}r], or more narrowly transcribed as [ndr] to account for the plosive-like release – at least in Ahamb, for which we have the palatography and linguography data. This is most likely also the case for Farsaf.

Future work on Ahamb, Farsaf and other languages with NDR can shed more light on the properties of this rare complex segment and the importance of its different aspects with regard to articulation, acoustics and perception.

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