ACOUSTIC PROPERTIES OF THE LATERAL CONTRAST IN NINDE

Caroline Crouch

University of California, Santa Barbara
crouch@ucsb.edu

ABSTRACT

Ninde, an Oceanic language of Vanuatu, contrasts an alveolar lateral approximant with a second lateral phoneme that patterns phonologically with the uvular fricative and in careful speech involves an interdental constriction. In this paper I compare spectral properties of the two segments and formant transition out of each segment for three vowels /a e o/.

Center of gravity, skew, and kurtosis do not distinguish the two, indicating that the second lateral phoneme is not a fricative, as some previous work has suggested. The only factor that significantly distinguishes transitions from the two laterals is the average F2 value, which is lower for vowels following the non-alveolar lateral. This is consistent with a more posterior dorsal constriction than that of the alveolar lateral. Given the phonological behavior of this segment, I propose that it involves a uvular constriction.

Keywords: acoustics, laterals, Vanuatu, phonation, language documentation

1. INTRODUCTION

This paper presents an acoustic analysis of a contrast between two lateral phonemes in the Oceanic language, Ninde. This contrast is diachronically unstable and is currently only preserved by a subset of older fluent speakers. One lateral is the alveolar approximant /l/, while the other has not been accurately identified; its phonological and articulatory properties point in different directions for its identification. Our analysis shows that the acoustic correlates of this second lateral, most significantly a lowered F2 for following vowels, are consistent with a uvular constriction.

2. THE NINDE LANGUAGE

Ninde is an Oceanic language spoken in the South West Bay region of Malekula, Vanuatu. There are approximately 1,000 speakers across five villages (Lawa, Labo, Lorlow, Mahapo, and Windua) two hamlets (Enimb and Lamlow) and scattered smaller hamlets throughout South West Bay.

Many of the typologically rare phonetic and phonemic features of Ninde are common on Malekula, e.g. bilabial trills and labialized bilabials, but Ninde is set apart from neighboring languages by its phonetics and phonology. The historical origin of the uvular fricative in Proto-Oceanic *r is unique among the languages of Malekula; the high front rounded vowel is an innovation unique to Ninde; and the second lateral phoneme is not found anywhere else on the island.

2.1. Previous research on Ninde

Ninde has been the subject of some study [10][6] but largely in the realm of morphosyntax. Ninde is also included in Charpentier's *Atlas Linguistique du Sud-Malakula (Vanuatu)* [2], and the anthropologist Bernard Deacon spent time in South West Bay [4]. Crouch and Schaefer (2017)[3] provides a new overview of language based on fieldwork done in 2015 and 2016.

2.2. Previous transcriptions of the non-alveolar lateral

The transcription of the second lateral phoneme has been inconsistent over time, which is to be expected given the diachronic instability of the segment. Early work, included missionary translations of the New Testament, do not transcribe a second lateral phoneme. Later sources are consistent in noting the presence of what speakers sometimes refer to as 'heavy l' and there is consistency across sources in transcribing certain words with 'heavy l.' However, different strategies for writing and transcribing this sound are used.

Charpentier[2] notes 'heavy l' by adding a dot to a regular 'l', and does not make any claims about the phonemic or phonetic nature of the segment. Dimock et. al.[6] consider it to be a voiced alveolar lateral fricative [ɮ]. Crouch and Schaefer[3] follow this convention. Literacy materials developed in 2015 as part of a teacher training initiative run by the Vanuatu Department of Education use 'th' to represent 'heavy l', because of the presence of interdental contact in careful speech.

2.3 Non-acoustic properties of the non-alveolar lateral

The non-acoustic properties of 'heavy l' (abbreviated as 'hl' from this point forward) are contradictory and unique. Phonologically, 'hl' patterns with the uvular fricative. Its distribution is restricted; it cannot appear adjacent to high vowels. 'hl' also lowers adjacent /e/ to [a], which the uvular fricative does as well. This process is blocked by word-final [a]-raising.

The articulation of this segment is not obviously uvular at first observation. Production of 'hl' does involve a lower jaw position than production of [l], but in careful speech the tongue pokes out from between the teeth for 'hl.' Speakers specify that the tongue curls over the upper teeth during 'hl', and observation reveals that lip-rounding is also a component of careful production of 'hl'.

Speakers also describe a tenseness in the throat for 'hl', as though a heavy object is placed on their heads and reject pronunciations of 'hl' as a simple interdental fricative.

3. METHODOLOGY

This study uses data from four speakers, all of whom live in or near Lawa village. Three speakers are members of the same family, and the fourth has lived near Lawa for decades, though she is not originally from the area. Her speech is not identified as containing any dialectal features that set it apart from Ninde as spoken in Lawa.

All speakers were recorded with a Zoom H8 camera and a Zoom H4N recorder with either a Shure SM10A-CN headworn microphone or a Sennheiser EW 100 wireless lapel microphone. The recordings used for this study are all from lexical elicitation sessions, so the speakers are talking more slowly and there is much less segment reduction and deletion than there is in casual, rapid speech.

Measurements of the lateral segments themselves used a set of 247 tokens across both lateral types, with both segments appearing in word-initial and word-medial contexts. For measures of formant transitions out of a lateral, 143 tokens of intervocalic laterals were used, with a roughly even distribution between the two lateral and three vowel categories.

3.1 Acoustic analysis

Three types of measurements were taken: spectral moments of the laterals themselves, formant measurements for the transition out of the laterals, and measures of phonation for both the laterals and the vowel. The beginning of the vowels was determined based on the increased intensity associated with vowel as opposed to the laterals. The spectral moments measured were center of gravity, skew and kurtosis [5]. H1-H2, H1-A1, H1-A2, and H1-A3 were measured for phonation quality. Each set of measurements tests a specific hypothesis about the non-alveolar lateral. They are, in order:

(1) The non-alveolar lateral is not a fricative, despite previous work suggesting this
(2) The non-alveolar lateral has a uvular constriction
(3) The non-alveolar lateral differs in laryngeal setting from the alveolar lateral

Evidence for the second hypothesis has been laid out in section 2.3. The third hypothesis is formed based on the likely historical origin of 'hl'. In related languages, we find voiceless fricatives and /l/ where Ninde has 'hl.' The most likely source for Ninde 'hl' is the coalescence of voiceless fricatives with the alveolar lateral approximant. Because of the competing requirements of the vocal folds for those two kinds of segments (abduction and adduction, respectively) we might expect that a non-modal phonation, most likely breathy voice, was the result of this process.

Recordings were analysed in Praat using a series of Praat scripts to extract formant measurements at three points during the first quarter of the vowel. Spectral moment and phonation measurements were taken at three points over the entire segment, both for laterals and for the following vowel in the case of phonation measurements [11]. Data were then analysed in R [1].

4. RESULTS

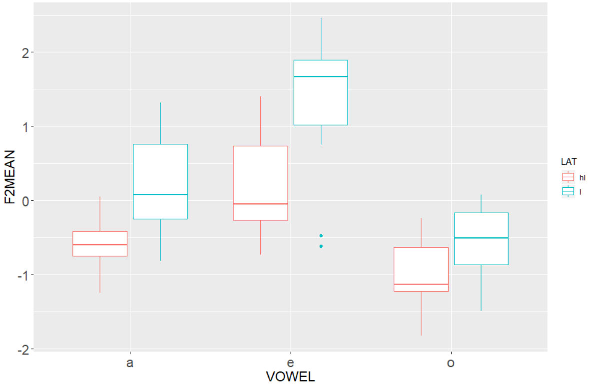
4.1. Spectral moments

None of the spectral moments were significantly different for the two laterals.

4.2. Formant transitions

Visual exploration of the data indicated that the first two formants were likely to be significant correlated with the identity of the preceding lateral. A generalized linear mixed effects model with dependent variable Lat (preceding lateral), independent variables MeanF1 and MeanF2, and random effects Speaker and Vowel showed that MeanF2 was significant ($p<.001$) in distinguishing the identity of the preceding lateral, but that MeanF1 was not. Post-hoc t-tests showed that F2 was significant at all three points of measurement: $1/16^{th}$ of the way through the vowel, $1/8^{th}$ and $1/4^{th}$. Figure 1 below shows the mean F2 values for each vowel quality after 'hl' and 'l'. Vowel quality is on the x-axis, always in the order /a e o/, and mean F2 is on the y-axis. The 'hl' condition is the right of each pair, and 'l' is the left.

Figure 1: Boxplot of mean F2 values by vowel quality and preceding lateral



Figures 2-4 show the F2 values for each vowel and preceding lateral condition at each of the three timepoints measured.

Figure 2: Boxplot of F2 differences at first timepoint

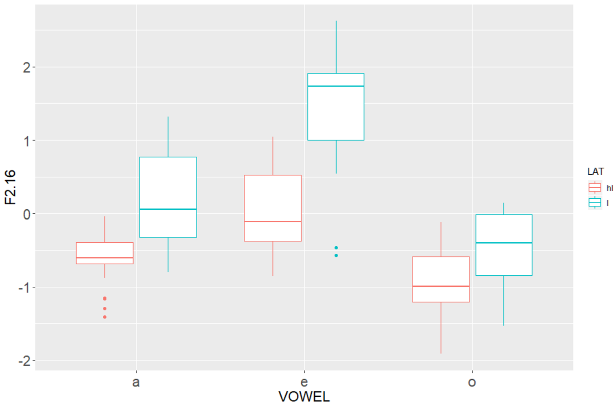


Figure 3: Boxplot of F2 differences at second timepoint

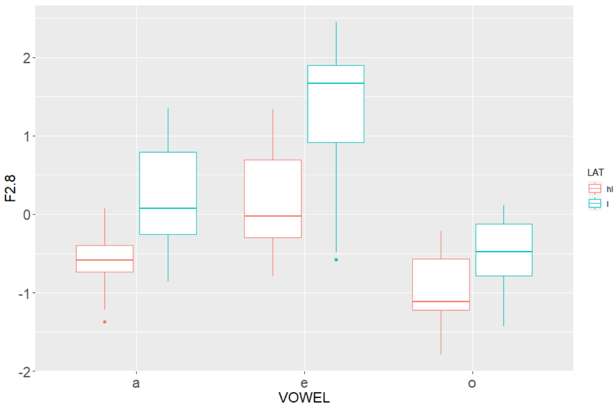
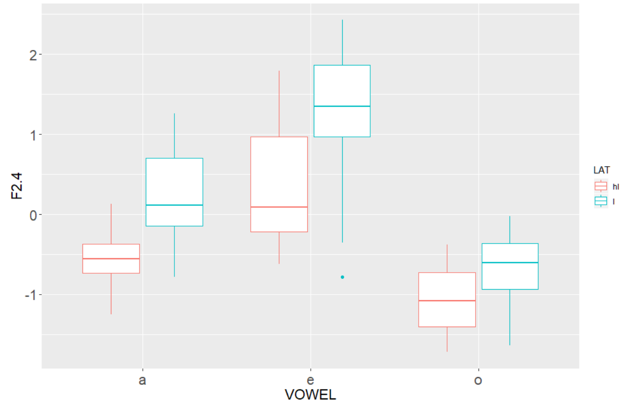


Figure 4: Boxplot of F2 differences at third timepoint

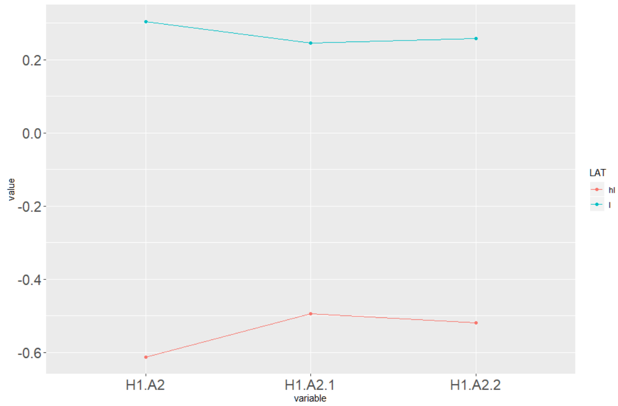


4.3. Phonation measures

No relationship was found between the identity of a preceding lateral and these measurements for vowels; 'hl' is not pre- or post-aspirated.

For the laterals themselves, however, visual exploration of the data indicated that H1-A2 and H1-A3 were the two measures most likely to be significant. A generalized linear mixed effects model with Lateral Types as the independent variable, Average H1-A2 and Average H1-A3 as the independent variables, and Speaker as a random effect, showed that both measures were significant predictors of lateral type. H1-A2 was more significant, and Figure 5 below shows the mean differences (scaled) between the laterals for H1-A2 at all three timepoints. 'l' is the top line, and hl' is the bottom line.

Figure 5: Mean differences in H1-A2 at all three timepoints



Most striking about this is that 'hl' has consistently and significantly lower values for H1-A2, which is the opposite of what is expected for a breathy segment. 'hl' does have higher H1-A3 values than 'l', but this is a less significant relationship. Figure 6 below shows average H1-A2 plotted against H1-A3.

Fitted lines for both ‘hl’ and ‘l’ are included; the line for ‘hl’ is the upper line, and ‘l’ the lower.

Figure 6: Mean H1-A2 vs mean H1-A3 for lateral type

5. DISCUSSION

The lack of significance for any of the spectral moments tells us that ‘hl’ is likely not a fricative, confirming the hypothesis put forward in section 3.1.

The lowered F2 in transitions out of ‘hl’ is consistent with a dorsal constriction. Because of the phonological behaviour of ‘hl’ this constriction is likely a uvular one. Additionally, alveolar laterals have been shown to have posterior (velar) constrictions [8], so the constriction for ‘hl’ is further back than this. This also explains the lower jaw position during the production of ‘hl’.

The phonation measurements are the most surprising. The hypothesis was that ‘hl’, as a result of its origin in voiceless fricative + /l/ sequences, may show some pre- or post-aspiration, or a degree of breathiness during the segment itself. The slightly higher H1-A3 found for ‘hl’ as compared to ‘l’ supports this hypothesis, but ultimately it has to be rejected because H1-A2 is significantly higher for ‘l’ than for ‘hl’. This indicates that there may be significant differences in phonation between the two segments but further research, ideally using an EGG is necessary.

The uvular constriction of ‘hl’ should be considered its defining feature despite the interdental-to-linguolabial anterior constriction found in careful speech. The anterior constriction is not maintained in rapid speech, and the uvular constriction dictates the phonological behaviour of the segment.

It must be noted, however, that this is a diachronically unstable segment and is merging or has already merged with /l/ in both production and perception for many speakers, even those who were raised in a Ninde-speaking environment by families who preserve the contrast. This instability is likely due to the variety of cues to this segment, and the fact that while it is visual salient in careful speech, it is not in casual speech. In fact, in casual speech there is often no visual evidence of an anterior constriction at all.

6. CONCLUSION

This paper presented an acoustic analysis of the lateral contrast in Ninde, which has never been fully described before. The results show that the non-alveolar lateral likely has a uvular constriction, which is to be expected given the phonological patterning of the segment. Additionally, the paucity of segment-internal cues to identity helps to explain the diachronic and synchronic instability of the non-alveolar lateral.

7. REFERENCES

[1] Boersma, Paul & Weenink, David (2008). Praat: doing phonetics by computer (Version 6.0.43) [Computer program]. Retrieved on September 8, 2018, from http://www.praat.org

[2] Charpentier, JM. 1982. *Atlas linguistique du Sud-Malakula (Vanuatu)*. Leuven: Peeters.

[3] Crouch, C., Schaefer K. 2017. *Overview of the Ninde Language*. Presented at APLL9. Paris: France.

[4] Deacon, B. 1934. *Malekula: A Vanishing People of the New Hebrides*. London: Routledge

[5] DiCanio, C. 2013. Time averaging for fricatives http://www.acsu.buffalo.edu/~cdicanio/scripts/Time_averaging_for_fricatives_2.0.praat

[6] Dimock, L., Pearce, E., Greenback, E., Isno, L. 2014. *A Sketch Grammar of Ninde*. Unpublished ms.

[7] Gordon, M., Ladefoged, P. 2001. Phonation types: A cross-linguistic overview. *Journal of Phonetics*. 29(4), 383-406.

[8] Narayanan SS., Alwan AA., Haker K. 1997. Toward articulatory-acoustic models for liquid approximants based on MRI and EPG data. Part I. The laterals. *J. Acoust. Soc. Am.* 101(2), 1064-1077.

[9] Ray, S. 1926. *Labo Grammar*. Cambridge: Cambridge.

[10] R Core Team. 2018. *R: A Language and Environment for Statistical Computing*. https://www.R-project.org

[11] VoiceSauceImitator http://phonetics.linguistics.ucla.edu/facilities/acoustic/PraatVoiceSauceImitator.txt