PHONETIC IMPLEMENTATION OF GEMINATES IN MALAYALAM NOUNS

John Local and Adrian P. Simpson*
Dept. of Language and Linguistic Science, University of York, U.K.
**Institute of Phonetics and Digital Speech Processing, University of Kiel, Germany*

ABSTRACT

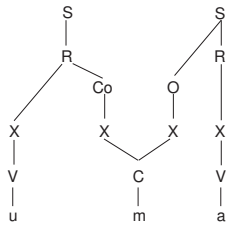
Malayalam employs gemination in syntactic and lexically distinctive roles. This paper presents an impressionistic and acoustic investigation of a subset of geminate consonants in Malayalam nouns. We show (a) that geminate sonorant consonants exhibit spectral differences as well as temporal ones and (b) that there are systematic spectral and temporal differences in vowels and consonants in nouns with and without geminates. Our findings suggest that gemination in Malayalam is best treated in terms of a long-domain phonological phenomenon having implications for articulatory and durational aspects of utterances extending over a number of syllables.

1. INTRODUCTION

Malayalam is a Dravidian language spoken by around 35 million speakers of Kerala state in the south-west of India. It exhibits two very different sets of phonetic alternations which have both been called gemination [1, 2]. The first set is found in the verb system, serving to distinguish intransitive and transitive verb forms. The second set is found in the nominal system and functions in a lexically distinctive manner.

1.1. Geminates

Geminates are reported for many languages of the world [3, 4] and have been the source of much debate in the phonological literature, e.g. [5]. The representation of geminates is not unproblematic though there is a consensus in contemporary nonlinear phonology that they are represented by two melodic consonant slots associated with a single timing slot — thus the representation of the geminate nasal in the Malayalam noun *umma* ('kiss') is:



Regardless of the frameworks within which gemination has been treated and the many languages for which it has been posited as a phonological unit or process, the accounts share the important characteristic that the phonetic implementation of gemination is routinely described as having an extremely limited domain: it is assumed to be found at a particular consonantal place in utterance. We argue that Malayalam provides an interesting data set which challenges this interpretation.

1.2. Gemination in Malayalam

Malayalam has a rich consonantal inventory [3] and employs gemination/consonantal length in syntactic and lexically distinctive roles. Long and short intervocalic sonorants can serve to distinguish otherwise phonetically similar lexical items and play a role in compounding [1], whilst the contrast between transitive and intransitive verb forms is displayed in part by the presence or absence of intervocalic geminates [2, 6] (transitive forms have geminate consonants). The gemination alternation in verbs involves a complex combination of temporal, articulatory and phonatory features extending over a number of syllables [6]. It must be remembered that were it not for the major grammatical function being fulfilled by these phonetic alternations there would be no reason to treat them in terms of a phonological alternation. The second set of patterns found in the nominal system involves consonantal types (sonorants) which do not participate in the gemination relationship in verb forms. We present an impressionistic and acoustic analysis of the phonetic detail of these geminates in Malayalam nouns and show that they exhibit stable spectral differences as well as temporal ones and that these differences extend well beyond the locus of the geminate consonants themselves.

In [6] we demonstrated that, for verbs, syllables containing geminates differ systematically from those without geminates in terms of: phonation (intransitive forms lax, breathy, with voiced intervocalic consonants; transitive forms tense, creaky with voiceless intervocalic consonants), consonantal and vocalic resonance (with vowels in intransitive forms opener and less peripheral than their transitive counterparts — short vowels before geminates exhibit noticeable fronting off-glides), as well as patterns of articulatory variability in adjacent consonants.

1.3. Gemination in Malayalam lexis

In nouns, with sonorants as intervocalic geminate consonants, we find similar consonantal and vocalic resonance differences as those identified in [6] as well as systematic differences in the durations of vowels preceding and following geminates. There is also some evidence that there exist durational differences between syllable initial consonants in what, for convenience, we will refer to as 'short' nouns (those without geminates) and 'long' nouns (those with intervocalic geminates).

Our findings suggest that gemination in Malayalam nouns, as with the verbs, should be treated in terms of a long-domain phonological phenomenon being implemented by articulatory and durational aspects of utterances extending over a number of syllables. This in turn raises questions as to the phonetic patterns which may need to be associated with what has been called gemination in other languages.

2. DATA AND METHOD

A series of face-to-face impressionistic recordings with one male speaker of Malayalam gave rise to a set of 35 disyllabic nouns

(see Table 1) with intervocalic nasals and laterals. The informant sat in a sound-treated room and orally translated a list of English glosses. The list items were in quasi-random order and were produced a total of four times in isolation and twice in a sentence frame. Recordings were subsequently digitized (10 kHz/12 bit). The digitized utterances were segmented into discrete vocalic and consonantal portions using typical auditory and spectral criteria. The segmentation provides the temporal basis for durational measurements in 3.1. The spectral measurements in 3.2 were made approximately at the midpoint of consonantal and non-final vowel portions and 35 ms from the start of final vowel portions. We report here only on data arising from the word-list productions.

3. RESULTS

3.1. Length and duration

There are striking auditory differences between nouns with geminate and those with non-geminate sonorants. Those with geminates give the impression of being crisply produced with tight, firm closure and release of all consonants in the word (similar findings are adduced for the long intervocalic consonants of Tamil in [7]). By contrast, the consonants in words with non-geminates sound lax and variable in their articulatory characteristics. In the long nouns lateral and nasal consonants have noticeably firm contact (often resulting in a stop-like percept when the occlusion is formed) in short nouns there is no such percept — and nasals consonants in short nouns, for instance, often give the impression of incomplete oral closure.

The geminate consonants are noticeably longer than their non-geminate congeners. Impressionistically, the nouns with geminate intervocalic consonants differ in the rhythmic relationship between the first and second syllable such that nouns with non-geminates and a short first vowel have short-long rhythmic relations between the syllables whilst those with geminates exhibit an 'equal-equal' rhythmic relationship between the two syllables [8].

The length and rhythmic differences manifest themselves in significant durational differences between the intervocalic sonorants as well as between the vocalic portions in both syllables. Table 1 gives mean durations of the intervocalic sonorants (**c**) and the initial (**v1**) and final (**v2**) vocalic portions. The final two columns contain vowel durations represented as proportions of the intervocalic sonorant duration. The data are arranged by increasing duration of the intervocalic consonant. (The romanization of the Malayalam words follows that of [9] with the exception that retroflex segments are symbolised 'rl' 'rn' — retroflex lateral and nasal respectively; long vowels and geminate consonants are written doubled.) In short and long noun pairs with analogous structure, e.g. *karli/karlli*, U-tests were carried out to identify significant durational differences between vocalic portions in initial and final syllables. Short and long nouns paired for testing are indicated by bracketed numerals after the gloss. Means marked with * are significantly different, those with *ns* are not.

Word	***Gloss***	**v1**		**c**	**v2**		**v1/c**	**v2/c**
parnam	money	83		40	59		2.08	1.48
vala	net	101		41	122		2.46	2.98
purli	tamarind (1)	55	*	42	107	*ns*	1.31	2.55
pana	palm tree (2)	89	*	45	87	*	1.98	1.93
karlam	design (3)	74	*ns*	45	62	*	1.64	1.38
parni	work (4)	92	*	46	116	*ns*	2.00	2.52
tala	head	83		47	113		1.77	2.40
viirna	musical instrument	156		49	94		3.18	1.92
varla	bangle	88		49	95		1.80	1.94
ila	leaf	89		51	111		1.75	2.18
puli	leopard	77		52	109		1.48	2.10
mala	mountain	89		52	100		1.71	1.92
aana	elephant	194		53	100		3.66	1.89
mula	breast (5)	67	*ns*	53	128	*	1.26	2.42
marni	bell	87		54	87		1.61	1.61
vila	price	75		56	105		1.34	1.88
maala	garland	187		58	79		3.22	1.36
karli	game (6)	82	*	59	100	*ns*	1.39	1.69
uuma	dumb	169		63	100		2.68	1.59
aama	tortoise	205		78	103		2.63	1.32
varllam	boat	86		149	45		0.58	0.30
vernna	butter	82		152	73		0.54	0.48
karllam	lie (3)	62	*ns*	154	45	*	0.40	0.29
parlli	church	77		158	60		0.49	0.38
mulla	jasmine (5)	49	*ns*	163	91	*	0.30	0.56
parlli	woman liar (6)	69	*	164	95	*ns*	0.42	0.58
kanna	buffalo (2)	73	*	178	72	*	0.41	0.40
karnni	link (4)	59	*	180	115	*ns*	0.33	0.64
purlli	spot (1)	41	*	182	98	*ns*	0.23	0.54
tarlla	old woman	82	*s*	183	91		0.45	0.50
unni	baby	79		186	104		0.42	0.56
panni	pig	76		187	84		0.41	0.45
palli	thief	75		188	93		0.40	0.49
umma	kiss	65		193	93		0.34	0.48
amma	mother	61		208	97		0.29	0.47

Table 1. Mean durations of intervocalic sonorants (**c**) and initial (**v1**) and final (**v2**) vocalic portions for all 35 nouns. Short nouns are at the top, long at the bottom. (See text for further details)

Table 1 shows that the medial sonorants in long nouns always have significantly greater duration than those in short nouns. The mean sonorant durations are 52 ms and 175 ms for short and long nouns respectively. Means for individual places of articulation range from 47 ms in short retroflex nasal nouns to 71 ms for short bilabial nasals. Bilabial nasals are also longest in the long nouns with a mean of 200 ms, with the long retroflex laterals have the shortest mean duration of 161 ms. The means of ratio of short:long sonorant duration is 1:3.4, ranging from 1:2.8 for bilabial nasals to 1:3.8 for apical nasals.

Besides the large durational differences between medial sonorants, we also find a number of significant durational difference between the vocalic portions in short and long nouns: the vocalic portions of short nouns are longer than those of long nouns. Of the six short-long pairs with similar structures com-

pared there is either a significant difference in first vowel duration (indexed 1, 2, 4, 6 in Table 1 above), second vowel duration (indexed 2, 3, 5 in Table 1 above) or across both syllables. For the sonorant noun pairs with final close vowel the vocalic portion in the first syllable of the short noun is longer than that of the long noun and there is no significant difference between the vocalic portions of the second syllable.

In the remaining lateral pairs significant durational differences are to be found between the open vocalic portions of the second syllable. And in the remaining nasal pair both vocalic portions in the short noun are longer than those in the long noun.

While we find significant differences between absolute durations in short and long noun pairs, differences in temporal organization which give rise to the rhythmic aspects noted above can best be reflected by considering durations in relative terms. In Table 1 this has been done by representing vowel duration as a proportion of medial sonorant duration. The average vowel/sonorant proportion for short vowels (excluding items such as *aama, uuma* etc.) in short nouns is 1.79 for **v1/c** and 2 for **v2/c**. In contrast, equivalent proportions in the long nouns have means of 0.39 for the **v1/c** and 0.48 for **v2/c**.

There is also evidence that initial consonants are significantly shorter in the nouns with 'long' rather than 'short medial laterals ($p < 0.05$ for initial plosives; $p < 0.005$ for initial sonorants). However, this is not the case for nouns with medial nasals where durational differences in initial segments for words with and without geminates are not statistically significant. (These results appear to accord with a durational interpretation of the airflow data for Tamil presented in [7]. Juliette Blevins reports (pers. comm.) that in some Australian languages initial consonant loss is predicted by the presence of intervocalic sonorants in the words in question — perhaps this is the limiting case of the 'shortening' we observe in the Malayalam data.)

3.2. Vocalic and consonantal resonance

We have shown that the phonetic implementation of geminates/non-geminates involves duration not only of the consonants themselves but also of surrounding vowels. Differences between the nouns containing geminates/non-geminates are not restricted to duration alone. We also observe a number of consistent differences in the consonantal resonance of the geminate/non-geminate consonants and in the quality of the vowels in the words.

In impressionistic terms, geminate consonants have clearer (more palatalized) resonance than their non-geminate congeners. This is irrespective of their place or manner of articulation. Such clear and dark resonance patterns (palatalization and its absence/velarization) are also known to be associated with dental and alveolar articulations in Malayalam [1, 3, 6] and to be involved in the distinction between the two apical sounds described as trills or taps [1, 3, 9, 10].

In addition, vowels preceding and following geminate consonants are different from those surrounding non-geminates — specifically vowels surrounding geminate consonants are more peripheral in quality than those surrounding non-geminates. So, for example, in the noun pair *mula-mulla* we find, impressionistically, that the intervocalic laterals in both words are clear, but the lateral in *mulla* is clearer, being maximally palatalized in some tokens. The rounded vowel in *mulla* is always fronter and closer than that in *mula*. The final vowel of *mulla* is open front quality, close to CV4, whereas that in *mula* is more centralized. Similarly, in the two words *tala*, *palli* we find that the non-geminate lateral is noticeably darker in resonance than the geminate one; the vowel preceding the non-geminate lateral in *tala* is impressionistically more open and not as front as the first vowel in *palli*. Figures 1 and 2 present F1-F2 space formant plots of the first vowels and sonorants in the four tokens of each of these nouns. (Each data-point represents an average of three measurements taken around the midpoint of the vowel or consonant).

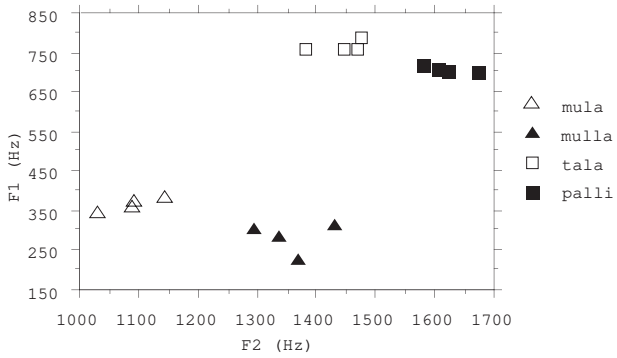


Figure 1. F1-F2 plot of first syllable vowels /u/-/a/ in *mula-mulla, tala, palli*

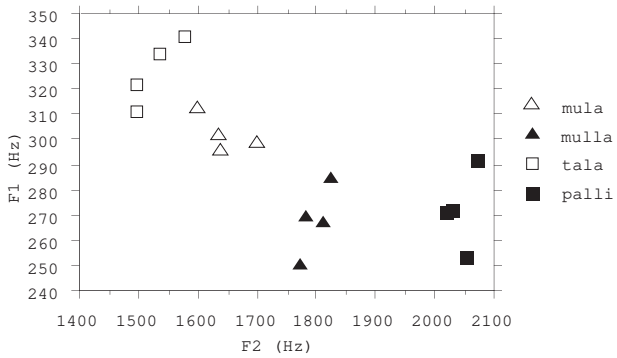


Figure 2. F1-F2 plot of /l/-/lː/ in *mula- mulla, tala, palli*

From Figure 1 we can see that for both /u/ and /a/ F1 values are lower and F2 values higher in geminate than in non-geminate contexts (all differences attain statistical significance; F2 differences significant $p<0.001$; F1 values attain significance, $p<0.01$). Similarly, Figure 2 reveals that geminate /lː/ consonants in these words have higher F2 values than the non-geminate /l/ and also differ in terms of their F1 (F2 differences significant $p<0.001$; F1 differences $p<0.01$). We take these acoustic facts to support our auditory impressions of relative clear resonance in the intervocalic geminate consonants.

Comparable results emerge for nouns with intervocalic retroflex laterals. Auditorily, *karli* and *karlli* both have back, half-open-mid vowel qualities in the first syllable, with that in *karlli* sounding generally less open but more advanced than that in *karli* (but see acoustic analysis in Figure 3). The vowel quality in the second syllable of *karlli* is also more peripheral than that in *karli*. It is both closer and further forward in the region of [i] whereas in *karli* the second vowel is centralized, [ɪ]. The intervocalic lateral in the long noun is palatalized whereas that in *karli* has clear resonance. For the *karlam-karllam* pair the first syllable qualities are akin to those found in *karli-karlli* with the first

vowel of the long noun being fronter than that of *karllam*. The vowel qualities in the second syllables are very similar in quality. Again we also find a clearer retroflex lateral in all productions of *karllam* than those of *karlam*, with that in *karllam* having front of central resonance that in *karlam* being central. Figure 3 presents F1-F2 space acoustic data for the first-syllable /a/ vowels in *karli*, *karlli*, *karlam* and *karllam*. Figure 4 gives F1-F2 space data for the intervocalic short and long laterals in the same words. (We note, in passing that the long retroflex laterals exhibit dynamic formant structure — noticeable movement of F3 — during their production; there is also movement of F2 in some tokens such that F2 remains steady or rises slightly over the first two-thirds of its duration and falls slightly over the last third.)

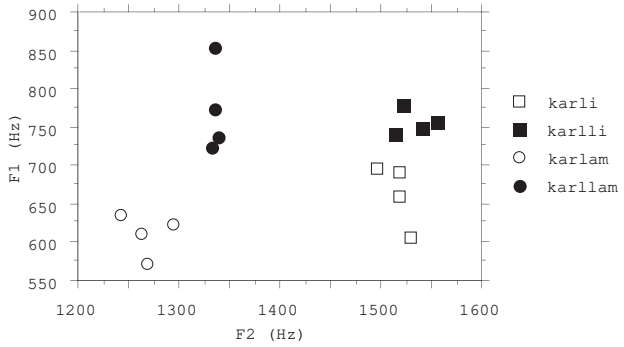


Figure 3. F1-F2 plots of /ɭ / /ɭː/ pairs with following /am/ or /i/

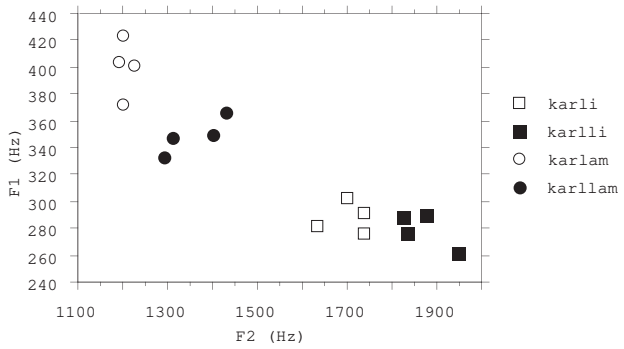


Figure 4. F1-F2 plots of /ɭ / /ɭː/ pairs with preceding /a/ and following /am/ or /i/

In Figures 3 and 4 the data partition into two main sets depending on the presence or absence of a close vowel in the second syllable. If the word contains a close front vowel in its second syllable (e.g. *karli*) there is an effect on the first vowel of the word such that it is relatively fronter (higher F2 value) than if there is a non-close front vowel in the second syllable (eg *karlam*). This effect is observed in other comparable pairs. As observed previously (Fig. 1), if the word contains a geminate consonant, the preceding vowel is relatively fronter irrespective of the effect of the vowel in the second syllable. Figure 4 provides F1-F2 plots for the laterals which follow the vowels given in Figure 3. Again we can see the 'final-i' effect and again we can observe the geminate consonant effect with higher F2 and lower F1 values for the geminate laterals. Here we find a patterning like that for non-retroflex laterals shown in Figure 2: higher values for F2 and lower F1 values for the geminate laterals. However, unlike the data presented in Figure 1, the data in Figure 3 show that before geminate retroflexes vowels are more *open* (higher F1 values) than before non-geminates — a reversal of the pattern in Figure 1. We have no good explanation for this phenomenon. It is also found for the other vowels in the system and with the other retroflex geminate consonants (retroflex nasals).

The patterns of relative frontness for geminate consonants and the durational and spectral variation in vowels in geminate/non-geminate nouns are robust and found throughout our dataset. Work in progress on the articulatory and acoustic characteristics of geminates in the speech of other Malayalam speakers suggests that these features are not idiosyncratic.

4. CONCLUSION

This paper has presented a number of qualitative and quantative differences between two groups of nouns in Malayalam. We have shown that rather than being restricted to consonantal length differences alone, the implementation of gemination has implications for most if not all of noun's phonetic shape, involving the temporal organization, vowel quality and resonance in consonantal portions. The consequence of attending to such phonetic details leads us to the conclusion that however one treats 'gemination' in Malayalam, there is no compelling case to do so in terms which focus on a particular point in utterance.

Equally important are the implications that the results of our investigations may have for the analysis of other languages where 'gemination' has been proposed and has been assumed to be only a matter of consonantal length. In impressionistic recording sessions with informants from Standard Italian, Sinhalese and Damascene Arabic, which also have 'long/geminate' phenomena, we have observed temporal, phonatory and articulatory patterns extending beyond the consonantal portions which are generally the focus of attention. Both these observations together with the durational and acoustic evidence we have presented here have convinced us that any investigation of 'gemination' must err on the side of caution and expect to find a complex range of phonetic patterns associated with larger stretches of utterance.

REFERENCES

[1] Mohanan, K.P & Mohanan, T. 1984. *Lexical phonology of the consonant system of Malayalam*. Linguistic Inquiry 15: 575-602.

[2] Nayar, P. 1972. Phonetic and phonological exponents of transitivity in Malayalam. In S. Agesthialingom & S.V. Shanmugam (eds.). *Third Seminar on Dravidian Linguistics*. Annamalainagar: Dept. of Linguistics.

[3] Ladefoged, P & Maddieson, I. 1996. *The Sounds of the World's Languages*. Blackwell Publishers: London.

[4] Laver, J. 1994. *Principles of Phonetics*. Cambridge University Press: Cambridge.

[5] McCarthy, J. 1986. OCP effects: gemination and antigemination. *Linguistic Inquiry* 17, 207-263.

[6] Local, J. and Simpson, A. 1988. The domain of gemination in Malayalam. In Bradley, D., Henderson, E.A.J. and Mazaudon, M. (eds.), *Prosodic analysis and Asian Linguistics: to honour R.K. Sprigg.* Pacific Linguistics, C-104, 33-42.

[7] Balasubramanian, T. 1972. *The phonetics of colloquial Tamil*. PhD Dissertation, University of Edinburgh.

[8] Abercrombie, D. 1964. Syllable quantity and enclitics in English. In Abercrombie, D., Fry, D., MacCarthy, P.A.D., Scott, N.C. and Trim, J.L.M. (eds.), *In Honour of Daniel Jones*, London: Longman Green, 216-22.

[9] Kumari, B. S. 1972. *Malayalam Phonetic Reader*. Central Institute of Indian Languages. Mysore.

[10] Whitley, E.M. 1958. Discussion: Acoustic Phonetics and Linguistics. *Proceedings of VIIIth International Congress of Linguists,* Oslo. 484-487.