Word-level prominence distinctions in Tamil

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ABSTRACT

This paper examines whether Tamil makes any prominence distinctions at the word level. There are no stress-based lexical contrasts in the language, and previous work, which is largely impressionistic, has reached no consensus on the existence of prominence distinctions, or their location within either the word or phrase. Results reported here indicate that word-initial syllables are marked by phonetic correlates associated with vowel reduction, which has frequently been implicated in prominence distinctions cross-linguistically. Vowels in initial syllables are significantly longer and less centralized in quality than those of word-medial or word-final syllables. Evidence is also presented suggesting that this pattern of initial prominence is independent of phrase-level effects.

1. INTRODUCTION

There are no lexical distinctions based on stress in Tamil and native speakers have no clear intuitions about its placement. There is no consensus in the literature on whether stress exists in the language, or on its location, although most descriptions favour either fixed initial stress or a quantity-sensitive dynamic system. These claims are largely based on impressionistic observations, but what little experimental work has been conducted has also failed to find any consistent phonetic correlates of non-emphatic stress [1,2]. This suggests that Tamil may not mark prominence at all at the word-level, as has been claimed, for instance, for Indonesian [3].

Another line of evidence points in a different direction: it has been observed that the vowels /i/, /a/ and /u/ have centralized quality and reduced duration in non-initial syllables [4,5]. The initial syllable is also singled out by Schiffman [5] as the only position in which /ai/ tokens are fully produced as diphthongs. Monophthongization to [ɛ] or [a], depending on dialect, is also reported by Asher [6], but only for final syllables of polysyllabic words. Differences in duration and vowel quality are well-established correlates of stress cross-linguistically, so this indicates that the language may mark prominence.

This study was designed to distinguish between the two possibilities – presence or absence of prominence at the word-level – by considering evidence of vowel duration and quality.

2. METHOD

Test words were selected containing the target vowels /i/, /a/ and /u/ and the diphthong /ai/ in different syllable positions – initial, medial and final. All were presented in the context of simple sentences, with no indication of emphasis. The immediate phonetic environment of the vowels was balanced as far as possible, as shown in Table 1, which contains all the /a/ vowels. The test sentences were recorded five times each by three native speakers, two male and one female. All were long-term residents of Pondicherry, a town in south-east India, where the recordings were made.

Context	Initial	Medial	Final
v_n	*v**a**ntaa*	*av**a**nukku*	*av**a**n*
v_	*v**a**raar*	*koɳʈuv**a**raatee*	*kiɻav**a**n*
l_	*l**a**ɳʈan*	*uɭɭ**a**ŋkai*	*kool**a**m*
_n	***a**npu*	*mook**a**nin*	*paiy**a**n*
r_	*r**a**ttam*	*paattir**a**ttai*	*citampar**a**m*
t/ʈ_	*t**a**lai*	*paartt**a**tu*	*eŋkiʈʈ**a***
t_m	*t**a**mpi*	*cit**a**mparam*	*ratt**a**m*
p_ra	*p**a**rantatu*	*citamp**a**ram*	
_nta	***a**nta*	*par**a**ntatu*	
p_ʈi	*p**a**ʈiccaan*	*ipp**a**ʈi*	
k_	*k**a**ttatu*		*uʈaikk**a***
_ll/#	*n**a**llatalla*	*nallat**a**lla*	*aɻakaan**a***
n_		*en**a**kku*	*en**a***
_n		*paiy**a**n-ŋŋu*	*mook**a**n*
ʈ_		*paʈ**a**ttai*	

Table 1: Words containing /a/ tokens: target vowels are emboldened.

Tamil has both a colloquial spoken variety and a formal variety used for writing, and the two are sufficiently divergent for the language to be classed as diglossic [7]. Written representations of colloquial Tamil are relatively rare, and there are no standards, official or unofficial, for spelling. In preparing the stimuli for orthographic presentation, therefore, colloquial forms were written as phonetically as possible within the limits of the writing system. Subjects were encouraged to speak in a colloquial fashion and encountered no difficulties in reading the sentences fluently. Nevertheless, it is possible that their production was influenced to some degree by spelling pronunciations. None of the speakers was sufficiently

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proficient in English to be comfortable translating into Tamil on the spot, which would have avoided the danger completely.

The data were recorded using a DAT recorder and lapel lavalier microphones (Audio-Technica AT803b), and subsequently digitized at a rate of 16 kHz (16 bit resolution). In a few cases tokens were discarded because of interference from background noise, accidental slips by the speaker or absence of identifiable formants. The total number of vowel tokens measured was 1139 monophthongs and 162 diphthongs. For each token cursors were placed at the onset and offset using the ESPS/*xwaves*™ software. The duration of the vowel was measured, and also the first and second formant frequencies at its midpoint. For the diphthongs F1 and F2 were additionally measured at points one quarter and three quarters of the way through the vocalic portion of the signal.

Linear predictive coding analysis was used to track the formants automatically, applying autocorrelation within a pitch period to identify broad spectral peaks corresponding to vocal tract resonances. Twelve coefficients were used in the linear predictive equation, and the window duration was 49 milliseconds, with 5 millisecond steps between analysis frames. The tracking was originally set to locate three formants, and this worked reasonably well for the two male speakers. Some difficulties were encountered for the female speaker, but these were largely resolved by resetting the tracking to search for four formants during measurement of her tokens.

Statistical analysis was performed using analyses of variance in which the independent variables were syllable position and speaker. In cases where the Levene test indicated that the variance of the data was not homogenous, the non-parametric Mann-Whitney test was employed.

3. RESULTS

Consistent and significant differences between speakers were found for the formant frequency values, both for the data set as a whole and for the individual vowels. Duration, however, was relatively unaffected by interspeaker variation: a significant difference was found only for the /a/ vowels ($p < .001$).

Analysis of the /a/ tokens revealed that their duration was significantly affected according to whether they appeared in an initial syllable or not ($p < .0005$). Boxplots illustrating the duration values are displayed in figure 1, which indicates that the primary distinction is between longer initial and shorter non-initial syllables, rather than being a gradient effect. This was confirmed by a repeated measures analysis of variance which showed the three-way distinction in syllable position not to be significant.

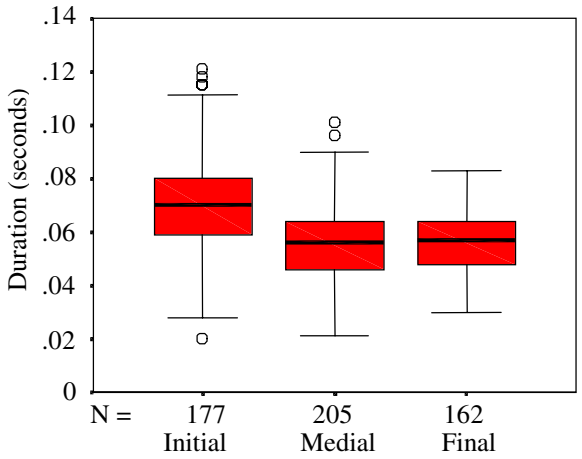

Figure 1: Boxplots of duration of /a/ tokens against syllable position for all speakers.

Syllable position also had a significant effect on the formant frequency values for /a/, F1 being higher ($p < .0005$) and F2 lower ($p < .001$) in initial than non-initial syllables. These results all suggest that the vowels of non-initial syllables are reduced in duration and centralized in quality.

Results for the /i/ tokens from the original data set proved inconclusive: values for duration in particular were confounded by a strong effect of final lengthening. A more controlled data set was therefore used, consisting of four reduplicated expressive words in which /i/ vowels appeared in the first and third syllables e.g. *kirukiruppu* 'giddiness'. Syllable position was found to have a significant effect on duration ($p < .013$), with vowels in initial syllables being longer. They were also characterized by significantly lower F1 and higher F2 ($p < .0005$ for both), indicating a more peripheral vowel quality.

The same pattern emerged clearly from analysis of the /u/ tokens: significantly longer duration in initial than non-initial syllables ($p < .004$) and highly significant differences in the formant frequencies correlated with syllable position ($p < .0005$), as illustrated in figure 2. The higher values for both F1 and F2 in non-initial syllables would again be consistent with a more centralized articulation but might also reflect less lip-rounding. (The five initial tokens that are not clustered with the rest were all contained in repetitions of a single test sentence by the female speaker: why these results diverge so markedly from the rest is not clear.) As with the /a/ tokens, a repeated measures analysis of variance confirmed that the significant distinction is between initial and non-initial syllables, rather than a three-way gradient effect.

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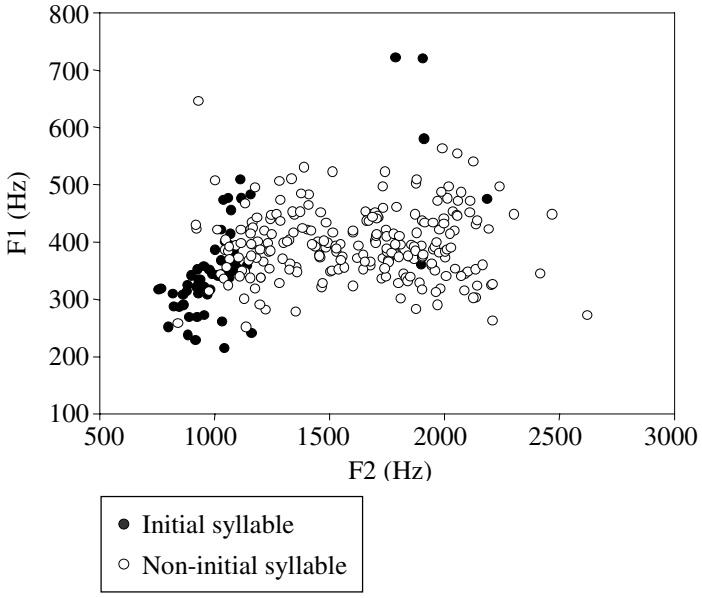

Figure 2: Scatterplot of F1 against F2 for /u/ tokens in initial and non-initial syllables for all speakers.

The duration results for the /ai/ diphthongs are in line with those for the monophthongs, i.e. the overall duration of the vocalic portion of an initial syllable is significantly longer than those of non-initial syllables ($p < .0005$), and there is no significant interspeaker variation. The change in formant frequencies over the central half of the diphthong was also affected by syllable position, the degree of change being significantly higher in initial than non-initial syllables ($p < .0005$ for both F1 and F2). Comparison of the rates of change revealed no marked differences: the gradients in figures 3 and 4 are not strongly differentiated. This suggests that the reported monophthongization is primarily a matter of reduced duration, rather than a contrast between a dynamic and a steady-state segment. However, it would be unwise to draw any firm conclusions, given a possible effect from spelling pronunciations.

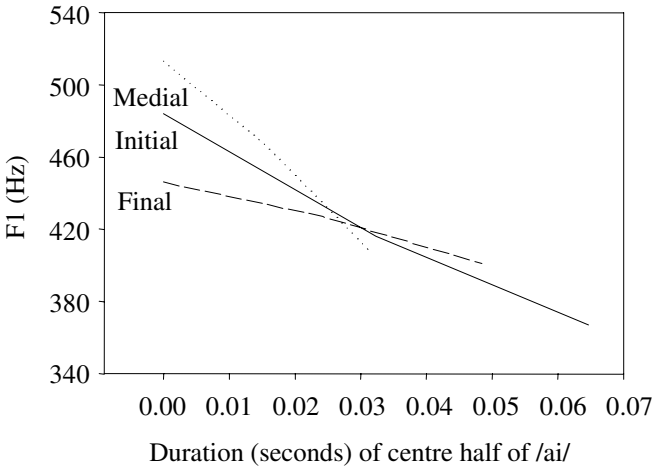

Figure 3: Line chart showing the change in F1 over the centre half of /ai/ in initial, medial and final syllables for all speakers.

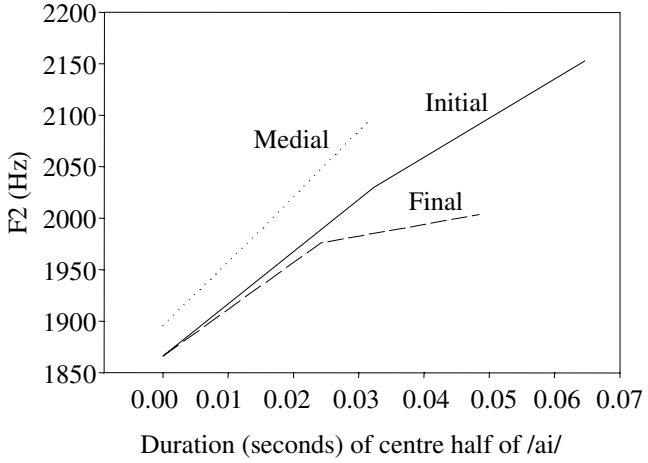

Figure 4: Line chart showing the change in F2 over the centre half of /ai/ in initial, medial and final syllables for all speakers.

No effort has been made thus far to control for the potentially confounding effects of accent, so the possibility that these results reflect prominence at the phrase rather than the word level should be considered. There is evidence for Dutch that accent increases the durations of both vowels [8] and syllables [9], and also affects spectral quality, although to a lesser degree than word stress. Moreover, the effects of accent are not limited to the specific syllable with which the main pitch movement is associated but are found in all syllables of the accented word. In order to control for any such effects in Tamil, tokens of vowels in unaccented words were analysed to see whether the same pattern of results would be found.

As with word-level prominence, there is no agreement on the location of accent in Tamil. Word order is consistently SOV and informal inspection of F0 contours suggests that the main accent does not fall on the rightmost constituent. When two lexical phrases precede the verb it is marked by a slight fall in the initial syllable to a level plateau. This typically extends to the final syllable, where there may be a further fall in declarative sentences. By contrast, pronounced peaks are associated with the preceding constituents. Tokens of vowels in sentence-final constituents were therefore assumed to be unaccented.

Eight /a/ vowels, all in verbs associated with the intonation contour described above, were chosen, four in initial and four in non-initial syllables. No significant differences in duration were found, which may be due to syllable structure, there being a disproportionate number of closed syllables in the initial condition. However, differences in vowel quality precisely paralleled those in the larger data set, i.e. significantly higher F1 and lower F2 in initial than non-initial syllables ($p < .0005$ for both). Figure 5 illustrates how the tokens broadly separate into two clusters according to whether they occur in initial or non-initial syllables.

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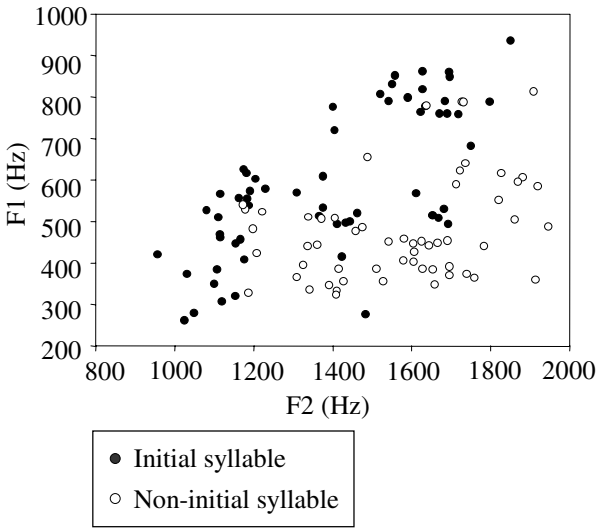

Figure 5: Scatterplot of F1 against F2 for unaccented /a/ tokens in initial and non-initial syllables for all speakers.

4. DISCUSSION

These results are evidence that the three Tamil monophthongs considered undergo reduction in both duration and quality in non-initial syllables. Moreover, these same effects are found in /a/ tokens controlled for the presence of accent, suggesting that they are independent of any phrase-level prominence. /ai/ tokens in initial syllables are also distinguished by greater length, although the rate of formant change is not significantly affected by syllable position. In conclusion, it appears that there are phonetic correlates of prominence at the word-level in Tamil, and that they are consistently associated with an initial syllable.

The phonetic parameters analysed in this study are limited, and it is possible that they are complemented by other correlates. Candidates for future investigation include the intensity of vowel tokens: unfortunately the recording conditions meant that the level of background noise was too high for any such analysis in this study. Spectral balance should also be considered: this is reported to be a more reliable correlate of word-level prominence than overall intensity in Dutch [9]. Another avenue for future research, largely unexplored at present, is the interaction between pitch and prominence in Tamil. Given the results reported here, the expectation would be that significant pitch excursions are associated with initial syllables. Informal inspection supports this hypothesis and it is being tested in work in progress.

A further line of investigation suggested by these results concerns the /ai/ diphthongs. In environments where monophthongization has been reported there was no firm evidence that formant structures are flattened. Since spelling pronunciations may be responsible, a priority would be to determine whether the same pattern is found in utterances where such an effect can be ruled out. Furthermore, as the structure of diphthongs is known to vary cross-linguistically [10], it would be interesting to establish the salient characteristics for Tamil, and in particular the relative importance of a dynamic structure, compared to having particular formant frequency values at the onset and offset.

A final question concerns the function of prominence in Tamil. The phonetic properties by which it is marked match those of classic stress-accent languages such as English and Dutch. However, there seems to be a difference of degree, or at least of perceptual salience, given that native speakers (even those with phonetic training), apparently find it so hard to judge where prominence is placed. One possibility is that its main role is to mark word boundaries: certainly giving prominence to initial syllables accords well with the morphological structure of Tamil. There is little or no prefixation in the language, and inflectional morphology involves the concatenation of one or more suffixes to a lexical root. A final, speculative suggestion would therefore be that the phonetic prominence of initial syllables revealed in this study guides the listener to the lexical content of an utterance.

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