Phonetics vs. phonology in Tamil *wh*-questions

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Abstract

Wh-questions in Tamil are not distinguished from declarative utterances by either pitch accent type or boundary tone. Acoustic analysis of data from 18 speakers comparing *wh*-questions with corresponding declaratives revealed that the lexical marking of interrogativity is nevertheless accompanied by differences in intonation. The most consistent result was raising of f_0 peaks in question words and in a majority of speakers, including all the females, sentence offset f_0 was significantly higher in questions. This tended to be accompanied by lowering of f_0 peaks following question words, resulting in some compression of the pitch register. In marking interrogativity Tamil thus manipulates gradient phonetic parameters, adding further fuel to the debate about whether such parameters can directly signal linguistic information or are mediated via some elaborated phonological representation.

1. Introduction

An association between high or rising pitch and interrogativity has long been recognized and corroborated by cross-linguistic surveys of question intonation, e.g. [1], [2], [3]. There is variation, however, both between languages and between different question types within the same language, in how this is implemented, if at all. The most common means for marking interrogativity seems to be a phrase-final rise, which can be straightforwardly represented phonologically as an H% boundary tone. Other devices for raising pitch, such as raised sentence onsets or pitch register modifications, involve gradient parameters that are less easily accommodated within the intonational phonology of autosegmental-metrical theory. Gussenhoven [5] explicitly locates effects of this kind in the phonetic implementation, arguing that they express meanings deriving from 'biological codes'.

A well-known example of gradient variation is Grønnum's analysis of Danish questions [5], in which accent pattern is fixed, and the global slope of the intonation contour differentiates between utterance types. More recent data from Dutch [6] and English [7] also show that parameters such as average f_0 and slope vary consistently as a function of utterance type. It is not clear, however, whether manipulation of f_0 slope, for instance, represents a direct linguistic choice or is simply a corollary of other, phonological differences.

Wh-questions in Tamil represent an interesting test-case in that their phonological tunes do not differ in any immediately obvious ways from those of declarative statements. There appears to be only one type of pitch accent in the Tamil phonological inventory and, as in many other languages [8], *wh*-questions in Tamil are not consistently marked by a final rise. However, work on the intonation of Tamil is still at an early stage and there has been no quantitative investigation of interrogative utterances. An experimental study was therefore conducted to establish firstly whether the lexical marking of interrogativity in these questions is accompanied by consistent differences in their intonation patterns, and secondly how any such differences might best be characterized.

2. Declarative intonation in Tamil

Previous research [9] on the intonation of Tamil read speech shows that typically each content morpheme in a declarative utterance is marked by an f_0 minimum in the first syllable followed by a rise to a maximum towards the end of the constituent. The striking exception is the phrase-final word, on which f_0 initially falls steeply and then tends to gradually decline or level out, as illustrated in figure 1. Each fall-rise-fall contour can be analysed phonologically as a sequence of a low and a high tone, which are assigned post-lexically. The low tone is aligned consistently within the initial syllable, and such syllables are also marked by distributional asymmetries and signs of weak phonetic prominence, suggesting that they may bear lexical accent [9]. The principles governing the alignment of the high tone are less clear. It may be a boundary tone marking the end of some low-level prosodic constituent, or it may form the trailing tone of a bitonal L*+H pitch accent. It is also possible for f_0 to decline smoothly over the course of a non-phrase-final constituent, from the peak at the end of the preceding morpheme to the valley in the first syllable of the next: such cases will be regarded as unaccented.

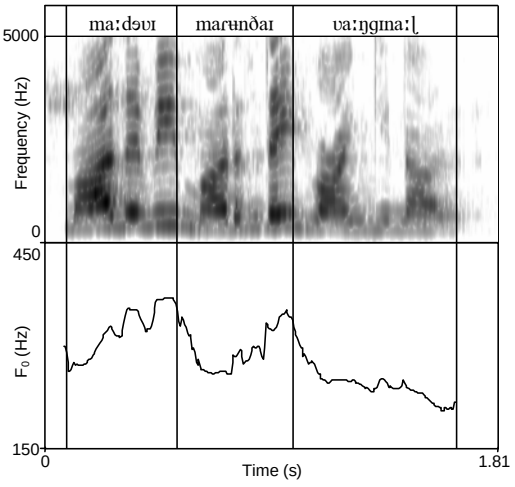

Figure 1: *Spectrogram and f_0 contour of declarative sentence (3) produced by female speaker BS.*

3. Experiment design

3.1. Materials

The materials were based on six declarative sentences of increasing length, designed to contain exclusively voiced segments in order to ensure unbroken f_0 traces.

Malli naɖandaaɭ (1)
Malli walk.past.3sf
'Malli walked.'

Raaman vandaan (2)
Raaman come.past.3sm
'Raaman came.'

Maadavi marundai vaaŋginaaɭ (3)
Madavi medicine.acc buy.past.3sf
'Madavi bought medicine.'

naaŋgaɭ eɳɳeyai marandoom (4)
we oil.acc forget.past.1pl
'We forgot the oil.'

Murugan eŋgaɭooɖu Maduraiyilirundu varuvaan (5)
Murugan we.assoc Madurai.abl come.fut.3sm
'Murugan will come with us from Madurai.'

anda maaɳavan iŋgee veegamaaga vandu irundaan (6)
that student here quickly come.vbp be.past.3sm
'That student has come here quickly (and stayed).'

For each of the sentences *wh*-questions were formed by substituting question words (in situ) for each non-final constituent in turn, e.g.

Murugan ***yaarooɖu*** *Maduraiyilirundu varuvaan?* (7)
Murugan who.assoc Madurai.abl come.fut.3sm
'With whom will Murugan come from Madurai?'

Half of the sentences were presented in isolation; for the other half the declaratives were preceded by questions designed to elicit broad focus responses and the questions were followed by answers. The materials were interspersed amongst eighty-five other stimuli containing either one or two sentences of formal Tamil, and also a set of twenty-one filler sentences. Two pseudo-randomised orders were produced, such that no two permutations of the same sentence were adjacent. Half the speakers were given one order, half the other. The stimuli were presented one at a time in Tamil orthography on the screen of a lap-top computer, and speakers were simply instructed to read them aloud. A set of eight sentences was presented initially for practice and two dummy sentences included at the end: all of these were discarded. An immediate repetition was requested for any utterances containing disfluencies.

3.2. Speakers

Recent studies of other languages, e.g. [10], have led to an increasing awareness of cross-dialectal differences in intonation and, in the absence of specific data, it seems reasonable to assume that Tamil is affected by similar variation. This potential source of variability was therefore controlled as far as possible by choosing speakers that formed a relatively homogenous group. In all twenty-four teenagers were recorded, of whom eighteen (nine male and nine female) were selected for analysis. All had spent their entire lives in Madurai, a city in central southern Tamil Nadu, and were thus unlikely to show regional variation in their speech. Age-related differences were also controlled by selecting subjects between fifteen and seventeen-years-old. The teenagers attended two schools in Madurai: a single-sex girls school and a mixed school, in which only boys were recorded. Both drew pupils from relatively affluent backgrounds, which should have reduced any variation correlated with social stratification.

The recordings took place in quiet rooms within the school complexes, and formed the first of a series of tasks. Since these included interactive exercises the teenagers were recorded in same-sex pairs. Lapel microphones (Audio-technica AT803b) were used in conjunction with a portable CD recorder, and the recordings were digitised at a rate of 22 kHz (16 bit resolution). Each of the 378 sentence tokens was stored as an individual speech file and f_0 traces were extracted by an autocorrelation method [11] using a step size of 10 ms in Praat [12]. Nine tokens were discarded because the speaker had either stumbled or misread the sentence.

3.3. Measurements

Using simultaneous displays of waveform, wide-band spectrogram and f_0 trace, the position of word boundaries was identified and the following points in the f_0 contours marked:

- sentence onset (S) – this was the first frame classified as voiced by the pitch extraction algorithm that fell at or after the onset of speech as determined by inspection of the wide-band spectrogram and waveform
- f_0 minimum (L) in the first syllable of a non-phrase-final morpheme, where one could be identified (79% of cases)
- f_0 maximum (H) in each non-phrase-final morpheme, where one could be identified (82% of cases)
- sentence offset (E) – this was the last frame classified as voiced by the pitch extraction algorithm that fell at or before the offset of speech as determined by inspection of the wide-band spectrogram and waveform.

F_0 values were measured in both Hertz and ERBs: since there were no noteworthy differences between the two sets of results, only those for Hertz are reported here.

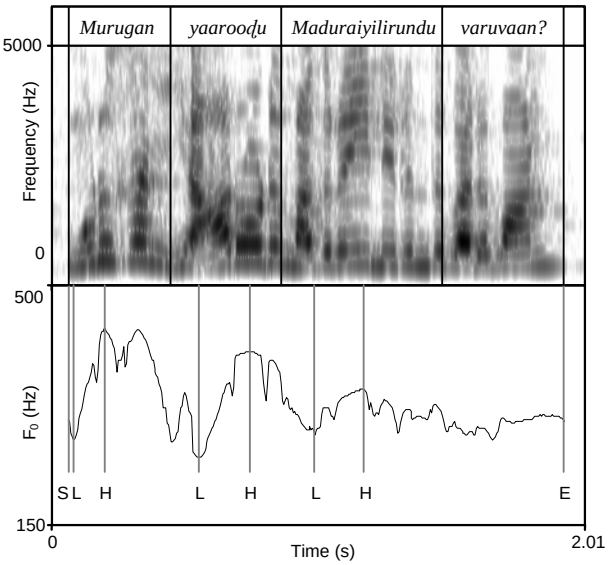

Figure 2: *Labelled spectrogram and f_0 contour of question (7) produced by female speaker CV.*

Figure 2 illustrates the application of these labelling criteria to a spectrogram and f_0 contour of question (7) produced by a female speaker. In a few speech files the f_0 trace was affected by pitch halving, resulting in some missing data points.

4. Results

4.1. Accentuation of the question word

The question word was always marked by a clear fall-rise-fall contour in the *wh*-questions, whether or not this was true of its declarative counterpart, but there were no other systematic differences in accent distribution. Question words also displayed consistently raised peaks relative to the corresponding constituent in the declarative. This was particularly evident when the question word occurred in phrase-initial position: in all six pairs of this type f_0 maxima were significantly higher, by an average of 33 Hz. Moreover, this trend was followed consistently by all speakers: out of 98 data points there were only 5 in which the question word peak was lower (and the magnitude of the difference even in these cases was on average only 4 Hz). The same general pattern was observed for phrase-medial question words, although in two sentence pairs the difference in peak height was not significant for $p < .05$ and the average difference was lower (15 Hz). A comparison of the f_0 minimum in question words with the low turning-point of the corresponding word in the declarative also revealed higher values overall in the questions, but only by an average of 5 Hz.

4.2. Sentence onsets and offsets

The values of f_0 at the sentence onset of the six declarative sentences were compared with those of the corresponding *wh*-questions uttered by the same speaker. Two sets of matched samples t-tests were performed, firstly splitting the data by sentence pair (12) and secondly by speaker (18). In eleven of the twelve sentence pairs there were no significant differences in f_0 onset between declaratives and *wh*-questions for $p < .01$, the one exception involving higher f_0 in the question. There were no significant differences for fifteen of the eighteen speakers; the remaining three had higher onsets in the questions. This suggests that raising onset f_0 in *wh*-questions is not a consistent prosodic cue to interrogativity.

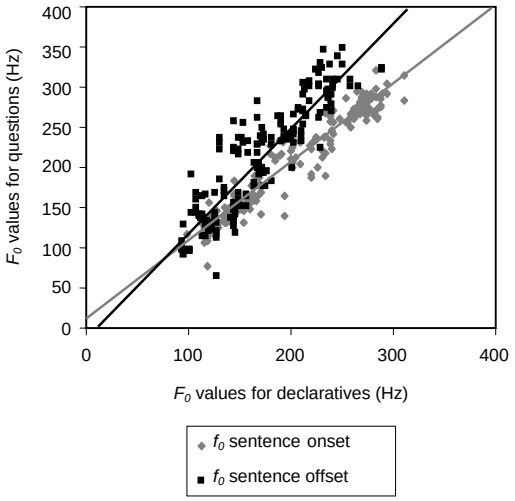

Figure 3: *Scatterplot of sentence onset and offset f_0 values in wh-questions against those in corresponding declaratives for all speakers.*

By contrast, matched samples t-tests comparing f_0 values at the sentence offset revealed clear differences between questions and declaratives, with the offset significantly higher in the questions for ten of the twelve sentence pairs. Of the eighteen speakers five failed to make a significant distinction for $p < .05$. Interestingly, all of these were male, suggesting that raising of offset f_0 in questions is a strategy employed more consistently by female speakers. The absence of any consistent difference in onset f_0 versus the tendency to raise offset values in questions is illustrated in figure 3.

4.3. Compression of pitch register

The evidence thus far suggests that there is a difference in the overall slope of the utterance between *wh*-questions and declaratives in the speech of most speakers. Figure 4 depicts possible ways in which this could occur. Pitch register is represented schematically by a top trend line through f_0 peaks and a baseline through f_0 valleys (cf. [13]), abstracting away, for now, from the question word. The use of such a model here is intended primarily as an illustrative convenience, rather than a theoretical commitment. Dashed lines indicate pitch register in *wh*-questions; solid lines the corresponding declarative.

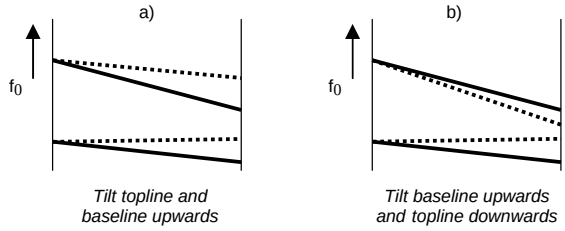

Figure 4: *Schematic diagrams illustrating pitch register modifications. Dashed lines indicate wh-questions, solid lines the corresponding declaratives.*

Both diagrams are compatible with the evidence thus far in that the baseline tilts upwards, but differ in the behaviour of the topline. In 4a question peaks become progressively higher compared to the corresponding f_0 maxima in declaratives and in 4b they become progressively lower. A further possibility is that there is no difference in scaling between the peaks of questions and declaratives (apart from the question word), in which case there would be no upper dashed line.

Pairwise comparisons of corresponding f_0 minima and maxima in questions and declaratives (excluding question words and their counterparts) suggest that 4b better represents the situation in Tamil. Of the ten f_0 minima preceding question words, seven were not significantly different from the corresponding point in the related declarative and three were significantly higher in the question. By contrast, the majority of f_0 minima after a question word (six out of seven cases) were significantly higher than their counterparts (by an average of 20 Hz). This is consistent with an upwards tilt in the baseline causing an increasing divergence between question and declarative as the phrase progresses. Comparison of figure 2 with figure 1 illustrates this difference quite clearly: the phrase-final fall in figure 1 contrasts with near level f_0 at the end of figure 2. Note, however, that the second f_0 minimum is lower than the first, indicating that raising of the baseline may follow the question-word.

F_0 maxima preceding a question word followed a similar pattern to the minima: for eight there were no significant differences between questions and declaratives and in just two there was a significant difference for $p < .05$, the peak being higher in the question. Four of the eight f_0 maxima after a question word again showed no significant difference between question and declarative, but the other half were significantly lower in questions than the matching declarative (by an average of 16 Hz), and three of these differences were highly significant. This suggests that the topline is tilted downwards, as in 4b, resulting in compression of the pitch register.

Again, however, there is one respect in which these results do not conform to the representation in 4b – the fact that two of the f_0 maxima preceding the question word were significantly higher than the declarative, though only just. According to 4b, any significant differences that are found are expected to be in the other direction. This suggests that the lowering of the topline is due to a local shift in pitch register following the question word, and may thus be better represented as in figure 5. The evidence for the raising of the baseline is less clear-cut: it too may follow the question word, as in 5a, or affect the whole utterance, as in 5b.

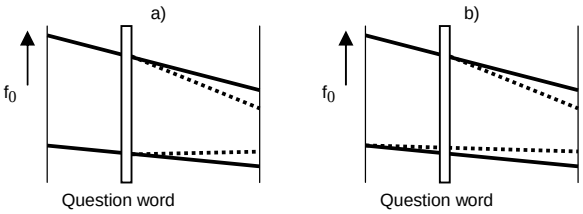

Figure 5: *Schematic diagram illustrating pitch register modification. Dashed lines indicate wh-questions, solid lines the corresponding declaratives.*

5. Discussion and conclusion

Acoustic analysis confirms that *wh*-questions in Tamil are differentiated from their declarative counterparts not only lexically, but also intonationally. The most consistent result is the raising of accent peaks in question words relative to the corresponding constituent in the declarative, especially in phrase-initial position. This is accompanied by modification of the pitch register in most speakers, involving raising of f_0 minima and lowering of f_0 maxima.

There are some points of similarity with *wh*-questions in Dutch [6] and English [7]: for example, prominent accents on question words are reported for both. Average f_0 slope in English is reportedly steeper in *wh*-questions than declaratives, and in Haan's analysis of Dutch *wh*-questions both the upper and lower regression lines slope downwards more steeply than in declaratives, with some compression of the pitch range. This matches the downward tilting of the topline in Tamil, but contrasts with the apparent raising of the baseline and significantly higher f_0 offset values in questions. In this latter respect Tamil more closely resembles Danish [5], in which there is also no consistent raising of onset f_0 (cf. Dutch onsets are raised, and average f_0 in English is higher in *wh*-questions than declaratives).

The two respects in which Tamil *wh*-questions are consistently differentiated from declaratives, the raising of the f_0 peaks in question words and modification of the pitch register, thus involve gradient parameters. There is some evidence that the two are not independent in Tamil: the instances where f_0 peaks are lowered follow the question word. This may be susceptible to a phonological interpretation, in terms of downstepping following contrastive focus on the question word. Impressionistic observation certainly suggests that relative scaling of accent peaks is closely correlated with focus structure in Tamil but further research is needed. The tendency to raise f_0 minima and sentence offsets may also be initiated by the question word, as in 5a, but the possibility remains open that this is a global setting, as in 5b. In marking interrogativity in *wh*-questions, Tamil thus appears to draw on resources generally regarded as matters of phonetic implementation.

6. Acknowledgements

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7. References

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