DIFFERENT FUNCTIONS OF PHRASE-FINAL F0 MOVEMENTS IN SPONTANEOUS PAPUAN MALAY

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ABSTRACT

This paper studies phrase-final F0 movements in Papuan Malay, an under-researched language spoken in East Indonesia. Two functions of Papuan Malay phrase prosody are analysed here, namely the marking of phrase boundaries (demarcating) and the marking of important elements within the phrase (highlighting). The limited work on Papuan Malay suggests that its prosody mainly serves a demarcating function. This hypothesis is tested by means of an acoustic analysis of F0 in phrase-final syllables. Results confirm previous work on demarcation but provide new insights into the role of highlighting in this language, suggesting a relevant difference as to syllable position: While *final* syllables mark boundaries, F0 movements on *pre-final* syllables seem to serve a highlighting function.

Keywords: Papuan Malay, prosody, acoustic analysis, F0, word stress.

1. INTRODUCTION

Commonly, two main functions of phrase prosody are distinguished: marking boundaries between phrases (demarcating) and marking important elements within phrases (highlighting). Approaches to prosodic annotation or transcription use this dichotomy (e.g. [4],[8]), and the prosody of most languages fulfils both functions (e.g.[12]). However, the prosody of many languages is still poorly understood. Recent work suggests that the prosody of Papuan Malay and related varieties primarily serves a demarcating function ([24],[18]). The present paper further investigates this hypothesis.

1.1. Trade Malay prosody

Papuan Malay, spoken in the Indonesian provinces Papua and Papua Barat, belongs to the Eastern Indonesian Trade Malay varieties [10], together with Ambonese, Banda, Kupang, Larantuka, Manado and North Moluccan Malay. Apart from similarities on several linguistic levels [20], the varieties underwent diverging developments due to large distances between the language communities. Most varieties are reported to have the most prominent pitch excursions at the phrase end [11]. Papuan, Ambonese and to some extent Manado have been studied by means of acoustic or perceptual analyses.

A recent study investigated the perception and annotation of prominences and boundaries by native speakers of Papuan Malay phrases [24]. Considerably higher agreement between the native listeners was found for boundaries than for prominences. The presence of a pause and absolute word duration were among the acoustic cues that affected participants' perception the most. The results suggest that prominence is not a relevant perceptual concept in the prosody of Papuan Malay, either at the word or phrase level. As for language production, however, recent work showed consistent acoustic evidence for word stress in duration, formant displacement and spectral tilt ([13],[14]), indicating the relevance of word prosody in this language. A study on repeated mentions in Papuan Malay found support for universal prosodic reduction processes in duration and not in F0 [15].

For Ambonese Malay an acoustic analysis was carried out [18] and earlier work reporting Ambone as a stress-language [27] was reanalysed. Crucially, no support for word stress or pitch accents was found. For example, corrective focus and post-focus conditions showed identical F0 contours. Commonly observed phrase final pitch excursions in this language were analysed as boundary tones with a weak temporal integration. Thus, the pitch excursion spans both final and prefinal syllables in the phrase. Ambonese is therefore similar to Papuan Malay in that prosodic phenomena are mainly demarcative.

In Manado Malay, evidence from F0 contours indicated prosodic marking of focus on the subject, object, verb or predicate [26]. While this suggests a highlighting function, the different focus realizations were only found in phrase-final position. There was no evidence for narrow focus marking in Manado Malay prosody. As for word prosody, Manado Malay was claimed to have fairly regular penultimate stress except when that syllable contains a schwa, in which case stress is ultimate. Furthermore, pitch accents that mark focus were claimed to only occur on stressed syllables. The acoustic evidence for the claims on Manado Malay prosody is, however, limited to plotted F0 contours.

1.2. Summary of previous findings and research aims

Trade Malay studies suggest that prosodic phenomena are bound to phrase ends. They differ as to whether these phenomena are only demarcative or also highlighting. As for Papuan and Ambonese, the main function of prosody is likely to be demarcative only. Further research is needed to substantiate these findings. It also remains to be seen how word-level and phrase-level prosody relate in Papuan Malay, as the two levels interact in many languages ([21],[9]).

This study reports acoustic analyses of F0 in spontaneous Papuan Malay data. F0 is chosen as it appears to be the most important cue for phrase prosody cross-linguistically [17]. Two main analyses investigate 1) the range of F0 movements in five different syllable positions within a phrase, and 2) the influence of word class on the F0 movements of pre-final and final syllables in the phrase as an indication of their potential highlighting function.

2. METHODS

2.1. Data collection procedure

Papuan Malay speech was collected in a storytelling task [23]. Participants were instructed to watch a short Pear story video clip [6] on a laptop and tell what they had seen to an interlocutor who did not see the video. The six-minute video clip showed a story about a man picking pears, in which the actors did not use any speech. This clip has been previously used in cross-linguistic studies on narrative production [6], and elicits unscripted and spontaneous speech. Participants and interlocutor were seated next to each other during the retelling. The interlocutor could ask clarification questions during the retelling, which happened up to three times per participant. Recordings were made using a Sony ECM-MS957 unidirectional stereo microphone connected to a Sony HDR-SR11 video camera. The task lasted between two and five minutes.

2.2. Participants

All participants were students at the University of Papua. There were 10 male and 9 female participants (M_{age} = 22, age range = 20-28). All of them were native speakers of Papuan Malay.

2.3. Data preparation

Audio tracks were extracted from the recordings and converted to 48kHz, 16 bit, mono wave files. Native Papuan Malay speakers transcribed and segmented the speech. Segmentation was carried out at the level of intonation units [7], broadly corresponding to intonation phrases [19]. Six labellers annotated all words (N = 9582) and syllables (N = 18357) using Praat textgrids [5]. All labellers received phonetic training to set label boundaries by auditory and visual inspection of the waveform and were familiar with the syllable structure of Papuan Malay.

2.4. F0

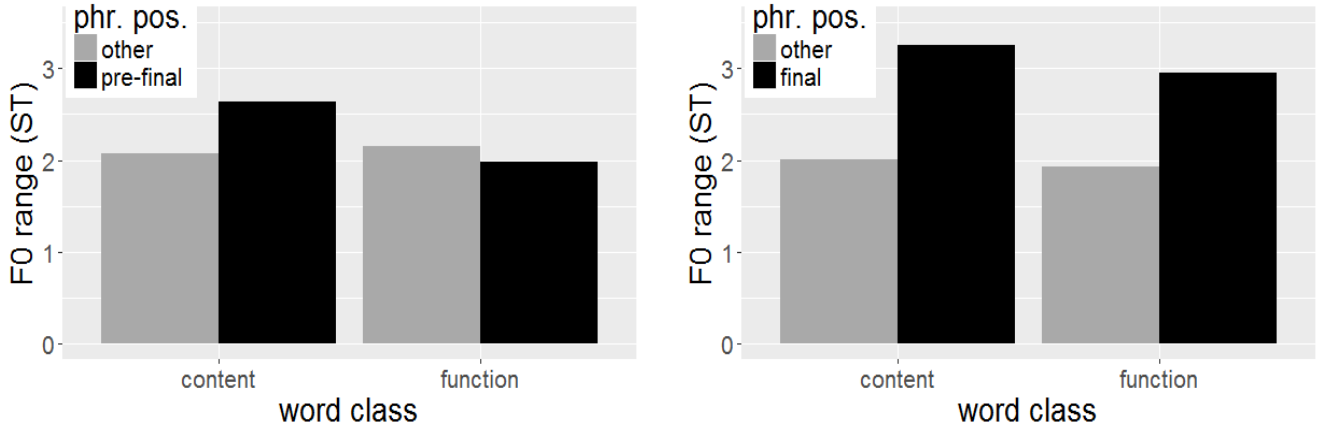
A subset of the labelled syllables (N = 9208) was selected for the F0 analysis on the basis of the following criteria. Syllables in words produced with hesitation, or that were unidentifiable due to laughter, severe speech reduction (i.e. mumbling), interruptions or background noise were omitted. Words with double vowel sequences were also omitted, as these resulted in ambiguous syllabification (either VV or V.V, see [16]). To maintain a number different phrase positions (see section 2.5) syllables were only selected when they occurred in phrases with at least five syllables.

F0 measures were taken from the voiced part of each syllable, for which Praat [5] was able to detect consecutive periodicity. The boundaries of the voiced interval either occurred within or coincided with (one of) the syllable boundaries. For each voiced subinterval the difference between the F0 minimum and maximum (F0 range in semitones, ST) and their timestamps were measured. As for the direction of the F0 movement we labelled a 'rise' when the F0 minimum would occur before the maximum, and a 'fall' when the F0 minimum would occur after the maximum. The labels were only given for movements above the perceptual threshold (g_{thr}), measured in semitones per second for a given duration T, as expressed in the formula: $g_{thr}(ST/s) = .16/T^2$ (see [1], p. 32). Rise-falls within one syllable were rare (N = 49) and therefore omitted.

2.5. Labelling

The position of each syllable in a phrase was labelled in three rounds, maintaining either a five-way distinction (first, second, medial, pre-final or final) or two two-way distinctions (pre-final vs. all other; and final vs. all other). Furthermore, the location of the syllable in the word and whether the syllable was stressed (based on indications in [16]) were labelled. Acoustic evidence was found for these indications in [13] and [14]. Syllables were labelled for word class; either content words (adverbs, nouns, verbs) or function words (conjunctions, demonstratives, numerals, prepositions, pronouns, question words, tags). Stative verbs in Papuan Malay often correspond to adjectives in English [16]. For the statistical analyses targeting the word class differences (see

Figure 1: F0 range (ST) of syllables in two-syllable content and function words in pre-final (black, left) and final (black, right) phrase position in comparison with other (grey) positions within the phrase.



section 2.6), a narrower subset of the data was taken by selecting only two-syllable words in order to account for word-length biases (i.e. function words tend to be shorter than content words).

2.6. Analyses

First, a LMM analysis in R [22] using the lme4 package [2] was carried out with F0 range as response, with syllable position in a phrase (5 levels: first, second, medial, pre-final, final) as predictor and with participants and items (words) as random intercepts and slopes. Relevant to the current study are the post-hoc pairwise comparisons using Tukey HSD test (Bonferroni corrected) between all syllable positions. Second, two LMM analyses (for each two-way position distinction) were carried out to specifically test the extent to which the pre-final and the final syllable, respectively, serve a highlighting role. This was tested by comparing content and function words (consisting of two syllables, cf. section 2.5), of which the former carry more semantic weight than the latter and are therefore assumed to be more likely to show an effect of highlighting [3]. In the analyses, F0 range was the response and the interaction between word class (two levels: content, function) and position (two levels: pre-final *or* final, other) were predictors. Stress (two levels: stressed, unstressed) was added as predictor to account for possible effects of word prosody ([13],[14]). Participants and items (words) were random intercepts. Random slopes were omitted as they worsened the model fit worsened (lower AIC). Third, the distribution of rises and falls (counts) was calculated separately for penultimate and ultimate stress and assessed in chi-square tests.

3. RESULTS

F0 range was significantly larger in either the pre-final or the final syllable in all pairwise comparisons (Tables 1a and 1b). This contrasts with the three non-significant comparisons, which involved the first, second or medial position.

Table 1a: Mean F0 range in ST (SD) in different syllable positions within a phrase.

first	second	medial	pre-final	final
1.71	1.91	1.97	2.38	3.30
(2.18)	(2.22)	(2.21)	(2.71)	(3.17)

Table 1b: Pairwise comparisons for F0 range in different syllable positions within a phrase.

Pairwise comp.	*b*	*SE*	*z*	*p*
first-second	.20	.11	1.82	n.s.
first-medial	.23	.09	2.39	n.s.
first-pre-final	.68	.11	6.07	< .001
first-final	1.61	.11	14.05	< .001
second-medial	0.03	.08	.32	n.s.
second-pre-final	.48	.10	4.80	< .001
second-final	1.41	.10	13.69	< .001
medial-pre-final	.46	.08	5.91	< .001
medial-final	1.38	.08	17.20	< .001
pre-final-final	.92	.10	9.45	< .001

The pre-final syllables (Fig. 1, left) showed no main effect of word class on the F0 range. However, position (β = .60, *SE* = .12, *t* = 5.03, *p* < .001) as well as the interaction between position and word class (β = -.68, *SE* = .20, *t* = -3.31, *p* < .001) were significant. These effects showed that in pre-final position F0 movements were overall larger (*M* = 2.36, *SD* = 2.71) compared to other positions (*M* = 2.12, *SD* = 2.44), and that this difference was significantly larger for content words ($M_{\text{pre-f}}$ = 2.64, *SD* = 3.10; M_{other} = 2.07, *SD* = 2.37) than for function words ($M_{\text{pre-f}}$ = 1.98, *SD* = 2.22; M_{other} = 2.15, *SD* = 2.40). The phrase-final syllables (Fig. 1, right) showed a main effect of position (β = 1.31, *SE* = .13, *t* = 9.98, *p* < .001) in that final syllables have

larger F0 range (M = 3.36, SD = 3.26) than other syllables (M = 1.99, SD = 2.30). No (interaction) effect involving word class was found. Stress had a significant effect in both LMM analyses (β = .16, SE = .07, t = 2.24, p < .05) in that stressed syllables had smaller (M = 2.10, SD = 2.40) pitch movements than unstressed syllables (M = 2.26, SD = 2.57).

The distribution of rises and falls showed a limited number of observations for words with ultimate stress, which is expected given the distribution of word stress in Papuan Malay [16]. Note that this limits the representativeness of the ultimate stress data. The respective chi-square tests (Table 2) revealed two different deviations from the chance-level expected values. For penultimate stress, significantly more pre-final rises and final falls were observed than expected (standardized residuals: -/+ 3.95), whereas for ultimate stress more pre-final falls and final rises were observed than expected (standardized residuals: -/+1.55).

Table 2: Chi-square results on the distributions of rises and falls in phrase-final two-syllable words with penultimate and ultimate stress.

		F0 movement		Statistic	
Stress	Phr. pos.	Rise	Fall	χ^2	p
penult	pre-f.	151	108	15.62	< .001
	final	141	195		
ult	pre-f.	1	4	2.40	n.s.
	final	9	6		

4. DISCUSSION AND CONCLUSIONS

The results of the current study confirm the literature on Trade Malay in that the largest F0 movements are found at the end of phrases and that they are often rising-falling patterns. Crucially, the phrase-final syllable shows the largest F0 ranges, pre-final syllables show second largest F0 ranges, and the ranges on the first, second or medial syllables are comparable in size. Pre-final and final syllables also differ significantly in F0 range, which suggests that phrase boundaries are mainly marked by (the F0 movement on) phrase-final syllables. This is in line with cross-linguistic observations for prosodic marking of boundaries (e.g. boundary tones or final lengthening). Note that spreading of phrase-final prosodic phenomena is possible, in that final lengthening can affect pre-final syllables as well [25]. A comparable analysis for Ambonese suggests that the phrase-final boundary tone occurs *somewhere* on the final two syllables, thus having a loose temporal alignment [18]. Although alignment was not investigated here, Papuan Malay seems to be similar in this respect.

Preliminary evidence for highlighting was found only in pre-final phrase position, where content words have larger F0 movements than functions words. This effect is unlikely to reflect word prosody, as F0 movements were shown not to correlate with word stress and no differences would be expected between word classes [14]. Nevertheless, it is possible that the position of phrase pre-final F0 movements in content words was determined by word stress patterns. In this respect Papuan Malay could be similar to Manado Malay, which was reported to mark focus by phrase-final pitch accents realized on stressed syllables [27]. A crucial difference with Manado is that the current results do not contribute to the question of whether Papuan Malay marks focus. Our study rather suggests that regardless of their exact function, F0 movements in Papuan Malay seem to result from an interplay between word level and phrase level prosody, with crucial differences between the final two syllables in the phrase.

Further indication that the F0 movements are different in phrase-pre-final and phrase-final position comes from the distribution of rises and falls. Due to the frequent occurrence of penultimate stress, rising-falling patterns are among the most common phrase-final movements, in line with [18] and [11]. Regardless of the influence of word stress, however, rises occurred almost equally often on pre-final and final syllables, whilst falls occurred more often with final syllables. The frequent use of final rises could be related to the narrative style studied here, in which continuation rises are frequent.

In sum, this study provides indication that it is useful to distinguish the two phrase-final syllable positions from each other when investigating the functions of Papuan Malay phrase prosody. More research is needed on prosody in specific highlighting conditions (i.e. focus, emphasis). This could be done by adding information structure annotations to the current data and/or by eliciting scripted speech to control for the segmental material on which F0 is realized. Furthermore, future work should investigate the perceptual relevance of phrase final F0 movements.

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