F0 PEAK ALIGNMENT IN MOROCCAN ARABIC POLAR QUESTIONS

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ABSTRACT

This paper contributes phonetic evidence to ongoing debate regarding the position of Moroccan Arabic in prosodic typology, with the aim of determining how phrase-edge tonal events should be represented in the intonational phonology of the language. A salient phrase-final rise-fall tonal event, found in MA polar questions, is used as a case study. We examined the alignment of the f0 peak of this tonal movement, relative to potential landmarks in prosodic structure, in a set of 112 polar questions extracted from a corpus of read and spontaneous speech collected in Casablanca. A comparison of f0 peak alignment in tokens containing an unstressable final CV syllable vs. a stressable final CVC syllable suggests that the rise-fall tonal event observed in MA polar questions is best understood as a pitch accent marking prominence at the phrasal level.

Keywords: Prosody, intonation, peak alignment, f0, Arabic.

1. INTRODUCTION

A key question to resolve in analysis of the intonational phonology of Moroccan Arabic (MA) is whether the language displays edge-marking, in the form of boundary tones only, or both head- and edge-marking, in the form of pitch accents as well as boundary tones. In the context of a detailed phonetic description of MA intonation [3], Benkirane proposes a simple phonological representation of the typical prosodic contour in MA: an LHL rise-fall, realised at the beginning or end of the utterance. He does not assign the status of head (pitch accent) or edge (boundary tone) to any of the tones, and thus remains agnostic as to their phonological affiliation.

Benkirane does however note that an utterance-final rise-fall (as found in polar questions) cannot be realised on an open CV syllable in MA. This observation appears to rule out a purely edge-based interpretation of the LHL analysis: if the LHL tones are all edge tones, comprising an utterance initial %L then a final complex HL% boundary tones, for example, we might expect it to be possible for the HL% boundary tone to be realised on a syllable of any weight, if it is not prominence-lending but instead demarcative in function.

In the present paper we exploit this property of MA as a diagnostic for the phonological affiliation of tonal events in the language, by investigating the phonetic alignment of the f0 peak in the salient final rise-fall in polar questions, in tokens with/without a final 'unstressable' CV syllable.

2. BACKGROUND TO THE STUDY

In common with other varieties of Arabic spoken in the Maghreb/North Africa, MA has three full vowels /i a u/ but only one short vowel /ə/, and permits complex consonant clusters in all positions [5]. Descriptions of stress in MA are strongly divided on the question of whether the language has lexical stress or not (see [15] for a comprehensive overview). Those accounts which allow for lexical stress in MA agree on how stress is assigned: stress a final CVC syllable, else stress the penultimate syllable. Some studies suggest that this rule applies only in citation forms, but is superseded by phrasal or rhythmic considerations in connected speech [5].

Given the interdependence of word and sentence level prosody, it is not surprising that there are similarly differing views in the few studies of MA intonation that have been put forward: i) MA has no lexical stress, all tonal events are boundary tones [9]; ii) MA has lexical stress but tonal events are boundary tones [7]; iii) MA has lexical stress, and has both prominence-lending and edge-marking boundary tones [3].

These prior studies were based on auditory impression and/or qualitative phonetic analysis. However, fine-grained variation in the phonetic alignment of the f0 peak can serve as an independent diagnostic of the phonological association of pitch events [10;11]. This paper thus contributes quantitative phonetic evidence with the aim of resolving the question of how tonal events should be represented in the intonational phonology of MA.

3. METHODS

3.1. Materials and data collection

The data examined here are drawn from a larger corpus of MA data collected in Casablanca [12]. The data comprise both read speech, in the form of a scripted dialogue, and different types of spontaneous speech, including a map task [cf. 1] and unscripted

conversation in response to topic prompts (e.g. food, sport or cars). In the scripted dialogue, the syllable structure of the last lexical item in each utterance is systematically varied so as to provide a range of potentially stressable/unstressable tokens. In addition, the unfolding dialogue (about a cousin's wedding) provides a definite context for each utterance, with the results that participants generally converge on a single prosodic realisation of the sentence modality and information structure of each token [13]. All materials involve participants interacting with a partner, and the presence of an interlocutor, together with an element of communicative purpose in the tasks, yields a good range of prosodic expression in the recordings.

Twelve participants (6M/6F), were recorded in same-sex pairs; their ages range from 19-34 and none report any hearing difficulties. All of the participants speak Casablanca Moroccan Arabic as their first language, alongside French and English as a foreign language; none were native speakers of any variety of Berber. Recordings were made in a quiet classroom at the University of Casablanca, directly to .wav format at 44.1kHz 16 bit using a Marantz PMD661 solid state recorder, with each participant recorded to a separate channel via a head-mounted Shure SM10A microphone. Editing and transcription of the data was performed by the authors using Praat [4] and ELAN [6].

3.2. Data selection and analysis

A subset of 112 polar questions was selected for analysis from the polar questions elicited in the scripted dialogue, and from polar questions produced in the map task and free conversation data. The status of an utterance as a polar question was verified by two authors; generally, in spontaneous data, next-turn-proof evidence [14] independently confirms this status (i.e. the question is answered by a 'yes' or 'no' from the other participant). The selection process also excluded any tokens realised with a prosodic contour other than a salient final rise-fall, or in which the pitch contour was perturbed by disfluency, or the presence of non-sonorant consonants or non-modal voice quality. In total 46 tokens were selected from the read speech data and 66 from spontaneous speech data.

The following intervals in each sound file were manually annotated using a Praat textgrid: i) the duration of the target word (the last lexical item in the utterance); ii) the stressed syllable of the target word (based on auditory impression, and by reference to vowel duration and to the intensity contour); iii) the final syllable of the target word. In words containing a final CVC syllable, it was generally this syllable which was identified as stressed (cf. [3]), and in these cases the intervals labelled for the final syllable and the stressed syllable are co-extensive. Overall, 66 tokens (31 from read speech) were labelled with stress on the penult syllable and 46 tokens (15 from read speech) were labelled with stress on the final syllable. A sample pitch trace for type of token is provided in Figures 1-2.

Figure 1: Rise-fall realised on a word with a final stress [maw.ˈʒud] 'present' (moca-ynq6-f1).

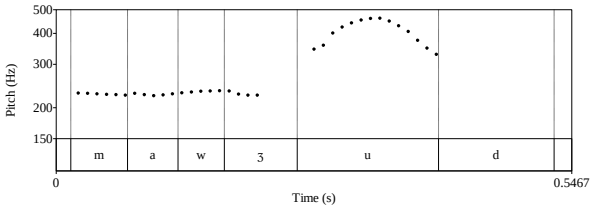
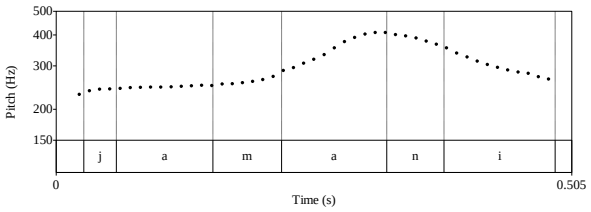


Figure 2: Rise-fall realised on a word with penult stress [ja.ˈma.ni] 'Yemeni' (moca-ynq1-f1).



The following measurements were extracted from each labelled token, using a Praat script:

- start, end and duration (in ms.) of: target word, accented syllable, final syllable;
- f0 in semitones at 10 equidistant points across: target word, accented syllable, final syllable, accented syllable + final syllable as one domain;
- the position of the f0 peak.

The following derived measures were calculated:

- peak delay: the distance of the f0 peak from the start of the accented syllable
- edge offset: the distance of the f0 peak from the end of the target word.
- relative peak delay: peak delay as a proportion of accented syllable duration.

The f0 contour across various domains (word, accented syllable etc) was plotted using Excel. Duration measurements were analysed using SPSS.

4. RESULTS

Relative peak delay provides a measure of the position of the f0 peak relative to the duration of the accented syllable) (cf. [2]); if values of *rpd* are the

same across tokens bearing penult vs. final stress, this would support the hypothesis that the target of association of the f0 peak in MA is the accented syllable (and thus that it is a pitch accent).

Edge offset provides a measure of the distance of the f0 peak relative to the end of the utterance (= end of the target word); if values of *edge offset* are the same across tokens bearing penult vs. final stress, this would support the hypothesis that the target of association of the f0 peak in MA is the phrase-edge (and thus that it is a boundary tone).

Figures 3 and 4 show 95% confidence intervals around mean values of relative peak delay and edge offset by stress position, respectively. Linear mixed models for each variable, with stress as a fixed factor, and speaker and item as random factors, support the trends that can be seen in the figures: there is a significant difference between penult vs. final stress tokens for *relative peak delay* (F (1,105.98)=70.22; p=.000), and a small but nonetheless significant difference for *edge offset* (F (1,95.5)=5.407; p=.022).

Figure 3: Mean and 95% CI: relative peak delay, by stress position and by data source.

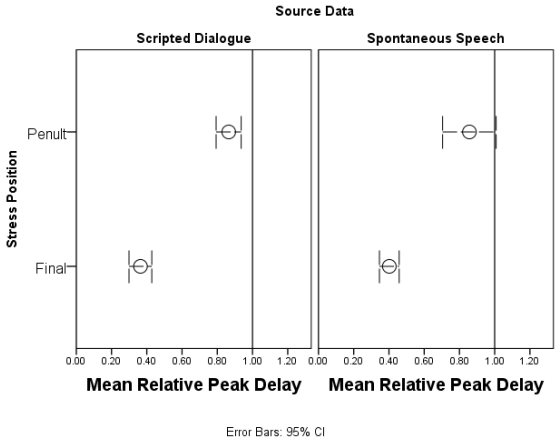
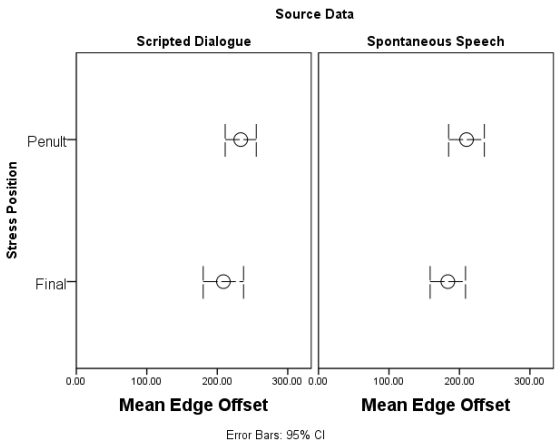


Figure 4: Mean and 95% CI: edge offset.



This initial comparison suggests that evidence from f0 peak alignment does not support analysis of the rise-fall contour in MA polar questions as a pitch accent, as the peak is not consistently aligned relative to the accented syllable. At the same time, however, the f0 peak does not appear to be aligned at a fixed distance from the utterance-edge, as might be expected in the case of a pure edge-marking tone.

A plot of mean f0 at 10 equidistant measuring points, in tokens with final vs. penult stress, across other potentially relevant prosodic domains, suggests that the alignment of the shape of the f0 contour is not similar across stress positions when measured across the final syllable (Fig.5). The domain which the f0 peak appears to be consistently aligned within is the final foot, defined as the final CV.CV or final CVC (Fig. 6).

Figure 5: F0 (in semitones) measured at ten intervals through the final syllable in the utterance.

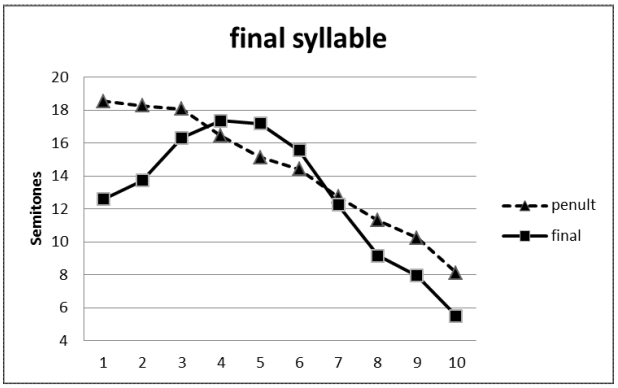
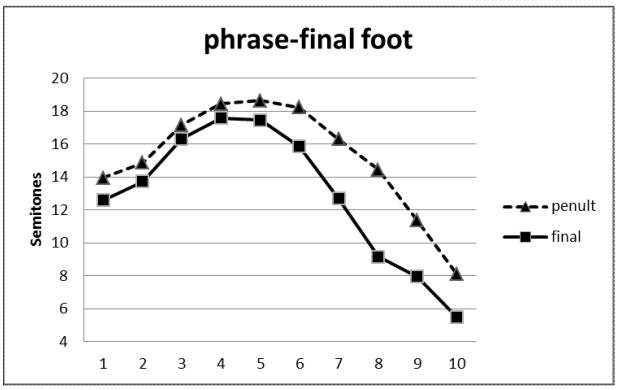


Figure 6: F0 (in semitones) measured at ten intervals through the final foot (CV.CV or CVC).

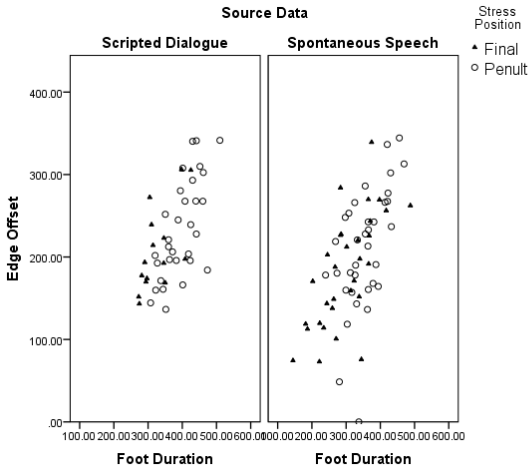


The generalisations made thus far are confirmed through a series of correlations (Pearsons' R):

- peak delay x accented syllable duration: R=.19; p=.844
- edge offset x final syllable duration: R=.300; p=.001
- peak delay x foot duration: R= .451; p<.001
- edge offset x foot duration: R=.658; p<.001

The best fit results from correlation of edge offset (the distance of the f0 peak from the utterance-edge) with the duration of the final foot (CV.CV or CVC), as illustrated in Fig. 7.

Figure 7: Scatter plot of edge offset x foot duration (defined as final CV.CV or CVC).



5. DISCUSSION

The results of quantitative investigation of f0 peak alignment in 112 tokens containing a final rise-fall pitch contour in MA reveal a complex picture. Although it seems plausible to rule out analysis of the rise-fall contour as a canonical pitch accent (since peak does not display alignment to the accented syllable), nor does the f0 peak display consistent alignment at a fixed distance from the utterance edge, or within the final syllable, as might be expected if it were a purely edge-marking tone.

Instead, the results suggest that we are dealing with an edge tone which displays association with the rightmost foot of the utterance. We suggest that this is consistent with analysis of the rise-fall as an edge-aligned pitch accent, which targets the final-foot of the rightmost word in the phrase. This matches the analysis of Benkirane [3], and also parallels recent consensus regarding analysis of phrase-final tones in French [8].

6. CONCLUSION

Evidence from f0 peak alignment in the distinctive phrase-final rise-fall contour in MA polar questions indicates that this tonal event cannot be analysed as either a simple pitch accent or as a pure edge tone. Instead it displays alignment consistent with analysis as an edge-aligned pitch accent. Further work is needed to investigate non-tonal cues to stress in MA.

7. REFERENCES

[1] Anderson A, Bader M, Bard EG, Boyle E, Doherty G, Garrod S, et al. The HCRC Map Task Corpus. L&S 1991;34:351-66.

[2] Atterer M, Ladd DR. On the phonetics and phonology of "segmental anchoring" of F0: evidence from German. JPhon 2004 Apr;32(2):177-97.

[3] Benkirane T. Intonation in Western Arabic (Morocco). In: Hirst D, Di Cristo A, editors. Intonation systems: a survey of twenty languages.Cambridge, MA: CUP; 1998. p. 345-59.

[4] Boersma P, Weenink D. Praat: doing phonetics by computer (Version 5.3.49) [http://www.praat.org]. 2013.

[5] Boudlal A. Constraint interaction in the phonology and morphology of Casablanca Moroccan Arabic. Université Mohammed V, Rabat, Morocco; 2001.

[6] Brugman H, Russel A, Nijmegen X. Annotating Multi-media/Multi-modal Resources with ELAN. Proc LREC 2004 2004.

[7] Burdin RS, Phillips-Bourass S, Turnbull R, Yasavul M, Clopper CG, Tonhauser J. Variation in the prosody of focus in head-and head/edge-prominence languages. Lingua 2014.

[8] Delais-Roussarie E, Post B, Avanzi M, Buthke C, Di Cristo A, Feldhausen I, et al. Intonational Phonology of French: Developing a ToBI system for French. In: Prieto P, Frota S, editors. Intonation in Romance. OUP; 2015.

[9] El Zarka D. One ra many meanings. Syntax, semantics and prosody of the Moroccan modal particle ra and its Egyptian Arabic counterparts. STUF-Language Typology and Universals Sprachtypologie und Universalienforschung 2012;65(4):412-31.

[10] Gussenhoven C. The phonology of tone and intonation. Cambridge: CUP; 2004.

[11] Gussenhoven C. The Phonology of Intonation. In: de Lacy P, editor. The Cambridge Handbook of Phonology.Cambridge: Cambridge University Press; 2007. p. 253-80.

[12] Hellmuth S, Almbark R. Intonational Variation in Arabic database. (in prep). www.york.ac/uk/res/ivar

[13] Hellmuth S, Almbark R. Intonation in spoken Arabic dialects. (in prep).

[14] Hutchby I, Wooffitt R. Conversation Analysis. 2nd ed. Polity Press; 2008.

[15] Maas U. Die marokkanische Akzentuierung. In: Kuty R, Seeger U, Talay S, editors. Nicht nur mit Engelszungen [Beiträge zur semitischen Dialektologie: Festschrift für Werner Arnold zum 60. Geburtstag].Wiesbaden: Harrassowitz Verlag; 2013.