

Prominence at edges? Some evidence from Maltese wh-words using periodic energy

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Maltese is a language with lexical stress and regular pitch accents as well as phrase accents, with secondary association to postnuclear stressed syllables, and edge tones [1]. Moreover, Maltese wh-words exhibit alternation in the tonal association conditioned by the question type in which they are embedded. Tones associate with the left edge of the wh-word in direct questions, and with the lexically stressed syllable in indirect and quoted questions (Fig.1 illustrates representative examples) [2,3,4]. This alternation holds regardless of the metrical structure of the word and seems to be pragmatically rather than phonologically conditioned [5].

Following [2], we investigate the relation between tonal association and prosodic strength in the two different tone bearing positions in Maltese wh-words (left edge association or head association). In a language that has pitch accents to cue prominence (a head prominence language according to [6]), the initial syllable, if not stressed, would not typically cue prominence, but rather juncture. Using the periodic energy mass metric (henceforth, mass) from the *ProPer* toolbox [7] as a measure of strength [8;9], we compare cases in which complex wh-words exhibit a falling pitch accent on the stressed syllable (indirect and quoted questions), to cases in which the wh-words bear an H tone at their left edge, i.e. word initially (direct questions). Our aim is to explore whether there are acoustic indications for a prominence cueing function of H tones associated to the left edge of wh-words. The difference between indirect and quoted questions is that in quoted questions, the wh-words are in narrow focus.

Comparing mass on word-initial and stressed syllables (see Fig.2), the model shows higher mass values on the stressed syllable across questions ($\delta_{\text{direct}} = 0.23$; $\delta_{\text{indirect}} = 0.44$; $\delta_{\text{quoted}} = 0.53$). For direct questions, the model suggests that there is no reliable difference between the word-initial syllable marked by an early H peak and the stressed syllable following it, but only a trend towards higher mass on the stressed syllable (CI [-0.68, 0.29], $P(\delta > 0) = 0.8$, evidence ratio = 4.09). For indirect questions, the model suggests an overall, even if not overly strong, tendency towards higher mass on the stressed accented syllable compared to the word-initial toneless syllable (CI [-0.91, 0.09], $P(\delta > 0) = 0.92$, evidence ratio = 12.07). Contrarily, in quoted questions, the model favours the interpretation of higher mass values on the stressed syllable as opposed to the word-initial syllable (CI [-0.99, 0], $P(\delta > 0) = 0.95$, evidence ratio = 18.46). Comparing word-initial syllables bearing an early H peak (direct) to toneless word-initial syllables (indirect) (Fig.2), the model shows a modest increase in mass on the word-initial syllable bearing a H peak ($\delta = 0.09$). Although mass differs between word-initial syllables with and without a tone, this difference is only very subtle, suggesting a weak but not reliable trend towards increased mass on the word-initial syllable with a H tone (CI [-0.11, 0.29], $P(\delta > 0) = 0.81$). Moving to stressed syllables, the model estimates only a slight difference between stressed syllables with flat pitch preceded by a H peak early in the word (direct) and stressed syllables bearing a falling pitch accent (indirect) ($\delta = -0.12$). In this respect, the model does not provide indications for a reliable difference between these two syllable conditions, but only a trend towards lower mass values on stressed syllables with flat pitch (CI [-0.34, 0.08], $P(\delta > 0) = 0.87$).

Overall, our results provide subtle rather than strong evidence of prosodic enhancement as a function of tonal association. In quoted questions, mass is undoubtedly greater across the whole wh-word compared to other conditions, presumably because narrow focus enhances the overall

mass on quoted wh-words, while the word-internal relations reflect greater prosodic strength on the stressed accented syllable as compared to the toneless word-initial one. Leaving aside quoted questions, our data does not provide unambiguous support in favour of mass enhancement in complex wh-words neither when the word-initial syllable carries an early H peak (direct) compared to toneless word-initial syllables (indirect) nor when the stressed syllable is marked by a pitch drop (indirect) compared to stressed syllables with flat pitch (direct). In both cases, we only see a subtle tendency of mass enhancement on the word-initial syllable marked by the early H peak as well as a subtle tendency for mass reduction of the stressed syllable when pitch is flat compared to when there is a fall in pitch. Hence, mass appears to remain constant, and generally unaffected by the intonational events on the wh-word, while the stressed syllable appears to preserve its prosodic strength in all cases.

In its most concise form, our main result can therefore be formulated as follows: in Maltese (at least in complex) wh-words, mass enhancement is not conditioned by tonal association (neither head nor edge) but rather by lexical stress. We found that the lexically stressed syllable preserved its prosodic strength, i.e., was always prosodically strong, independently of whether it bore a falling pitch accent or had level pitch. Moreover, the present study shows that the word-initial H tone does not affect the relative prominence between the stressed syllable and the word-initial one, and thus is unlikely to cue prominence on the initial syllable. It is nonetheless possible that the early H peak has a different prominence-related function, such as a prominence cueing function at the word level (i.e., to make the entire word more prominent in relation to other words in the utterance) [10;11]. Future research is planned to address this matter.

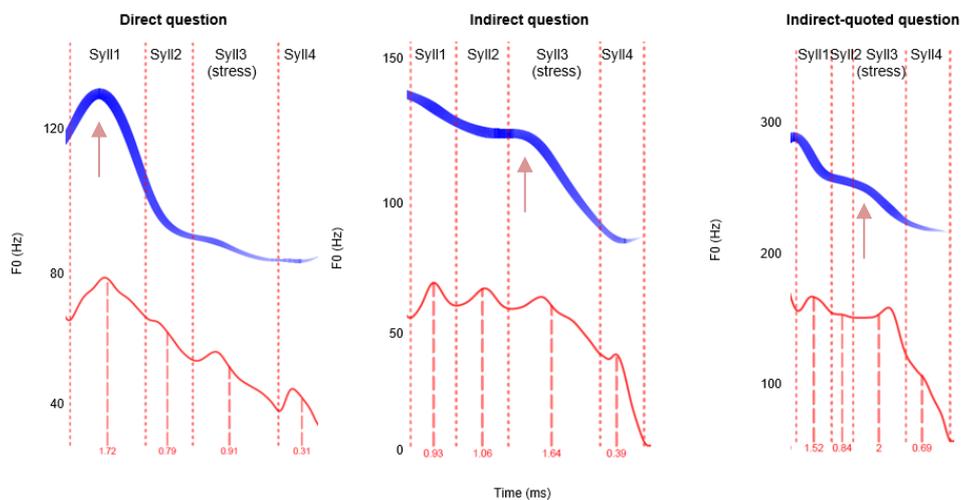


Fig. 1. Periograms and periodic energy curves of the complex wh-word "ma' min minnhom" produced by a Maltese native speaker across question types. The dotted vertical red lines denote syllable intervals and the dashed vertical red lines depict the center of mass within intervals. Arrows refer to F0 inflections.

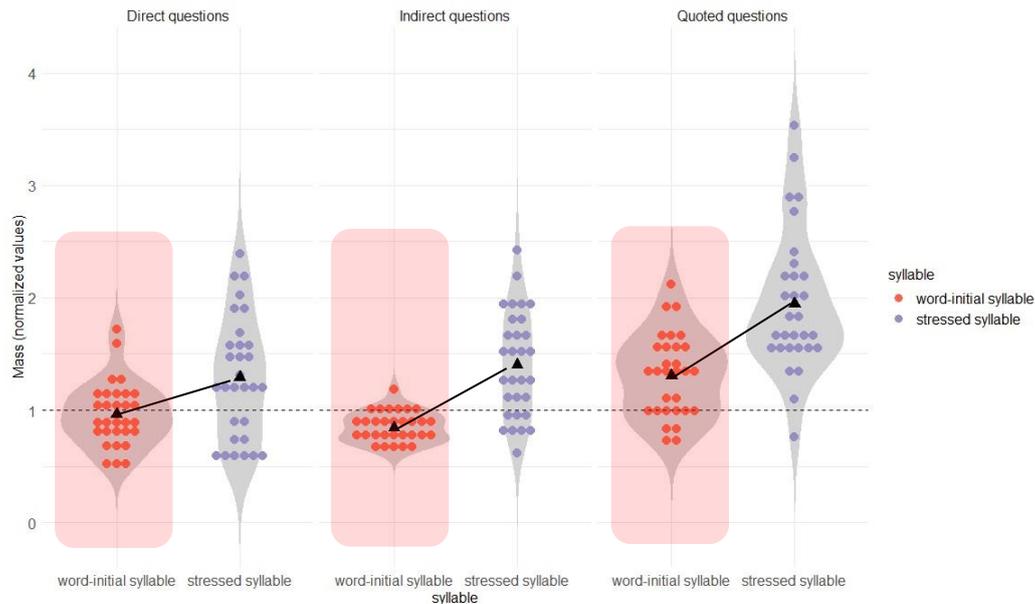


Fig. 2. Mass values (I = average strength) of word-initial and stressed syllables (x -axis) across *wh*-words as a function of direct (left panel), indirect (middle panel), and quoted (right panel) questions. Violin plots depict the distribution of the data. The width of each curve depicts the density of the data in each region. Points within violins illustrate individual data points for word-initial (in red) and stressed (in purple) syllables across *wh*-words. Black triangle points depict mean values across *wh*-words and speakers. Pink boxes facilitate comparison of word-initial syllables across conditions.

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