Acoustic correlates of stress and focus in Syrian Arabic

This paper presents the results of a study of word and sentence level prosody in Syrian Arabic (SA), a colloquial dialect of Standard Arabic spoken in Syria. The study is mainly based on the dialect of Damascus (Damascene). The study investigates two aspects of SA: the properties of stressed vowels in different positions in a word and how these properties are amenable to the expression of focus in three different word orders. The work also considers sentences with presentational focus on verb, subject and on object in three different word orders. There is some phonological literature on the placement of stress in various Arabic dialects, Cowell (1964) and McCarthy (1980). The stress phenomena of SA are of theoretical significance [6]. Since it has lexical stress it has been shown to share properties of other stressed languages such as English etc. The forms in (1) below exemplify the basic rule of accentuation:

(1)	a. mada´ares	'schools'	kata bti	'you (f. sg)
	b. ka´tab	'he wrote'	ka´atab	'he wrote to'
	c. da´rasu	'they studied'	ma´drase	'school'
	d. dara´st	'I/vou (m. sg.) studied'	zaaru´uk	'they visited you (m. sg.)'

Stress falls on the *penultimate* syllable when it is heavy (1a) or in disyllables (1b). Otherwise stress falls on the *antepenult* (1c). Finally, stress falls on the *ultima* when it is *superheavy* (1d). Previous work on Arabic intonation and stress such as De Jong and Zawaydeh's (1999), on Ammani Jordanian Arabic, have shown that duration and fundamental frequency are the correlates of stress in statements and questions. The current study, however, examines the data in three word orders (VSO, SVO and VOS) using 7 speakers. In addition, this study concentrates on the phonetic cues of focus in SA which has not been done before. The data is recorded from seven native speakers of Damascene variety of SA (6 males & 1 female) studying in the India (age group 26 – 30). The recordings were carried out at IIT Guwahati in a sound proof recording booth by using Tascam DR-100 MKII recorder connected to a Shure unidirectional head worn microphone. Table (2) below exemplify the corpus for the study:

Sentence type	Target word	Stress position	
	A.verb	a. σ σ σ b. σ σσ c. σσ σ	a. penult b. antepenult c.ultima
I. VSO (V)	B. subject	a. σ σ σ b. σ σσ c. σσ σ	a. penult b. antepenult c.ultima
	C. object	a. σ σ σ b. σ σσ c. σσ σ	a. penult b. antepenult c.ultima
	1.verb	a. σ σ σ b. σ σσ c. σσ σ	a. penult b. antepenult c.ultima
II. SVO (S)	2. subject	a. σ σ σ b. σ σσ c. σσ σ	a. penult b. antepenult c.ultima
	3. object	a. σ σ σ b. σ σσ c. σσ σ	a. penult b. antepenult c.ultima
	1.verb	a. σ σ σ b. σ σσ c. σσ σ	a. penult b. antepenult c.ultima
III. VOS (O)	2. subject	a. σ σ σ b. σ σσ c. σσ σ	a. penult b. antepenult c.ultima
	3. object	a. σ σ σ b. σ σσ c. σσ σ	a. penult b. antepenult c.ultima

Three types of questions were selected in the corpus: Verb focus question, Subject focus question and Object focus question as described below in 1, 2 &3.

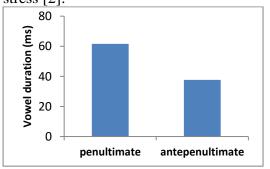
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1. Verb question:
Q: ſu:´
             Sə'mel ?a'hmad?
                      Ahmad
                                                ('What did Ahmad do?')
    what
             did
A: ka'tab
             ?a'ħmad
                              l-waz<sup>s</sup>i:'fe
                              the-homework
                                                ('Ahmad wrote the homework')
    wrote
             Ahmad
    Subject question:
                              l-waz<sup>s</sup>i:'fe?
Q: mi:'n
             ka 'tab
                              the-homework
                                                ('Who wrote the homework?')
    who
             wrote
    ?a'ħmad
                              1-waz<sup>s</sup>i:'fe
                      ka 'tab
                              the-homework
    Ahmad
                      wrote
                                                 ('Ahmad wrote the homework')
    Object question:
Q: _su:'
             ka 'tab
                     ?a'hmad?
                      Ahmad
                                                ('What did Ahmad write?')
    what
             wrote
A: ka´tab l-waz<sup>s</sup>i:´fe
                              ?a'ħmad
            the-homework
                              Ahmad
                                                ('Ahmad wrote the homework')
    wrote
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(2)

The speakers uttered the response sentences to the verb, subject and object with narrow focus on A, B and C respectively. Vowel duration and Max F0 of stressed syllables of the target words (A, B & C) were measured in three word orders (focused & non-focused) in three response sentences, each representing three stress positions. Hence the same sentences provided the data for both stress as well

as focus. Vowel duration and F0 values were measured for stressed (a) penultimate and (b) antepenultimate syllables, (c) stressed vs. unstressed penultimate syllables and (d) stressed vs. unstressed antepenultimate syllables to investigate the correlates of stress in SA.

Measurements of vowels of stressed syllables of (2) I, which is the default word order, showed that vowel duration in (a) penult position (which is the default position for stress placement in SA) is greater than that of (b) antepenult syllables (F(1, 41) = 40.255, p < 0.05). The syllable position effects are plotted in Fig. 1. Another significant durational difference is between stressed and unstressed syllables (in penultimate and antepenultimate): Vowels in stress positions a & b in Table (2) are longer than those in unstressed (a) (F (1, 41) = 84.831, p < 0.05) and (b) (F (1, 41) = 56.914, p < 0.05) syllables .The stress and position effects are plotted in Fig. 2. Analyses of the fundamental frequency patterns are different from the durational patterns. Fo values do not show a significant difference between (stressed) a & b positions in Table (2). This result makes SA different from Jordanian Arabic (De Jong & Zawaydeh 1999), where both duration and fundamental frequency are the correlates of stress [2].



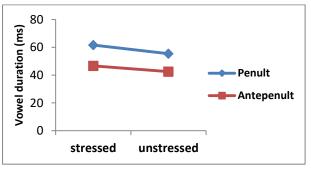


Figure 1. Mean vowel durations of stressed penultimate and antepenultimate positions

Figure 2. Mean vowel durations by position and stress

The analysis of F0 patterns of stressed syllables (a, b & c in Table (2)) of focused constituents A, B and C show a significant difference in all stressed positions when focused, as in 2 (I), where (F (2, 188) = 4.002, p < 0.05), 2 (II) (F (2, 188) = 16.730, p < 0.05) and 2 (III) (F (2, 188) = 11.853, p < 0.05), respectively. Measurements of vowel durations of focused constituents show a different result from F0 patterns where only the focused A & B are different. However, the statistical test shows that all constituents are significantly different; A (F (2, 188) = 6.247, p < 0.05), B (F (2, 188) = 8.338, p < 0.05) & C (F (2, 188) = 6.309, p < 0.05), regardless of their default word order. The acoustic correlates of focus investigated in this study are thus F0 values and vowel duration of the stressed syllables. These acoustic cues are used in a number of languages to mark accentual prominence at the word-level [9], and may be divided into: melodic cues (F0), temporal cues (duration and length) and dynamic (loudness) [9]. Our analysis shows that focus not only increase the duration of a vowel, but also tends to increase the fundamental frequency of that vowel. These results show that both melodic and temporal cues are used to mark focus in SA. The focused constituents in (2) I, II & III show that (A & B) have significantly longer duration in all stress positions (a, b & c). On the other hand, F0 of all the focused constituents (A, B & C) are more prominent in all stress positions.

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