Acoustic Manifestation of Stress and Focus in Arabic

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The main acoustic properties of prominence, referred to here as stress (word-level) and focus (sentence level), are duration, pitch (F0) and intensity, and sometimes vowel quality. This raises the question of how, if the same properties are used, speakers distinguish among the various uses. Arabic is particularly interesting in this regard since one of the properties, duration, is also a phonemic property, playing a role in contrastive vowel (and consonant) length. It is thus predicted that duration will not be a cue for prominence since this would obscure its role as a lexically contrastive feature.

We examine the acoustic properties of stress and focus in standard Arabic, as spoken by 10 Jordanian university students. As part of a larger cross-linguistic investigation of prominence, we limited our examination to 10 of each of the vowels /a, i, u/, both short and long, and stressed and unstressed (n=120). The stimuli are three syllable (real) words, and to minimize other possible effects, we only measured vowels in open syllables word-initially, as illustrated in (1). (The target is bolded; stress is marked with an acute accent.)

(1) a. Stressed Target V: /‘ka:taba/ ‘he wrote’, /‘ka:taba/ ‘he corresponded with’

b. Unstressed Target V: /‘ka:tiba/ ‘we wrote’, /‘ka:תיבa/ ‘write to her’

Most analyses of the acoustic properties of stress (across languages) are confounded with focus due to the target’s placement in focus position in typical carriers of the format “Mary said XXX three times.” To avoid this, we used two short dialogues of the form shown (in English) in (2). The target “XXX” is focused in (a), but not in (b), where a following word is focused shown by italics. (120 items x focus/non-focus conditions: n = 240 per speaker.)

(2) a. Q: What did Mary say in the morning?
   A: Mary said XXX in the morning.

b. Q: Did may say XXX in the morning?
   A: No, Mary said XXX in the afternoon, not in the morning.

A Binary Logistic Regression Analysis (BLRA) of the first 5 speakers to determine which properties contribute significantly to the automatic identification of stress and focus, revealed successful classification for stress in the absence of the focus confound (90%). The classification of focus in the absence of stress is weak (66%), but improves on the stressed syllable (84%), as focus is usually manifested most consistently on the stressed syllable of a word. In all cases, of the properties considered (F0, duration, intensity, vowel centralization), F0 was the main classifier. As predicted by the phonemic role of duration in Arabic, this property was not a significant cue for either stress or focus. The findings were essentially the same for short and long vowels separately and when they are combined. Descriptive results confirm the BLRA findings as seen in substantial differences in Mean F0 and the trivial differences for duration presented in Figures 1 and 2.

![Figure 1: Mean F0 of Short and Long Vowels in Stressed/Unstressed and Focus/Non-Focus Positions](image1)

![Figure 2: Duration of Short and Long Vowels in Stressed/Unstressed and Focus/Non-Focus Positions](image2)