Contrastive focus and F0 patterns in three Arabic dialects

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Abstract

A comparison of the acoustic realizations of contrastive focus was carried out for three Arabic dialects (Moroccan Arabic, Kuwaiti Arabic and Yemeni Arabic) using five speakers from each dialect. Acoustic correlates like F0 peak alignment, vowel duration, F0 excursion size were found to be quite different. Other aspects such as F0 contour shape, pause usage also varied. The clear differences found in these acoustic features enable separation of Moroccan Arabic from the two other dialects.

1. Introduction

One primary function of prosody is to provide cues about the informational structure of discourse. Generally, words carrying new or important information in a given discourse become focalized in the utterance. Special weight can be given to any part of the utterance by using lexical, syntactic and intonational means. This is termed *narrow focus* as opposed to *broad focus* in which all parts of the utterance are given equal prominence (Ladd 1980). Contrastive focus, which is the main object of the study, is a subset of narrow focus whose function is to indicate an exclusive selection of an alternative out of a group of two or more possibilities. Focus for contrast is traditionally distinguished from focus for intensification, which is simply an equivalent means to using an intensifying adverb (Coleman 1914, cited in Hirst & Di Cristo 1988). In general, the prosody of Arabic is still under-researched compared to segmental aspects like pharyngealization. Focalization has been studied in Modern Standard arabic (Moutouakil 1989, Mawhoub 2000), Egyptian Arabic (Norlin 1989, Hellmuth 2006), Moroccan Arabic (Mawhoub 1992, Benkirane 2000, Yeou 2005) and Lebanese Arabic (Chahal 2001). However, Cross-dialectal studies on the comparison of intonation patterns are rare.

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The present study aims at investigating some acoustic correlates of contrastive focus patterns in elicited speech from three Arabic dialects. The study of cross-dialectal variability is motivated by several reasons. First variability constitutes a substantial source of information for prosodic typology. Second, such source of information can be relevant for Arabic dialect modeling aiming at improving automatic speech recognition for Arabic. Finally, investigating dialectal variability enhances our understanding of the impact of dialect patterns on the pronunciation of Modern Standard Arabic.

2. Method

The speech material consisted of 10 declarative sentences containing target words: (a) words with terminal CV:C sequences: ([ħali:m], [sali:m], [ʔami:n], [mimu:n], [ʒali:l]); and (b) words with terminal CVCV: sequences: ([ħali:ma], [sali:ma], [ʔami:na], [mimu:na], [ʒali:la]). The words, which are all personal names, were incorporated in the following carrier sentence: ʒabt m(a)ʕaña *ʔami:n* lbarħ/mbariħ "She came with *Amin* yesterday." The sentence was produced in two focus contexts: no focus and contrastive focus on the underlined word. Recorded prompt questions were played to subjects to elicit production of the target sentences. The contrastive focus reading was prompted by a question such as "Did she come with Mohamed yesterday?" (for the answer sentence "She came with *Amin* yesterday") which requires contrastive focus on the target word, in this example *Amin*. The speech material was read by 5 native speakers of each Arabic dialect (Moroccan Arabic, Kuwaiti Arabic, Yemeni Arabic). Each dialect group contained 3 males and 2 females who were all in their twenties and speak the same variety.

Speech samples were recorded using professional equipment and digitized in real time and stored on the computer's hard disk. The keywords were segmented on the basis of simultaneous visual displays of the waveform, wideband spectrograms and F0 contour using PRAAT. The following segmental landmarks were manually identified in each utterance (cf. Figure 1):

"C0" (the onset of the stressed syllable, i.e. the beginning of the initial consonant),

"V0" (the onset of the stressed vowel),

"C1" (the end of the stressed vowel),

"V1" (the onset of the following unstressed vowel),

"L" (the beginning of the F0 rise, i.e. F0 minimum)

"H" (the peak of the F0 rise, i.e. F0 maximum)

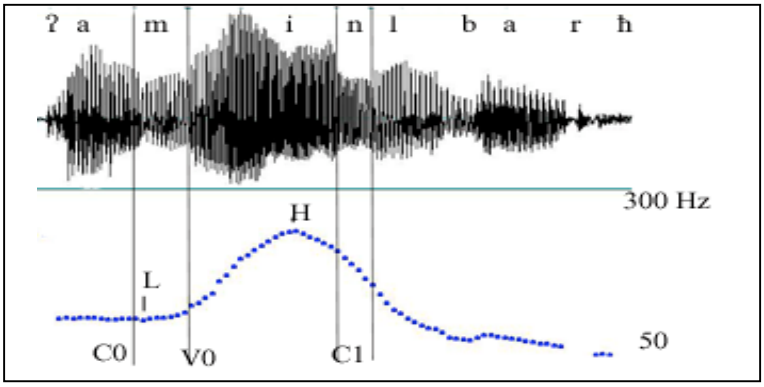

Figure 1. Waveform and F0 track showing measurement points.

From these three segmental points, the following measurements were extracted:

- Alignment of H (F0 peak alignment: H minus C1),
- Vowel duration (the duration in ms of the stressed vowel, i.e. C1 minus V0),
- Rise size (the F0 change between L and H in semitones (st) in the stressed syllable).

3. Results

3.1. Effect of focus on vowel duration and rise size

Table 1 and 2 show the effect of contrastive focus on F0 excursion size and accented vowel duration by comparing the measurements points in two conditions: 1) contrastive focus condition ([+F]), and 2) non-contrastive focus condition ([-F]. It can clearly be seen that under contrastive focus, the accented vowel becomes longer and the rise size becomes larger in all the three dialects. The duration and F0 attributes of contrastive focus that have been established by several researchers are largely corroborated here (e.g. Couper-Kuhlen 1984, Cooper & al. 1985). There are however differences across the dialects regarding these acoustic attributes. We start first at looking at rise size and assess whether the cross-dialectal difference in F0 excursion size is significant. The F0 excursion size between the two focus conditions is larger is Moroccan Arabic (5.33 st), lower in Yemeni Arabic (0.33 st) and intermediate in Kuwaiti Arabic (3.25 st). A two-way ANOVA shows that there is a significant main effect of rise size $F(1, 297) =$

305.558, $p < 0.0001$) and dialect $F(1, 297) = 57.35$, $p < 0.0001$). The interaction between the two factors is also significant $F(1, 297) = 74.337$, $p < 0.0001$).

It is worth noting here that in Yemeni Arabic, unlike the other dialects, the rise size does not differ much between the two focus conditions and the ANOVA shows that the difference is not significant (cf. Table 1). Individual mean values for the five Yemeni speakers are all low: -0.09 st (Speaker 4), 0.07 st (Speaker 5), 0.63 st (Speaker 1), 1.1 st (Speaker 2) and 1.4 st (Speaker 3).

	Rise size (st)			
	[+F]	[-F]	Difference	ANOVA
Kuwaiti Arabic	6.26 (3)	3.01 (1.3)	3.25	p <0.0001
Moroccan Arabic	10.37 (3.3)	5.04 (2.3)	5.33	p <0.0001
Yemeni Arabic	5.37 (2.1)	4.74 (2.5)	0.63	p =0.768

Table 1. Mean rise sizes and standard deviations in semitones (st) in two conditions: a) contrastive focus condition ([+F]), and b) non-contrastive focus condition ([-F]). The two columns to the right show the difference in st between the two conditions along with probability values.

Regarding the effect of contrastive focus on vowel duration, Table 2 gives mean values of the stressed vowel and differences between the two focus conditions for the three Arabic dialects. Results of separate ANOVAs are also displayed in Table 2. As can be seen, significant contrasts exist between the two focus conditions. All the dialects show a lengthening effect when the target words are under contrastive focus. This lengthening effect is greatest in Moroccan Arabic (49 ms). It is comparable for Kuwaiti Arabic and Yemeni Arabic, 29 ms and 35 ms, respectively. A two-way ANOVA was conducted to assess whether such differences in lengthening were significant. As for rise size, there was a significant main effect of dialect $F(1, 297) = 38.180$, $p < 0.0001$) and duration $F(1, 297) = 332.599$, $p < 0.0001$). The interaction between the two factors was also significant $F(1, 297) = 15.291$, $p < 0.0001$).

	Vowel duration (ms)			
	[+F]	[-F]	Difference	ANOVA
Kuwaiti Arabic	161 *(30)*	132 *(22)*	29	p <0.0001
Moroccan Arabic	147 *(48)*	98 *(18)*	49	p <0.0001
Yemeni Arabic	131 *(27)*	106 *(15)*	25	p <0.0001

Table 2. Mean vowel duration and standard deviations in millisecond (ms) in two conditions : a) contrastive focus condition ([+F]), and b) non-contrastive focus condition ([-F]). The two columns to the right show the difference in ms between the two conditions along with probability values.

3.2. F0 peak alignment, syllable structure and focus

One of the motivations of the paper is to see if syllable type affects F0 peak alignment as was reported for Moroccan Arabic in Yeou (2004). Table 3 presents average values for F0 peak alignment and vowel duration in two conditions: closed syllables (CV:C) and open syllables (CV:).

Table 3 shows that that F0 peak alignment varies in the three Arabic dialects. Moroccan Arabic differs from both Kuwaiti Arabic and Yemeni Arabic in exhibiting a peak alignment pattern based on syllable type: the F0 peak is aligned within the end of the stressed vowel in closed syllables, but it is aligned after the stressed vowel in open syllables. Kuwaiti Arabic and Yemeni Arabic pattern similarly in aligning the peak within the accented vowel. However, alignment is relatively later in the former than in the latter.

	F0 peak alignment (ms)			Vowel duration (ms)		
	CV:C	CV:	Δ	CV:C	CV:	Δ
MA	-32.8 *(-26)*	15 *(32)*	48.2	175 *(48)*	120 *(30)*	55
KA	-9.8 *(-56)*	-8.3 *(-72)*	1.5	168 *(28)*	154 *(31)*	14
YA	-41.8 *(-34)*	-42.4 *(-22)*	.6	140 *(28)*	123 *(24)*	17

Table 3. Mean values and standard deviations for F0 peak alignment and vowel duration in two conditions: closed syllables (CV:C) and open syllables (CV:). Δ= difference in ms between the two conditions, MA= Moroccan Arabic, KA= Kuwaiti Arabic, YA= Yemeni Arabic.

A two-way ANOVA was conducted to assess whether such differences in alignment were significant. There was a significant main effect of syllable type $F(1, 147) = 9.317$, $p = 0.003$) and dialect

$F(1, 147) = 7.727$, $p < 0.0001$). The interaction between the two factors was also significant $F(1, 147) = 9.344$, $p < 0.0001$). ANOVAs were conducted separately for each dialect to see if alignment of F0 peak varies with syllable type. Results revealed a significant main effect of syllable type for Moroccan Arabic, $F(1, 98) = 63.316$, $p < 0.0001$, but not for Yemeni Arabic, $F(1,98) = 0.009$, $p = 0.926$, nor for Kuwaiti Arabic, $F(1,98) = 0.018$, $p = 0.893$.

As regards the effect of syllable type (open vs. closed) on vowel duration, Table 3 shows that vowel duration differs in the two conditions in all the dialects. This difference is statistically significant for Moroccan Arabic, $F(1, 98) = 46.534$, $p < 0.0001$, Yemeni Arabic, $F(1,98) = 10.640$, $p = 0.002$, and Kuwaiti Arabic, $F(1,98) = 5.573$, $p = 0.020$. The duration difference is greatest in Moroccan Arabic (55 ms) and is comparable for Kuwaiti Arabic and Yemeni Arabic, 14 ms and 17 ms, respectively.

The results of this paper seem to give some support to a durational explanation for the difference in F0 peak alignment in Moroccan Arabic as the F0 peak is aligned 32.8 ms before the offset of the focused vowel in closed syllables and 15 ms into the next consonant in open syllables. A structural explanation, however, seems to better account for alignment differences in Kuwaiti Arabic and Yemeni Arabic: the focused vowels differ significantly in duration, yet the F0 peak is all the time realized within the boundaries of the vowel.

3.3. Intonation patterns for contrastive focus

In the three Arabic dialects, the shared strategy used to convey contrastive focus consists of a rising-falling movement like the one used for broad focus. As shown by Figure 2 and Figure 3, the accented syllables of focused words stand out clearly from the surroundings. This is brought about by considerably raising the F0 of the focused syllable and diminishing the F0 deflections on succeeding and preceding stressed syllables.

Visual inspection of the patterns used to mark contrastive focus indicates that there are some differences between the dialects. First, there is some variation regarding the pre-focal stress groups. In Moroccan Arabic, four speakers out of five realized a deaccentuation and a lowering of the syllables preceding the focused word. Figure 2 is an example of such realization. The prefocal constituent starts at very a low level and remains relatively flat until the focused word. On the other hand, the Yemeni and Kuwaiti speakers do not produce a flattening out of the preceding stressed syllables. Figure 3 and Figure 4 show there is always a partial accentuation of the pre-focal stress groups which start at a mid level. Only the post-focus is realized with

an important lowering and shrinking of F0. The deaccenting found in Moroccan Arabic is in agreement with Benkirane (2000) who shows that outside focused words, Moroccan Arabic words do not show accentual prominence.

Secondly, the F0 movement of contrastive focus is much more locally defined in Kuwaiti Arabic and Yemeni Arabic than Moroccan Arabic, where it may span the entire focused word (cf. Figure 2). Finally, unlike Yemeni Arabic and Moroccan Arabic, Kuwaiti Arabic uses two different intonation patterns for focalization: 1) the rising-falling movement common to the three dialects in 58% of all cases; and 2) a high rising F0 contour to the end of the focalized word in the remaining 42%. The F0 rise is sometimes followed by a short period of silence. Figure 5 is an illustration of this pattern. In this example, the F0 rises during the accented vowel /iː/ and reaches its peak towards the end of the postvocalic consonant /m/ of the word under contrastive focus [ħaliːm]. There is a short pause of 110 ms immediately following the word in contrastive focus. It is worth noting here that pauses with Kuwaiti speakers are found to mark contrastive focus not only with the high rising F0 contour but also with the common rising-falling contour. The pause is used in 52% of all cases and its average duration is approximately 115 ms (s.d.= 42 ms).

Informal perception tests with two Kuwaitis indicate that the two F0 contours code different semantics. The sustained F0 contour seems to be associated with *uncertainty* or *incredulity*, whereas, the rising-falling contour is associated with *certainty*: the speaker is categorically confirming the exclusive selection of an alternative out of two or more possibilities and is not asking for confirmation.

The sustained high F0 contour to the end of the word in contrastive focus used by Kuwaiti Arabic can be interpreted as a high intermediate phrase boundary tone H-, similar to the one reported for Spanish (cf. Face 2002). The rising-falling movement common to the three dialects can be considered as a L+H* pitch accent as the F0 peak is often realized with the boundaries of the focused vowel.

4. Conclusion

Findings of the present paper indicate that clear differences emerged between three Arabic dialects. First, there is variation as to the effect of syllable structure on F0 peaks. The effect is not significant in Yemeni Arabic and Kuwaiti Arabic as the F0 peak occurs within but near the end of the accented vowel in both open and closed syllables. In Moroccan Arabic, however, the effect of syllable structure is

significant: the F0 peak occurs within the accented syllable in closed syllables, but outside the syllable in open syllables. Second, the intonational patterns used to mark contrastive focus are different: 1) Unlike the other dialects, Moroccan Arabic shows de-accenting before focused words; 2) Kuwaiti Arabic uses an additional strategy to convey focus which is that of a high rising F0 contour to the end of the accented word. Finally, vowel lengthening and F0 excursion size associated with contrastive focus are more marked in Moroccan Arabic than in Yemeni Arabic and Kuwaiti Arabic.

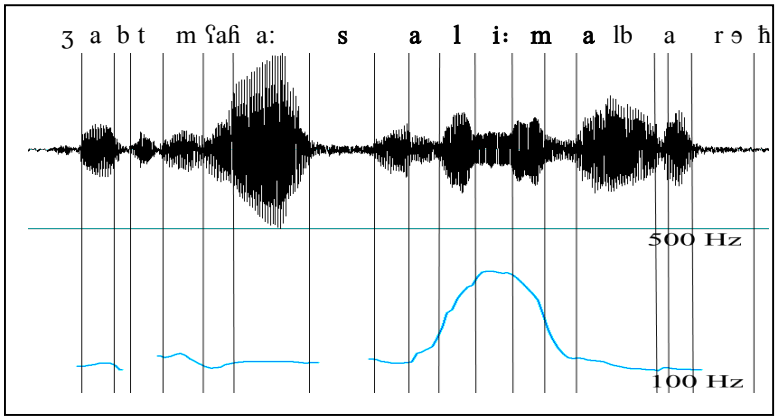

Figure 2. F0 track for /ʒabt mʕaɦa sali:ma lbarɔħ/ spoken by a Moroccan (Speaker 3).

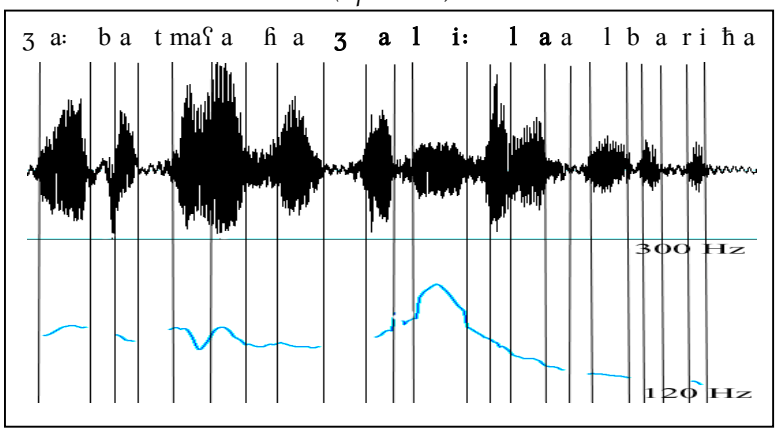

Figure 3. F0 track for /ʒa:bat maʕaɦa ʒali:la albariħa/ spoken by a Yemeni (Speaker 4).

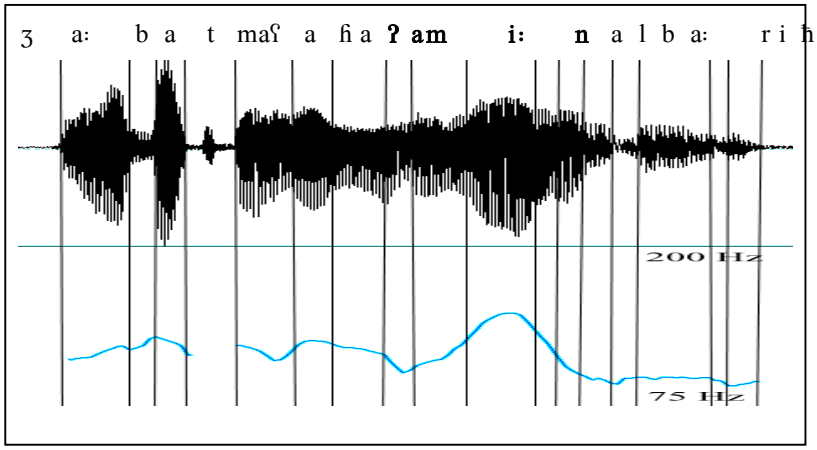

Figure 4. F0 track for /ʒa:bat maʕaɦa ʔami:n alba:riħ/ spoken by a Kuwaiti (Speaker 3).

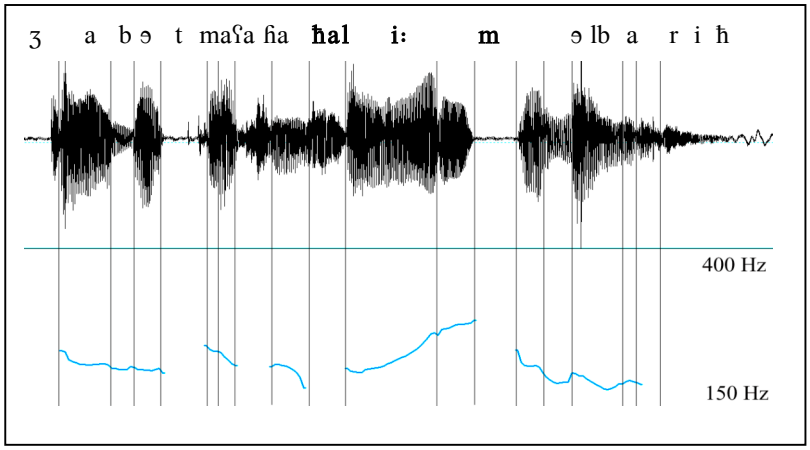

Figure 5. F0 track for /ʒa:bət maʕaɦa ħali:m əlbariħ/ spoken by a Kuwaiti (Speaker 1).

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