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Emphasis Spread in Algerian Arabic Sounds: An Acoustic Experimental Study on Bordj Bou-Arreidj Dialect

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ABSTRACT

Many studies have been carried out on emphasis in Modern Standard Arabic (MSA) and Arabic dialects but not Algerian Arabic. This article is the first account on the acoustic spread of emphasis in Algerian Arabic, Bordj bou-Arreidj dialect specifically. PRAAT Speech Analysis was used to measure the formant frequency F2 of plain/emphatic vowels as articulated by participants. SPSS, then, was used for statistical analysis. The findings revealed that emphasis affects vowels by notably lowering their F2 and this lowering is significantly greater for /a/ and /a:/ than for /u/ and /u:/. Also, emphasis spread to adjacent vowels is argued to be bidirectional and symmetric.

Keywords: Acoustic Phonetics; Algerian Arabic; Bordj Bou-Arreidj dialect; Emphasis; Formant Frequency; PRAAT.

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INTRODUCTION

Modern Standard Arabic (MSA) and different Arabic dialects are characterized by a distinct linguistic feature which is emphasis. They have minimal or near-minimal pairs of contrasting emphatic consonants [s^ʕ], [t^ʕ], [ð^ʕ], [d^ʕ] and plain consonants [s], [t], [ð] and [d] correspondingly. Early Arab linguists defined emphasis as ‘spreading and raising/covering of the tongue’, ‘elevation of the back of the tongue (dorsum)’, and ‘thickness and heaviness’ (Lehn, 1963). As mostly reported in the literature, the articulatory configuration that permits to generate emphasis is pharyngealization. It is a secondary constriction in the pharynx while articulating the emphatic sound that spreads into the adjacent vowel or vowels (Abudalbuh, 2011).

In fact, many studies have been carried out on emphasis in MSA and almost each Arabic dialect (E.g. Abudalbuh, 2011 in Jordanian Arabic; Al-Masri & Jongman, 2004 in Northern dialect of Jordanian Arabic; Almbark, 2008 in Syrian Arabic; Jaber et al., 2019 in Urban Jordanian Arabic; Hassan, 2005 in Iraqi Arabic; Laufer & Baer, 1988 in Nablus, Beirut, Baghdad and Berr-Zeit dialects; Pick, 2016 in Lebanese Arabic; Salam, 2012 in Lybian Arabic; Shar & Ingram, 2010 in Saudi Arabic; Yeou, 2001 in Moroccan Arabic) but not Algerian Arabic. Only one study was carried out on Algerian Arabic (Omri, 2017) which investigated mainly the acoustic cues of emphasis in general. To name a few dialects that were abundantly investigated in terms of emphasis, the following studies can be cited: Iraqi Arabic (Hassan and Esling, 2007), Jordanian Arabic (Abudalbuh, 2011), Northern dialect of Jordanian Arabic (Al-Masri & Jongman, 2004), Lebanese Arabic (Hassan & Heselwood, 2011; Pick, 2016), Egyptian Arabic (Aldamen, 2013), Palestinian Arabic (Al-Adam, 2015); Syrian Arabic (Almbark, 2008); Urban Jordanian Arabic (Jaber et al., 2019); Nablus, Beirut, Baghdad and Berr-Zeit dialects (Laufer & Baer, 1988); Lybian Arabic (Salam, 2012); Saudi Arabic (Shar & Ingram, 2010). Because results from previous literature cannot be generalized to all Arabic dialects as Lehn (1963: 30) argued: “emphasis apparently functions differently in different dialects”, an investigation on each dialect is very necessary. In light of this interesting and vivid area of research on different Arabic varieties, further investigation is required to be carried on Algerian Arabic. This study aims at providing the first account for the acoustic study of the spread of

emphasis in one of Algerian Arabic dialects specifically, Bordj Bou-Arreridj dialect (BBA dialect).

2. Literature Review

Though emphasis appears to receive attention only lately, interest in it is in fact dated back to Medieval Arab linguists; the time when reports on it were chiefly descriptive. The majority of next accounts were articulatory in the main. Recently, emphasis investigations shifted to be primarily acoustic. Emphasis has been tackled so far in most Arabic dialects. Nevertheless, among them, very little attention has been given to Maghrebi dialects as compared to Levantine and Middle East dialects. Algerian Arabic, particularly, has not gained any attention in this regard at all except only one recent account (Omri, 2017) which investigated a few aspects of emphasis.

In the eighth century, Sibawayh reported emphasis as ‘covering’ and described emphatic sounds as ‘al-huroof al-almutbaqa’. Depicting emphasis ‘itbaq’, he said it’s “the contact of the front part of the tongue with the front part of the palate while the back part of the tongue is raised towards the ‘upper’ part of the palate” (Semaan, 1968, p. 45 as quoted in Al-Masri & Jongman, 2004). Technological advances led the interest in emphasis to be primarily articulatory in terms of accounting for the secondary constriction. Articulatory cues, then, varied between tongue retraction (e.g., Lehn, 1963), velarization (e.g., Trubetzkoy, 1969), glottalization (e.g., Ladefoged, 1971), labialization (e.g., Watson, 1999), uvularization (e.g., Zawaydeh, 1999) and most regularly pharyngealization (e.g., Watson, 2002). Nevertheless, from plentiful examinations in the literature it could be said that pharyngealization has been the most important reported articulatory cue of emphasis. Huneety and Mashaqba (2016) attributed this to the fact that the pharynx is ‘barrowed’ during the articulation.

After the launch of sound spectrography in the 1940s, exact acoustic examinations of speech have become applicable which permits precise measurements like frequencies, amplitude and segmental length. For the first time, Obrecht (1968) claimed in his book ‘Lebanese Arabic’ that F2 frequency is the most important acoustic correlate for emphasis perception. Shortly after, many studies followed concentrating on emphasis in other varieties of Arabic (as cited in Hassan & Heselwood, 2011). In 1975, Kahn investigated the acoustic cues of emphasis in Cairene Arabic, concentrating on males and females production. He found that F2 of the vowel adjacent to an emphatic sound doesn’t lower

in females' production as much as it does in the males' production. His report agrees with Lehn's claim that males emphasize more than females do (as cited in Almasri & Jongman, 2004). Another fascinating feature of emphasis is its spread. Even more fascinating is the process of spread which many phoneticians (e.g., Younes, 1993) depicted as a non random operation. Younes (1993) pointed out that it is governed by "an intricate set of rules whose violation strikes the native ear as foreign or unacceptable." (p. 120). In 1995, Davis examined a northern and a southern dialect of Palestinian Arabic. In terms of Grounded Phonology, Davis showed that emphasis spread operates asymmetrically: "leftward emphasis is not blocked for the entire word but rightward emphasis is always blocked by [+high, -back] vowels" (p. 468). This also stood against one of Lehn's reported results that /i/ and /u/ at all times block emphasis spread.

In a perceptual as well as acoustic account of Urban Jordanian Arabic, Al-Masri (2009) examined monosyllabic and bisyllabic words. In all contexts, he reported F2 decrease and F1 and F3 increase as significant correlates of emphasis. Considering the nature of emphasis, he argued that it is gradient as demonstrated from the three formants. Moreover, he stated that low front vowels exhibited greater effect of emphasis than the high back vowel. The greatest effect of emphasis on /æ/ and /æ:/ in terms of F2 decrease was exhibited at the midpoint which is in agreement with what Card (1983), Wahba (1993 as cited in Aldamen, 2013) and Shar and Ingram (2010) reported.

In 2011, Abudalbuh examined monosyllabic minimal CVC pairs with the plain/emphatic contrast at the initial position of the pairs. He reported F1 and F3 increase and F2 decrease as important cues of emphasis but only in specific contexts. In terms of VOT, emphatic stops had significantly lower values of VOT than plain counterparts and this was marked merely for voiceless stops which exhibited shorter VOT. Moreover, emphatic fricatives and plain vowels were shorter than plain fricatives and emphatic vowels, respectively. In contrast, the spectral mean exhibited no differences between emphatic and plain contexts. In his sociophonetic examination, Abudalbuh (2011) argued that emphasis is greatly exhibited in males' articulation than in females' which goes in agreement with some accounts such as Lehn's and Kahn's.

Investigating /s/ and /s^h/ in Moroccan Arabic in 2001, Yeou reported a decrease in F2 and an increase in F1 of the emphatic vowels especially at its initial position as compared to the midpoint. In 2007, Zeroual, Hoole, Fuchs, & Esling restricted their study of emphasis to the

examination of merely /t/ and /tʰ/. They argued that Voice Onset Time (VOT) was shorter in emphatic contexts.

Algerian Arabic, in terms of emphasis, has not received any attention especially acoustically except what was recently provided in the study of Omri (2017). The study investigated not a specific region in Algeria but many regions at once. The findings demonstrated that F1 increase and F2 lowering are reliable cues of emphasis at the onset, the offset and the midpoint in contrast to F3 which exhibited no main effect of emphasis except F3 lowering for /i/ at the onset/offset. Moreover, the study revealed that emphasis in Algerian Arabic is bidirectional with symmetric spread except for F1 at the onset/offset which exhibited stronger rightward spread than leftward spread. Also, emphasis proved to affect /æ/ more than it affected /i/ and /u/ with a greater effect on /i/ than /u/. Furthermore, the findings proved that VOT is an important correlate, exhibiting an asymmetric effect of emphasis which caused /tʰ/ to have shorter VOT than /t/ while causing /dʰ/ to have longer VOT than /d/. Vowel length, as well, proved to be a reliable cue of emphasis which caused vowels adjacent to emphatic consonants to be longer than vowels adjacent to plain consonants. Frication duration as well as spectral mean of fricatives, however, were found to be insignificant cues of emphasis.

In summary, numerous acoustic experiments on different Arabic dialects have been carried so far considering emphasis including mainly Palestinian Arabic, Jordanian Arabic, Lebanese Arabic, Egyptian Arabic and Iraqi Arabic. These investigations have tackled essentially the acoustic cues of emphasis, its domain and the effect of gender and vowel quality on its degree. It is interesting how emphasis operates differently from one dialect to another.

3. Rational of the Study

Emphasis is a unique feature that characterizes Modern Standard Arabic (MSA) and different Arabic dialects. Numerous studies investigated it acoustically in these different Arabic varieties including MSA, Jordanian Arabic, Lebanese Arabic, Syrian Arabic, Egyptian Arabic and Palestinian Arabic to name only few. Algerian Arabic, however, gained no attention in this respect except one study that investigated it in general. What is fascinating in these present-day debates is how emphasis operates differently from one Arabic dialect to another. The inability to generalize the previous findings on all Arabic dialects, though massive, urges to carry many investigations on emphasis in each Arabic dialect that has gained no or little attention in this respect such as Algerian Arabic.

4. Research Questions

This study aims at answering the following questions:

- How does emphasis affect the vowels adjacent to emphatic consonants?
- Which of the vowels triggers greater emphasis spread?
- Does emphasis spread rightward or leftward?
- Is emphasis spread symmetric or asymmetric?

5. Experiment

The study consisted of an analytical experiment of data as elicited from the speech of carefully selected participants.

5.1 Participants

Six native speakers of Bordj Bou-Arreridj Algerian Arabic participated in this study. They were recorded while uttering a previously prepared list of selected words (See Stimulus Materials section below). All the participants are aged between 18 and 24 with no speaking or hearing impairment and ethical guidelines were rigorously adhered to.

5.2 Stimulus Materials

The following tables constitute minimal pairs with emphatic/plain contrast /s/ and /s^h/ at the initial or final position. Some of them are nonwords of the dialect but are phonologically licensed. They were needed to constitute the requirement of minimal pairing.

Table 1. Minimal pairs with emphatic/plain contrast at the initial position

<u>The target Vowel</u>	<u>words with initial plain sounds</u>	<u>Gloss</u>	<u>words with initial emphatic sounds</u>	<u>Gloss</u>
/æ/ or /æ:/	/sæki:næ/	<u>a girly name</u>	/s ^h æki:næ/	<u>nonword</u>
/i/ or /i:/	/si:ni:mæ/	<u>cinema</u>	/s ^h i:ni:mæ/	<u>nonword</u>
/u/ or /u:/	/su:mi:jæ/	<u>a girly name</u>	/s ^h u:mi:jæ/	<u>nonword</u>

Table 2. Minimal pairs with emphatic/plain contrast at the final position

The target Vowel	words with final plain sounds	Gloss	words with final emphatic sounds	Gloss
<u>/æ/ or /æ:/</u>	<u>/istixlæ:s/</u>	<u>nonword</u>	<u>/istixlæ:s^ɕ/</u>	<u>extraction</u>
<u>/i/ or /i:/</u>	<u>/kæwæ:li:s/</u>	<u>behind scenes</u>	<u>/kæwæ:li:s^ɕ/</u>	<u>nonword</u>
<u>/u/ or /u:/</u>	<u>/tæħæmmus/</u>	<u>enthusiasm</u>	<u>/tæħæmmus^ɕ/</u>	<u>being roasted</u>

5.3 Procedures

The participants were asked to read each of the above words three times in the carrier sentence / guli --- θləθ mərræt/ ("Say --- three times") naturally and in a normal tone and rate. To control for the context effects, the word in the second sentence was considered and analyzed. While reading, they were recorded in a quiet space using a good quality recorder. PRAAT speech analysis software was used to analyze the recordings and get the acoustic measurements. SPSS, then, was used for statistical assessments.

5.4 Acoustic Measurements

The second formant frequency F2 of all vowels adjacent to emphatic /s^ɕ/ and plain/s/ was measured. F2 was chosen among other cues of emphasis that were mentioned in the literature as it was argued to be the most consistent and the most significant (Obrecht ,1968; Laufer and Baer, 1988; Wahba, 1993; Zawaydeh, 1999; Hassan, 2005; Abudalbuh, 2011; Jaber, Omari &Al-Jarrah, 2019 as examples). All measurements were taken at the midpoint of the vowel, defined as halfway between the vowel onset and vowel offset.

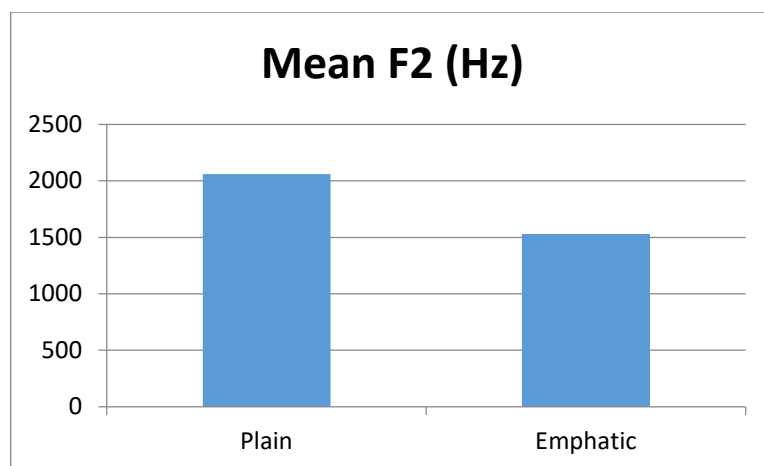
6.Findings

6.1 Emphasis Effect on Adjacent Vowels

A one-way ANOVA showed that there was a significant effect of Emphasis on the second formant frequency F2 [$F(1,70) = 15.29$, $p=0.00$]. F2 of vowels adjacent to emphatic consonants (with a mean of 1530 Hz) was considerably lower than F2 of vowels adjacent to plain consonants

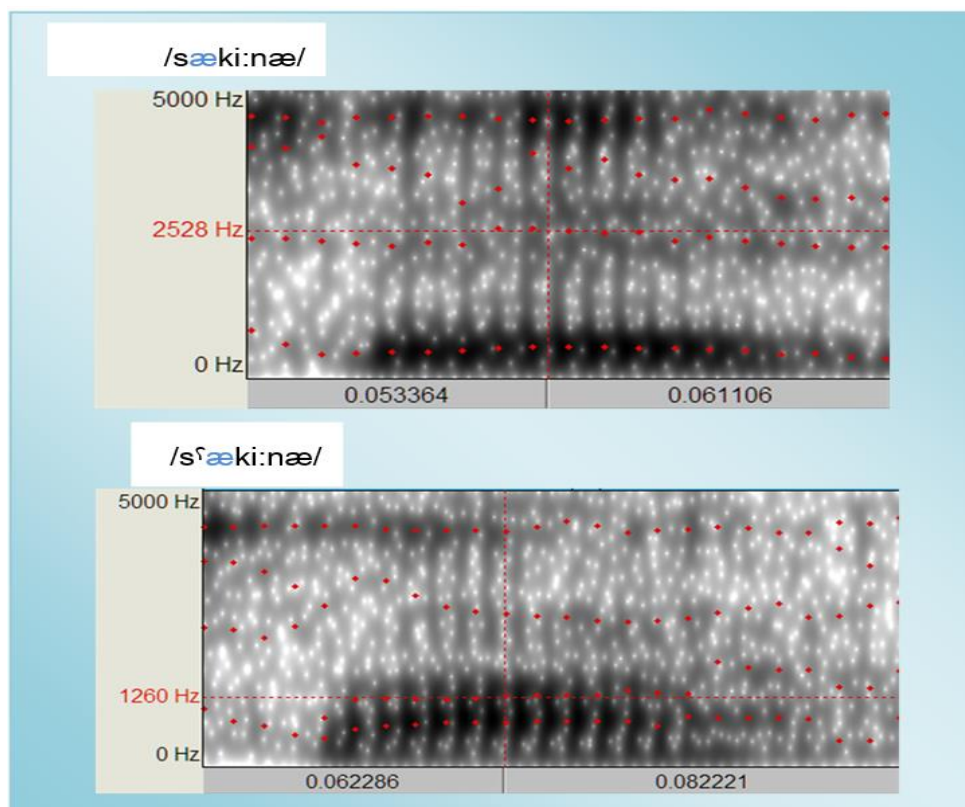
(with a mean of 2060Hz) as Figure 1 below shows.

Fig.1. The effect of emphasis on F2.



The spectrograms in Figure2 below illustrate the effect of Emphasis on F2 at the vowel midpoint of the same speaker. It is obvious that while F2 of the first /æ/ was about 2528 Hz when preceded by the plain consonant /s/ in the word /sæki:næ/ (first spectrogram), it lowered to reach only 1260 Hz when preceded by the emphatic consonant /s^ʕ/ in /s^ʕæki:næ/ (second spectrogram).

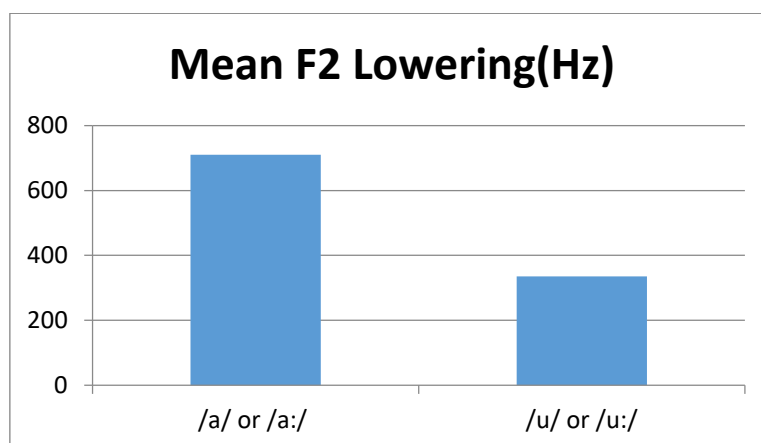
Fig.2. Comparison of F2 of the first vowel /æ/ in /sæki:næ/ and /s^ʕæki:næ/.



6.2 The Interaction between Emphasis and Vowel quality

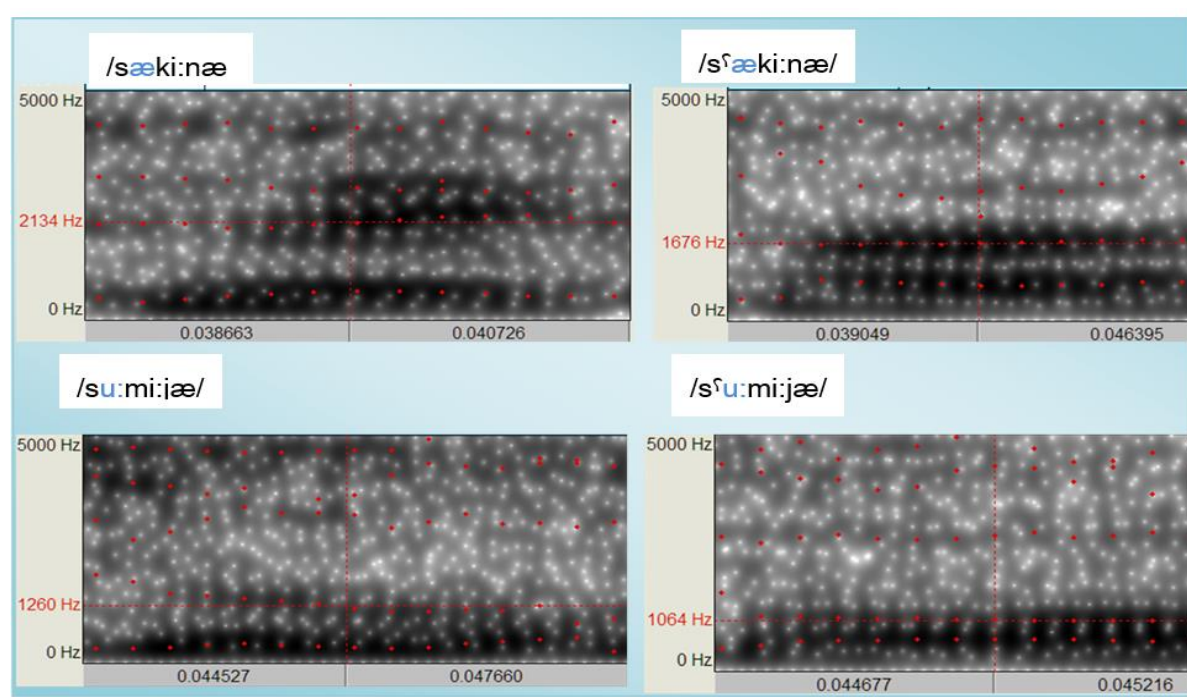
To elaborate more on the effect of emphasis, further analysis was carried to investigate which of the three vowels set /æ/ and /æ:/, /i/ and /i:/ or /u/ and /u:/ triggered greater effect. One Way ANOVA test of the difference between F2 lowering among the three vowel qualities revealed a significant interaction between emphasis (F2 lowering) and vowel quality [$F(2,33) = 4.52, p=0.02$]. A Bonferroni post-hoc analysis showed that emphasis effect (F2 lowering) was significantly greater for /æ/ and /æ:/ than for /u/ and /u:/ with a mean difference of 374Hz of F2 lowering as shown in the Figure3 below. It also revealed no significant difference of F2 lowering neither between /æ/, /æ:/ and /i/, /i:/ nor between /i/, /i:/ and /u/, /u:/.

Fig. 3. Comparison of the effect of emphasis on /a/ or /a:/ and /u/ or /u:/.



As illustrated in the spectrograms in Figure4 below, the effect of emphasis differs accordingly with the vowel quality. F2 of the first vowel /æ/ in the plain environment /sæki:næ/ was 2134 Hz. It lowered to be about 1676 Hz in the emphatic environment /sʰæki:næ/ with a difference of 458 Hz while F2 of /u:/ in the plain environment /su:mi:jæ/ was 1260Hz and lowered to be 1064 Hz in the emphatic environment /sʰu:mi:jæ/ with a difference of only 196Hz. Greater F2 lowering for /æ/ than for /u:/ means greater effect of emphasis on /æ/ than on /u:/.

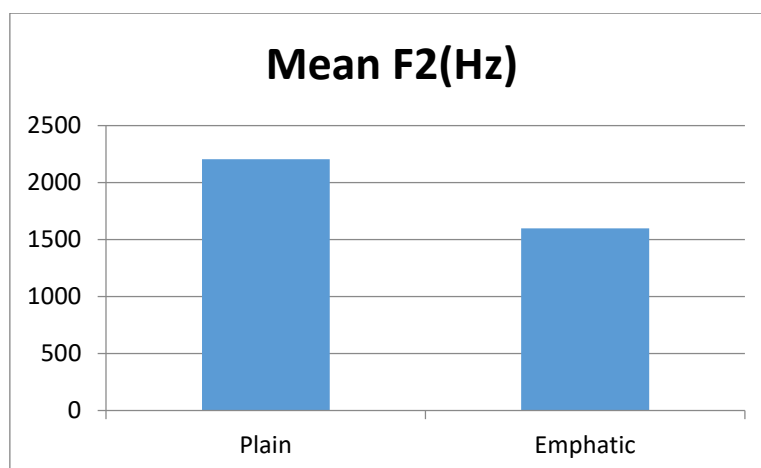
Fig. 4. Comparison between F2 lowering of the first vowel /æ/ in /sæki:næ/, /sʰæki:næ/ and of /u:/ in /su:mi:jæ/, /sʰu:mi:jæ/.



6.3 The Interaction between Emphasis and Position of Target Consonants

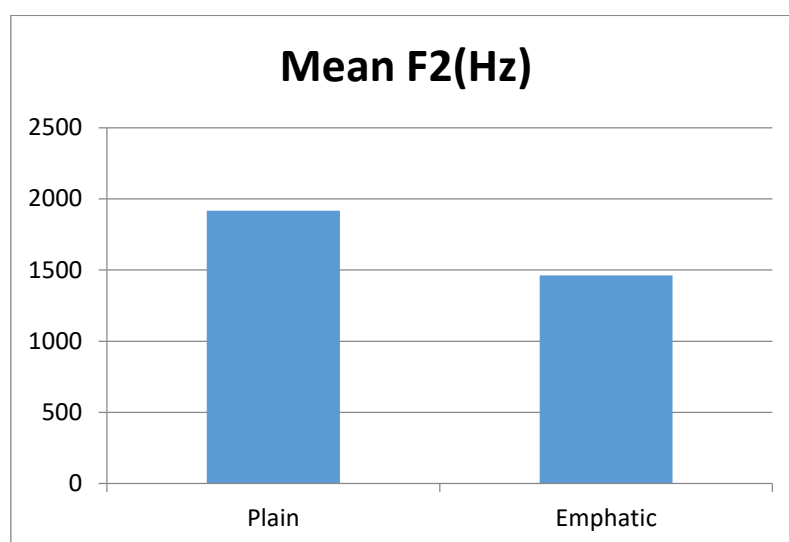
At the initial position, emphatic sounds affected adjacent vowels by lowering their F2 significantly as demonstrated from a one-way ANOVA test [$F(1,34) = 9.45, p=0.00$]. While the mean F2 of vowels preceded by plain sounds was 2205 Hz, it lowered to 1599 Hz for vowels preceded by emphatic sounds as shown in the following graph (Figure 5).

Fig. 5. The effect of emphasis on F2 of adjacent vowels at initial position.



At the final position, emphatic sounds affected adjacent vowels by lowering their F2 significantly as demonstrated from a one-way ANOVA test [$F(1,34) = 6.10, p=0.02$]. While the mean F2 of vowels followed by plain sounds was 1916 Hz, it lowered to 1462 Hz for vowels followed by emphatic sounds as shown below (Figure 6).

Fig. 6. The effect of emphasis on F2 of adjacent vowels at final position

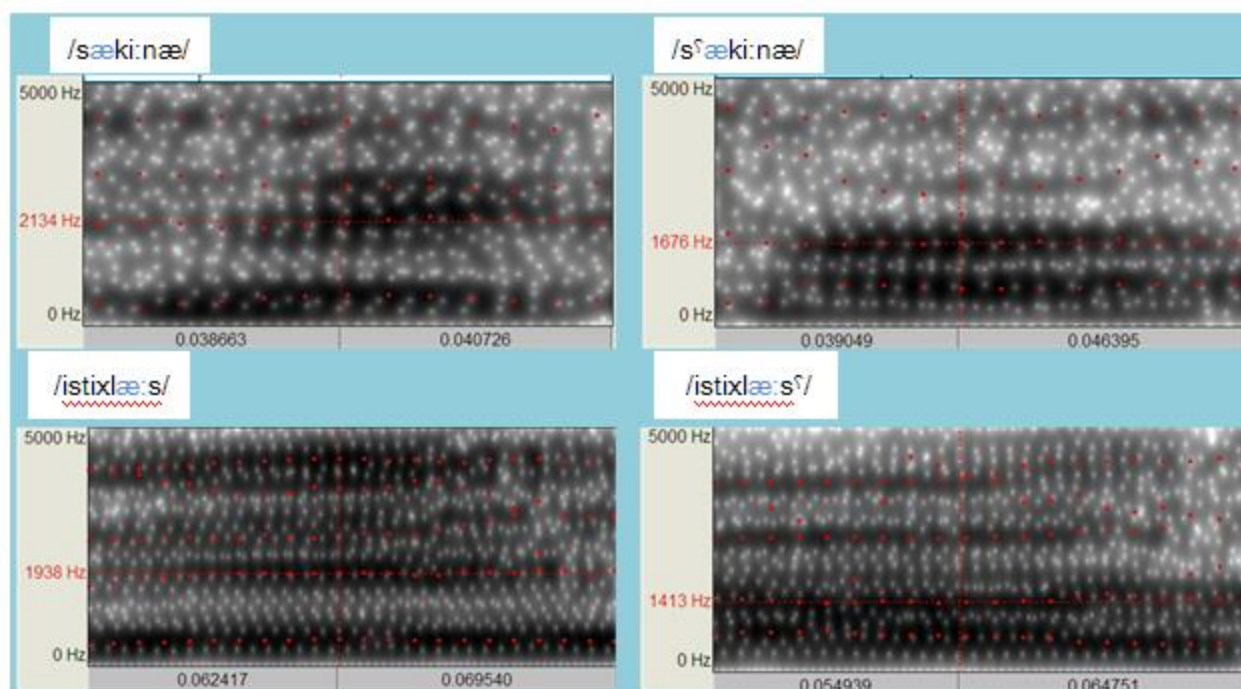


The fact that emphatic sounds caused F2 of adjacent vowels to be lowered whether at initial or final position reveals that emphasis spreads significantly in both directions; namely, rightward and leftward.

In order to reveal which of the directions triggered stronger effect of emphasis, a two-way ANOVA test was performed. It demonstrated that the interaction between emphasis and position is insignificant [$F(1,68) = 0.31, p=0.58$]. This indicates that there is no difference between the effect of emphasis when the emphatic sound is word-initial and when it is word-final; which means emphasis is bidirectional with a symmetric effect.

The spectrograms in Figure7 below illustrate the difference between the effect of emphasis at initial position and at final position. F2 of the first vowel /æ/ in the plain environment /sæki:næ/ was 2134 Hz, it lowered to be about 1676 Hz in the emphatic environment /sʰæki:næ/ with a difference of 458 Hz while F2 of /æ:/ in the plain environment /istixlæ:s/ was 1938 Hz and lowered to be 1413 Hz in the emphatic environment /istixlæ:sʰ/ with a difference of 525 Hz. This indicates that in fact emphasis operates both rightward and leftward with no prominent difference.

Fig. 7. Comparison between F2 lowering of the first vowel /æ/ in /sæki:næ/, /sʰæki:næ/ and of the last vowel /æ:/ in /istixlæ:s/, /istixlæ:sʰ/.



7. Conclusion

This study investigated for the first time the spread of emphasis in Bordj Bou-Arreidj dialect, one of the dialects of Algerian Arabic. It has been highly required to carry out such study in light of the numerous previous studies that investigated the aspect acoustically in different Arabic dialects, but not Algerian Arabic. Findings of previous literature cannot be generalized as Lehn (1963: 30) argued, “emphasis apparently functions differently in different dialects”. Al-Masri and Jongman (2004: 96) as well stated that “The fact that emphasis is evident in most dialects of Arabic does not necessarily mean that its correlates are identical.”

The findings revealed that, first, emphasis affects adjacent vowels by significantly lowering their second formant frequency F2. This is in accordance with how emphasis operates in many other Arabic dialects (Abudaljuh, 2011 in Jordanian Arabic; Al-Masri & Jongman, 2004 in Northern dialect of Jordanian Arabic; Almbark, 2008 in Syrian Arabic; Jaber et al., 2019 in Urban Jordanian Arabic; Jongman et al., 2011 in Urban Jordanian Arabic; Hassan, 2005 in Iraqi Arabic; Laufer & Baer, 1988 in Nablus, Beirut, Baghdad and Berr-Zeit dialects; Pick, 2016 in

Lebanese Arabic; Salam, 2012 in Lybian Arabic; Shar & Ingram, 2010 in Saudi Arabic; Yeou, 2001 in Moroccan Arabic).

Second, the study demonstrated that the effect of emphasis is significantly greater for /æ/ and /æ:/ than for /u/ and /u:/ which is in accordance with findings on some Arabic dialects such as Palestinian Arabic (Card, 1983). Also, emphasis effect was insignificantly different neither between /æ/, /æ:/ and /i/, /i:/ nor between /i/, /i:/ and /u/, /u:/. This opposes to emphasis behavior in some other Arabic dialects such as Jordanian Arabic in which emphasis role in lowering F2 is much greater in the vowel /æ/, then in /i/, then in /u/ (Jongman et al., 2011).

Third, vowels adjacent to emphatic sounds as compared to vowels adjacent to plain sounds revealed significant F2 lowering at both positions: word-initial and word- final. This means that emphasis is bidirectional; it operates both progressively and regressively. This is in accordance with emphasis behavior in many other Arabic dialects such as Rural Palestinian and Cairene Arabic (Youness, 1993), Syrian Arabic (Almbark, 2008) and Urban Jordanian Arabic (Jaber et al., 2019).

Finally, the findings revealed that the effect of emphasis is symmetric in terms of directionality as no major difference was revealed between the effect of emphasis when it spread rightward or leftward. This seems to operate similarly in a few dialects such as Palestinian (Card, 1983) but differently in many other dialects which exposed an asymmetric effect of emphasis such as Ammani Jordanian Arabic (Zawaydeh, 1999), Syrian Arabic (Almbark, 2008), rural Jordanian Arabic (Haneety & Mashaqba, 2016) and Urban Jordanian Arabic (Jaber et al., 2019).

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