

# The Role of Vowel Quality in Cuing Stress and Accent in Tunisian Arabic, Native English, and L2 English

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## Abstract

This study is an attempt to investigate the role of vowel quality in signaling stress and accent in Southern British English (SBE), Tunisian Arabic (TA), and English as produced by Tunisian speakers (L2 English). Results show that while both formant values are affected by lexical stress in SBE, only gradient F1 lowering can be used to predict lexical stress in TA. L2 speakers seem to have transferred this latter fact from their mother tongue as in their productions of English vowels, only F1 was affected by stress. Vowel reduction due to stress in TA and SBE was dissimilar, which affected L2 speakers productions. Vowel quality had no significant role in cuing accent in any of the languages explored.

## 1. Introduction

Prominence cannot be a matter of vocal effort alone. It is also a matter of prosodic and articulatory distinctness. The latter is evidenced in the fact that stressed vowels show more extreme formant frequencies than the same vowels in unstressed or unfocused positions, but languages and also dialects of the same language differ in the degree to which variation in stress or accent influences the articulatory distinctness of vowels. In fact, stressed or accented vowels have often been equated with clear or spectrally expanded vowels featuring articulatory effort and precision, that is, vowels lacking the spectral reduction that characterizes unaccented vowels.

## 2. Vowel quality as a cue to stress and accent in various languages

Harris [1] distinguished between two types of vowel reduction. The first one is called 'centripetal', where reduced reflexes are drawn into a central region. In English, for example, unstressed vowels are often reduced vowels which approach the schwa [ə] quality. The second one is called 'centrifugal' and vowels in this type of reduction are dispersed in the far corners of the space. The spectral profiles of centralized vowels and the 'corner' or point vowels can be viewed as less complex than those of the mid peripheral vowels. Centripetal and centrifugal reductions, according to [1], have the shared effect of diminishing the amount of phonetic information in the speech signal.

Vowel quality is often reported to be a cue to stress in many languages of the world. However, most of this research suffers from confounding stress with accent, which makes it difficult to know whether the results reported are those of lexical stress or accent. [2] found in their study of the acoustic correlates of linguistic stress and accent in Dutch and American English, that stressed vowels are characterized by a fuller vowel quality than unstressed vowels. Furthermore, focused constituents (marked by pitch accent) have a fuller vowel quality compared with

unfocused constituents. In Italian also, [3] and [4] showed a strict connection existing between word stress and vowel reduction; unstressed and word-final vowels showed a high degree of reduction if compared to stressed ones, especially (but not uniquely) in spontaneous speech. Their results, however, contradict with [6] who argued that Italian should be classified among the languages that are minimally affected by the reduction process.

Previous research on the role of vowel quality in cuing stress and accent in different languages of the world, thus, shows that vowel quality is a patchy cue not only cross-linguistically but also within the same language. Tunisian Arabic (TA), just like Modern standard Arabic and most other dialects of Arabic is known to be a language with phonemic length contrast, where changes in segment duration can affect the meaning of the word. An investigation of the acoustic correlates of stress and accent in TA [7] has revealed a lack of durational involvement of this language in lexical stress. No significant durational differences were found between stressed and unstressed constituents. Despite this latter fact, Tunisian learners of English produced significant durational contrast due to lexical stress. In addition, duration in TA was used to distinguish between accented and unaccented constituents.

The present paper reports results on the role of vowel quality in cuing stress and accent in Southern British English (SBE), Tunisian Arabic (TA), and English as produced by Tunisian speakers (L2 English, hereafter). It also tries to assess, qualitatively, the impact of the differences or the similarities to be found on the learning of English prosodic features by Tunisian speakers.

## 3. Method

### 3.1. Test material

Three experiments were designed to measure the acoustic correlates of stress and accent (including vowel quality) in SBE, TA, and L2 English. Minimal pairs of the kind "permit"/"pɛr'mit", were used as test words for SBE and L2 English. For each language, an experiment was designed to elicit from the speakers the desired pitch contours. Special sentences that guide the pitch accent to the target word [+focus condition] and others that place it elsewhere [-focus condition] were constructed to measure the acoustic correlates of stress and accent, independently. The vowels measured are all monophthong vowels existing in 12 disyllabic minimal pairs test words and they included /ɒ/ in pairs such as "cɒn'trækt"/"cɒn'trækt", /ɛ/ in "rɛ'kɔrd"/"rɛ'kɔrd", /ɜ/ in "pɛr'mit"/"pɛr'mit", and /ʌ/ in "sʌb'dʒɛkt"/"sʌb'dʒɛkt". For TA, near minimal pairs were used in the same focus and stress conditions. They included /ɑ/ in word pairs like 'fakkɑr/fak'kart, /ɛ/ in 'bɛddɛl/bɛd'dɛlt/, /ɪ/ in

'kɪsbɪt/kɪs'buh/ and /ʊ/ in /'mʊɹʒɪr/mʊɹʒɪ'tar

The frame sentences in which the target words were placed were the same and were designed, first to naturally elicit from the speakers the desired prosodic contour, and second to aid in segmentation.

Examples from SBE:

\*[+Focus] condition (lexical stress+ phrasal stress (pitch accent) on the target word 'permit')

Say **LICENCE** again

Say **PERMIT** again

\*[-Focus] condition (lexical stress only, the phrasal stress (pitch accent) is placed on word in bold)

A permit is another word for licence

**WRITE** permit again

**SAY** permit again.

Examples from TA:

\*[+Focus] condition (lexical Stress+ Phrasal Stress (pitch accent) on the target word 'fakkār')

/ qul ɣammam martin/ "say **consider** twice"

/ qul fakkār martin / "say **think** twice"

\*[-Focus] condition (lexical stress only, the phrasal stress (pitch accent) is placed on word in bold)

/fakkār kilma sehle / "Think is an easy word"

/ **qul** fakkār martin / "**Say** think twice"

/ **ɣawid** fakkār martin / "**Repeat** think twice"

The terms [+Focus], [-Focus] and their abbreviations [+F] and [-F] are used throughout the present paper to indicate the focus condition.

### 3.2 Subjects and recordings

The subjects for the English experiment were five male speakers of SBE with no known hearing or speaking disorders. They were between the age of 26 and 55, and were all either studying or working at the University of Edinburgh at the time of the recording. The recordings took place in one of the recording studios in the department of theoretical and applied linguistics (TAAL) in Edinburgh, UK. They were made in a soundproof room using an AKG hypercardioid microphone.

For Tunisian Arabic, the informants were three male and three female Tunisian students of English. Care was taken in the choice of these subjects so that they were all perfect native speakers of Tunisian Arabic, thus, no one had a parent who was

not Tunisian. This meant to avoid the risk that another dialect of Arabic or another language influences the subjects' speech. They had been learning English, in Tunisia, for at least seven years. These same subjects produced the English test words used to assess the use of vowel quality as a cue to stress and/or accent in L2 English.

The recordings took place in a soundproof room using a professional microphone. They were recorded directly onto a computer at a frequency response of 44.1 kHz, then down sampled to 16 kHz mono. The subjects read the cards presented to them three times for each block of cards.

### 3.3. Data analysis

Twelve sentences for each focus and stress condition were used to measure the monophthong vowels /ɒ, ɜ, ɛ, ʌ/ in the minimal pairs test words for both SBE and L2 English. For TA, ten sentences were used for each stress and focus conditions to measure the monophthong vowels /ɑ, ɛ, ɪ, ʊ/. The vowel formants were calculated from the nucleus at the most intense point through an automatic script (developed by [8]) that calculates F1 and F2 at the midpoint of a specific segment in a Text Grid file. The procedure is repeated for each occurrence of that segment in the Text Grid. F1 and F2 are calculated using 'To formant (burg)' and the tracker. Both of these algorithms set parameters as a function of speaker sex. Incorrect and unexpected formant values were checked by hand and corrected. The values obtained and the variations due to stress, focus, vowel type, sex, or to the interaction between these factors were assessed statistically through repeated measures ANOVA tests for each formant, separately

## 4. Results and interpretation

### 4.1. Results for SBE

The measurements obtained for SBE were checked for significance through a three-way ANOVA test that was performed for each formant separately with *vowel type*, *stress*, and *focus* as fixed effects, and with *repetition* and *speaker* as repeated measures. The results for F1 showed that the vowel type factor was non-significant. Focus was also found to have a non-significant effect on F1. On the contrary, the effect of stress on F1 was highly significant ( $F(1, 240) = 44.02; p < .005$ ). No two-way interaction was at all found between vowel and stress, vowel and focus, or between stress and focus. The three-way interaction between stress vowel and focus was also non-significant.

The first formant in these British English vowels seems, thus, to be affected by lexical stress only and that focus (i.e., accent) does not affect it. The five male speakers participating in this experiment lowered F1 of their vowels in the unstressed position. This suggests that they tend to open their mouths less when producing unstressed vowels than when producing stressed vowels as both reduction and less mouth opening are known to be responsible for changes in F1 when vowels are unstressed and/or unaccented. The results for F2 revealed that the vowel type effect was highly significant ( $F(3, 240) = 32.34; p < .001$ ). Focus had no significant effect on F2. Stress also had no significant effect on the second formant. The effect of the factor stress could, however, be seen in the significant interaction existing between vowel type and stress ( $F(3, 240) = 14.32; p < .001$ ), which indicates that the magnitude of the stress effect on F2 depends on the type of the vowel. The interaction between vowel

and focus was non-significant. The interaction between stress and focus was non-significant, too. In addition, the three-way interaction between stress vowel and focus was not significant.

The second formant in these British English vowels is, then, affected by vowel type and by the interaction between stress and vowel type, only. Since both F1 and F2 of these Southern British vowels are affected by lexical stress, vowel quality can, subsequently, be considered an acoustic correlate of lexical stress in this language. In fact, the spectral reduction of SBE vowels in unstressed positions seems to interact with their temporal reduction since these vowels shortened significantly in unstressed positions (as shown by the duration results obtained for these vowels and are reported in [7]). It is, actually, known in the phonetic literature that the shorter the vowel, the more centralized it becomes ([9] and [10]).

#### 4.2. Results for TA

For F1, a four-way analysis of variance was used with *sex*, *vowel type*, *stress*, and *focus* as fixed effects and with *repetition* and *speaker* as repeated measures. The results of this test revealed that *sex* had no main effect. *Vowel type*, *stress* and *focus* were all very significant with  $F(3, 288) = 28.70$ ;  $p < .005$  for *vowel type*,  $F(1, 288) = 63.58$ ;  $p < .05$  for the factor *stress*, and  $F(1, 288) = 139.01$ ;  $p < .005$  for the factor *focus*. No significant interaction was found between either, stress and sex, or between vowel and stress. A significant three-way interaction was, however, found between sex, stress, and vowel type.

For F2, a four-way ANOVA was used with *sex*, *vowel type*, *stress*, and *focus* as fixed effects, and with *repetition* and *speaker* as repeated measures. The results of this test showed that *sex* was highly significant ( $F(1, 288) = 75.45$ ;  $p < .05$ ), *vowel type* was very significant, too ( $F(3, 288) = 158.27$ ;  $p < .001$ ). *Stress* and *focus* were, however, non-significant. All types of interaction between the different fixed effects were found to be non-significant.

Stress and focus affect the first formant of TA vowels, but not their second formant. Although these vowels undergo some changes due to stress and focus, the degree of F2 change under stress and focus differs from vowel to vowel and from male to female speakers. Actually, these vowels have not changed their front-back positions. Extreme cases of reduction, where vowels lose their quality and become schwa like are scarcely observed in this experiment, especially in the [+Focus] condition, that is, when a pitch accent is realized on the vowel. The results of experiment 2 allow claiming that only gradient vowel height is a correlate of stress in TA.

The type of change occurring to unstressed vowels in TA seems to be rather similar to what Harris [1] referred to as 'centrifugal' reduction, as vowels in this type of reduction are dispersed in the far corners of the vocalic space. Figure 1 below shows the distribution of stressed and unstressed TA vowels in the vocalic space.

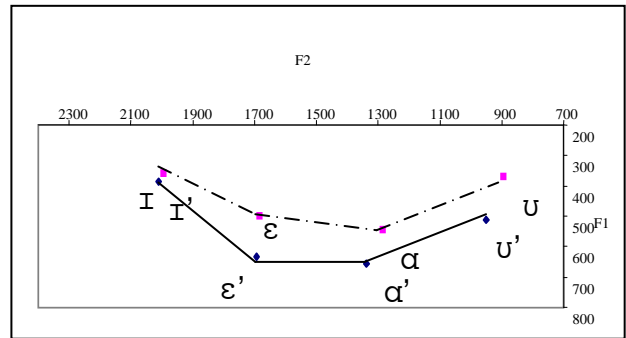


Figure1: Stressed and unstressed TA vowel by three male speakers. (') refers to the stressed vowel

This type of reduction is opposed to what Harris [1] called 'centripetal', where reduced reflexes are drawn into a central region in the vocalic space. The nature of vowel reduction observed in TA, in this experiment, may also be caused by the nature of the speech used; controlled speech, that is of course, different from spontaneous speech.

#### 4.3. Results for L2 English

A four-way ANOVA was used for the first formant of L2 vowels. In this statistical test, *sex*, *vowel type*, *stress*, and *focus* were used as fixed effects, while *speaker* and *repetition* were used as repeated measures. The results showed that the effect of *sex* on F1 was non-significant. The effect of the *vowel type* was significant with  $F(3, 288) = 6.20$ ;  $p < .05$ ). The effect of *stress* was highly significant, too ( $F(1, 288) = 259.01$ ;  $p < .005$ ). *Focus*, on the contrary, was shown to have no significant effect on the first formant. Significant interactions were found between sex and vowel ( $F(3, 288) = 5.23$ ;  $p < .05$ ) and between vowel and stress ( $F(3, 288) = 4.81$ ;  $p = .049$ ), though this latter's *F* value tended towards non-significance as its *p* value (.049) was very close to the critical *p* value (.05). All other types of interaction were non-significant.

For F2, a four-way ANOVA with *sex*, *vowel type*, *stress*, and *focus* as fixed effects and with *speaker* and *repetition* as repeated measures was also used. The effect of *sex* was found to be non-significant. *Stress* and *focus*, too, had no significant main effects on the second formant. *Vowel type*, on the contrary, had a very significant effect on the conduct of the second formant ( $F(3, 288) = 39.67$ ;  $p < .001$ ). Significant interactions were, however, found between sex and vowel ( $F(3, 288) = 10.80$ ;  $p < .05$ ), and between sex and stress where the statistical *F* value of the ANOVA test was highly significant ( $F(1, 288) = 340.20$ ;  $p < .001$ ).

It seems, here, that the effects of both vowel type and stress on F2 are moderated by the sex of the speaker. All other types of interactions were non-significant. Figure 2 below provides an F1/F2 plot of stressed and unstressed L2 vowels produced by three female speakers.

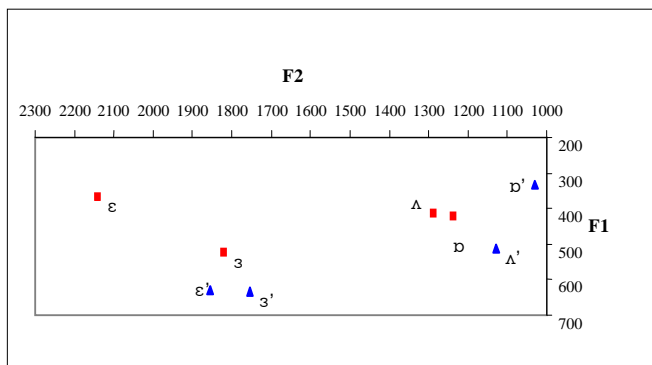


Figure 2: L2 vowel plot (F1/F2) for three female speakers in the [-F] condition. (') refers to the stressed vowel

The results, thus, show that stress affected vowel height only (reflected in F1) in L2 English, while no differences in backness (reflected in F2) have been observed. It can rather be asserted that Tunisian speakers do not make a native like reduction of English vowels in either unstressed or unfocused positions. The formants values of their unstressed vowels are not very close to those of schwa and do not approach the center of the vocalic space in a clear way. Here, a transfer from the mother tongue use of vowel quality can be noticed as in TA, only F1 was affected by stress and focus. This tendency not to make necessary vowel reduction is often observed in non-native careful speech and is known to be a good indicator of non-native accent. The use of vowel quality as a stress cue in L2 production seems to differ from their use of duration for the same purpose. Though SBE and TA show differences between both duration [7] and vowel quality as acoustic correlates of stress, transfer from the mother tongue happened only in the use of vowel quality, which may reveal the complexity of this cue for L2 learners, in particular.

## 5. Conclusion

The results generally show that the role of vowel quality in cuing stress and accent in SBE differs from TA. Different types of reduction were observed in the two languages, which influenced the production of this cue by Tunisian learners of English. This may explain the difficulties generally met by L2 learners (and often reported in the literature) in using this cue in their production of English and their inability to make native-like vowel reductions. Further research on other types of speech (rapid, spontaneous...) is, however, needed to get more insight into the role of vowel quality in accent and stress detection and its importance in the learning of English speech rhythm by non-native speakers.

## 6. References

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