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FORMANT ANALYSIS OF THE VOWELS OF THE MODERN STANDARD ARABIC IN ISOLATED CONTEXT

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ABSTRACT

This article discusses the formant analysis of Three Arabic vowels: / a i u / pronounced by 10 speakers in CV context. We are trying in this work to extract the acoustic characteristics of these vowels, especially their formants namely F1, F2 and F3. The results show a formant stability of these vowels, the formant mean occupy an acoustic space wider.

KEYWORDS – Formant Analysis, Coarticulation Effect, Vowel Triangle, Mean, F1-F2 Plane

1. INTRODUCTION

The achievements of the vowels are dynamic variables and depend on multitude of factors: the speaker, flow rate, the attitude of the speaker, his emotional state, etc. We are interested in the realization of the oral vowels in isolated context.

Such data in isolated context are not available on a large scale. “Calliope" [1] presents values for the data of vowels pronounced in the context /PV1/ where V1 is /e o u y Ø/ and /pV2ʀ/ where /i ɛ has ɔ œ/.

However, the presence of a /ʀ/ in Coda will tend to lengthen the vowel [2] and to increase the value of the F1 and a decline in the value of the F2 (F2 in most of the cases, but F2, F3 for the /i/) [3]. Gendrot & al.,and Adda-Decker present the formant values of vowels of a radio corpus, mixing as well the consonant contexts, prosodic in Word continues [4].

We have 10 men speakers speaking Modern Standard Arabic records, made from the same corpus, in similar conditions. For this study, we determine the formants of oral vowels of Modern Standard Arabic spoken in isolated CV context by 10 speakers. This work seeks to contribute to the establishment of formant values favoring both a significant number of speakers (10) and an exploitation of all oral vowels.

2. METHODOLOGY

We used CV context, where C is the consonant and V is the vowel. Initially, articulatory data were collected for ten Moroccan men. The corpus consists of 720 CV syllables, vowels used are / i a u /. The recording was done using a microphone (Labtec AM-232; Sensitivity: 35dB-, Impedance: 2.2 kOhm, bandwidth: 20 to 8500 Hz) at a distance of 20 cm in an isolated and quiet room via the "Praat" software. The sound is digitized directly on a PC with a sampling frequency of 22050 Hz. The CV syllables were segmented using the software "Praat".

10 men speakers are invited to pronounce 720 CV syllables, where C is the consonant and V is the vowel. The recording was made using a microphone (Labtec AM-232; sensitivity: -35dB, Impedance: 2.2 kOhm, bandwidth: 20-8500 Hz) at a distance of 20 cm in a secluded and quiet room via the "Praat" software. The sound is digitized directly on a PC with a sampling frequency of 22050 Hz because the maximum possible frequency is 11025 Hz beyond this frequency, the signal is extremely poorly sampled and the resulting sound is unusable. The quantization used is a linear 16-bit quantization to reduce the quantization error. The recording time is 2 seconds for each syllable.

3. PROCESSINGY

The isolated vowels are extracted, segmented and labeled manually with the “Praat” software. Each vowel was characterized by (1) the values of the formant mean over the entire length of the vowel, (2) the stability of the formants in the vowel. A global mean was extracted from the calculated means for all the vowels at the beginning, middle and end of the vowel. From these measurements, vowel triangles on axes F1-F2, F2-F3 are made.

4. RESULTS AND DISCUSSIONS

To study of vowels in isolated context, we need to check their formant stability by calculating a ratio of stability between the values of start and end of each vowel. The formula is ***(vowel end / vowel beginning) * 100***. A decrease formant is indicated by a percentage less than 100% while a rise formant is indicated by a higher percentage.

At the F1, we observe that the formants are unstable, not to exceed an average of 5.8% difference between the end and the beginning of the vowel with a standard deviation of 13.7%. /a/ (decrease) presents the most unstable F1, followed by / i / followed by / u / (increase). At the F2, the vowel / u / present on average a formant rise of 6.25% with a standard deviation of 11.3%. The other vowels have on average movements less than 3.25% between the end and the start of each vowel with a maximum standard deviation 13.7%. Les moyennes des mouvements sur le F3 et F4 ainsi que leurs écarts types sont moindres, ne dépassant jamais 1,83% de différence entre la fin et le début de la voyelle avec un écart-type de 6,21%. From these values, we can say the analyzed vowels are stable. These results are consistent with the approach "easy target" [5], where this vowel static indexes, which are sufficient for identification in perception.

Several researchers have studied the spectral values of oral vowels and acoustic data. Calliope found results based on a read speech corpus and whose consonant contexts affect the formant realization [1].

Gendrot and Adda-Decker defined a significant effect of coarticulation which vowels and consonants occupy different prosodic contexts [4]. Comparing our results with those found by Calliope & Gendrot and Adda, we noted that the average formant have extreme values. Table 1 provides a comparison of our results with those of Calliope and Gendrot and Adda [1] & [4].

We find that at F1, the open vowel / a / is performed with a higher F1 while the vowels / i u / have a lowest F1. These vowels are located in end positions and have spacing average vowels, according to their stroke phonological open or closed. At F2, the front vowels / i / have a higher F2 while back vowels / u a / are realized with a lower F2. The contrast between the line "prior" and "posterior" is acoustically enhanced. At F3, unrounded front vowels / i / have a significantly higher F3 than other databases, due to a shortening of the front cavity [3]. The F3 / i / is due to the anterior cavity, and consequently exchange cavities [6] & [3], the highest value of F3 is explained by a milder degree of labialization (district and / or protrusion) in continuous speech. The centralization of vowel triangle is a consequence of the phenomenon of "target-undershoot" the non-realization of expected targets [7]. Figures 1& 2 represent respectively Comparison of vowel triangles on the F1-F2 plane and Formant values on a plane F2-F3.

TABLE 1 - Mean values of F1, F2, F3 formants for each oral vowel (Calliope (French, Gendrot and Adda-Decker (French), OR: Our Results (Modern Standard Arabic))

Vowels / **Means**		**a**	**i**	**u**
Mean of F1 (Hz)	Calliope	788	306	311
	Gendrot & Adda	685	348	404
	OR	720	370	385
Mean of F2 (Hz)	Calliope	1503	2456	804
	Gendrot & Adda	1677	2365	1153
	OR	1710	2410	1000
Mean of F3 (Hz)	Calliope	2737	3389	2485
	Gendrot & Adda	2735	3130	2742
	OR	2800	3200	2570

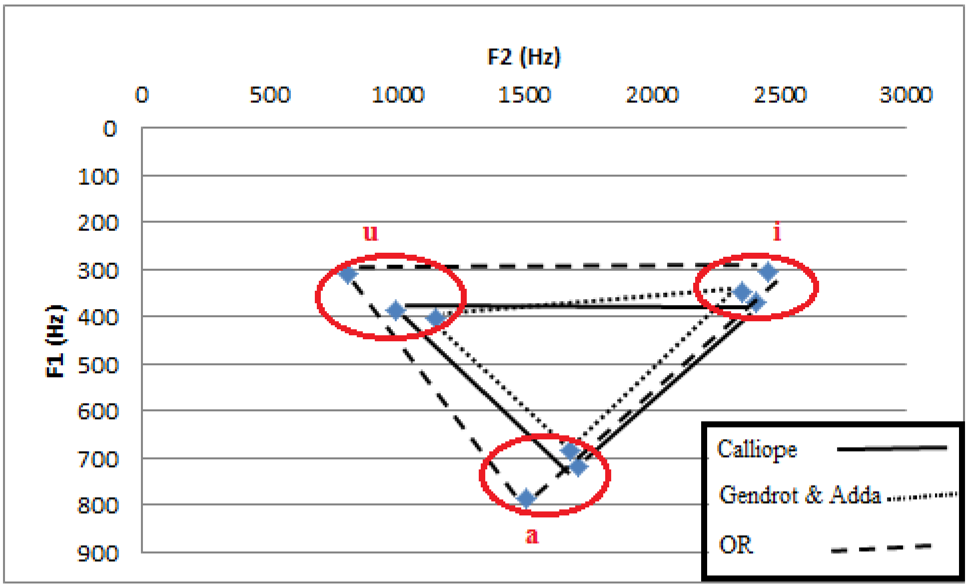

Figure 1: Comparison of vowel triangles on the F1-F2 plane

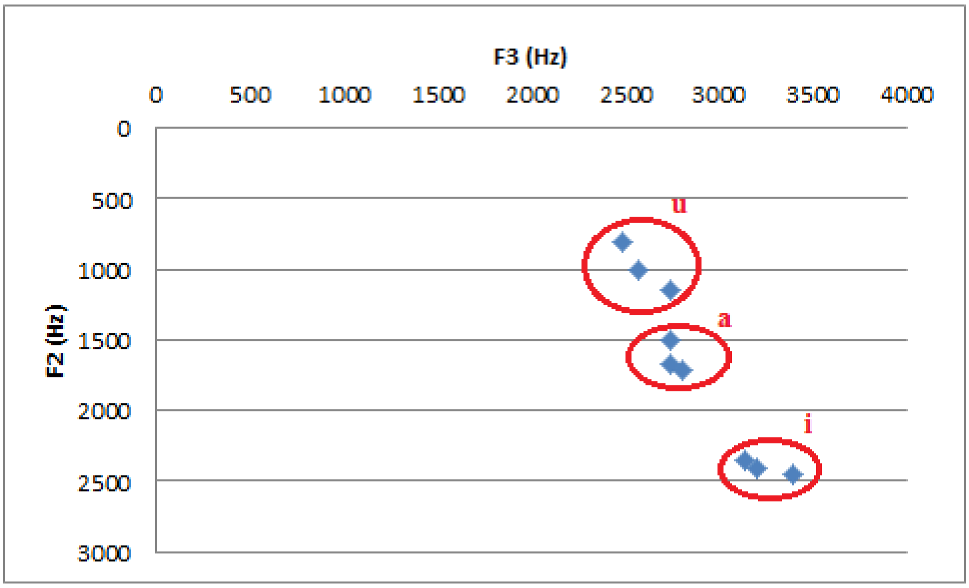

Figure 2: Formant values on a plane F2-F3

Concerning the /i/ vowel and because of the front cavity, these values have a lowering effect F3.

CONCLUSIONS

This study looked at the production of vowels of Modern Standard Arabic in isolated context. Having concluded that the relative stability of vowels, the average formant observed have shown higher than those of Gendrot-Adda [4] and Calliope [1] for most vowels (except

F1 closed vowels, the F2 the back vowels). These results show that the vowels occupy a larger acoustic space. The vowels / i u / are realized with a low F1, the vowels / a / with a high F1. Front vowels / i / F2 have a higher while back vowels / u a / are distinguished by a lower F2.

REFERENCES

1. TUBACH, J.-P., « La parole et son traitement automatique », Calliope. Masson, Paris, 1989.
2. LEON, P. R., « Phonétisme et prononciations du français » (4ème édition). Paris, Nathan¸2000.
3. VAISSIÈRE, J., « On the acoustic and perceptual characterization of reference vowels in a cross-language perspective ». In Proceedings of the 17th ICPhS, Hong Kong, pages 52-59, 2011.
4. GENDROT, C., ADDA-DECKER, M. & VAISSIÈRE, J., « Les voyelles /i/ et /y/ du français : focalisation et variations formantiques ». In Actes des JEP 2008, Avignon, pages 205-208, 2008.
5. MOUNIR, S., « Etude des effets de la coarticulation en langue Arabe: Anticipation et Persévération », Thesis, Physical and engineering sciences, Faculty of science and technology of settat, University Hassan 1st, Morocco, 2014.
6. FANT, G., 1960, « Acoustic Theory of Speech Production ». The Hague, Mouton.
7. LINDBLOM, B., 1963, « Spectrographic study of vowel reduction », Journal of the Acoustical Society of America 35, pp 1773-1781.