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Arabic Emphatics: The Evidence for Cultural Determinants of Phonetic Sex-Typing

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Abstract. Two studies compare men's and women's production of Arabic emphatics (pharyngealized consonants). The results of the first study with native speakers of Cairene Arabic indicate that women show significantly less acoustic differentiation between emphatic and nonemphatic segments. The results of the second study show that while Arab men and women differ significantly in their production of emphatics, American men and women who have been taught Arabic by male speakers are much more similar to each other in the pronunciation of emphatics.

Among Arabs, the magnitude difference in formant frequencies between men and women was found to be much greater than anatomically predicted by Fant and the direction of the sex-related formant differences was opposite to Fant's predictions. The results of these two experiments point toward nonphysiological bases of variation in vowel formants for men and women.

Differences between the way men and women speak have been noted, usually peripherally, by many linguists working with diverse languages. Primarily semantic and, less often, syntactic [Haas, 1944] differences have been studied. More recently, speech differences between men and women on the phonetic level have been investigated [Brend, 1971; Sachs *et al.*, 1971]. Fant [1966] in a straightforward comparison of male and female formant differences discovered that the variations are not related by a simple scale factor proportionate to the overall vowel tract length. Fant does state that his findings conform with anatomical constraints of the average female vocal tract. However, this study raises some questions about the possibility of modeling a sex-typed referent in vowel production. Fant [1966, p. 30] comments, 'These female/male departures from a uniform scaling are of some interest when attempting to normalize formant data ... They may not have a very crucial importance for the phonemic

identity of perceived vowels in connected speech but are undoubtedly of interest as speaker category determinants.'

SACHS *et al.* [1971], using the data of PETERSON and BARNEY [1952] as a reference, compared the formant differences between male and female children whose vocal anatomy had not matured to those whose vocal tracts had altered. This study, which was both acoustic and perceptual, found that preadolescent boys appeared to lower their formants without any corresponding anatomical cause. At the same time, the boys had greater fundamental frequency variation. Adult judges who were asked to decide whether a taped preadolescent voice was male or female were usually accurate except in the case of two girls who were consistently perceived as boys. These girls were subsequently identified in interviews with their neighbors as 'tomboys'. SACHS *et al.* [1971, p. 10] conclude that, '... the pattern of formants in male and female children may not be determined totally by their anatomical structure, and that these patterns are one of the cues that tell us whether a voice is male or female'.

In the two experiments which will be described here, I attempted to categorize the pronunciation of Arabic emphatics using acoustic parameters to compare differences based on sex and, to some extent, regional origin. Arabic *emphasis*, a technical term in Arabic phonetics (Arabic: *tafxim*) can be described as secondary pharyngeal articulation of certain consonants, usually stops and fricatives. Although classical or modern standard Arabic orthography represents only four emphatic consonants (t., d., s., and ð. or z.) which will be symbolized here by a following dot, in actual speech, in both standardized and colloquial Arabic, there is an enormous amount of variation.

Arabic emphatics (as well as the primarily pharyngeal consonants) have intrigued phoneticians as far back as the Middle Ages. LEHN [1963] cites some of the Arabic terms used by the medieval grammarians: *ʔitbaq* 'spreading and raising of the tongue', *ʔistiʕla* 'elevation of the dorsum' and *tafxim* 'thickness, heaviness'. Modern terms used to designate the articulatory nature of emphasis are: velarization, uvularization, pharyngealization, retraction, strong articulation, resonance and heaviness.

Acoustically, AL-ANI [1970] has characterized emphatics as '... not velar but rather pharyngeal'. This observation is based on numerous spectrographic measurements which revealed a marked lowering of the second formant and a slight raising of the first formant in vowels

following emphatic consonants. JAKOBSON *et al.* [1963] have characterized Arabic emphatics as flat, being acoustically manifested in 'a downward shift of all formants'. This definition does not differentiate pharyngealization from labialization.

DELATTRE [1971] establishes the covariation of the rise of the first formant with the fall of the second in pharyngealization. Thus, pharyngealization is not the same acoustically or perceptually [PADDOCK, 1970] as labialization. Not only the place of primary constriction but the place of secondary constriction in the vowel tract and the degree of closure at all or any constrictions affect the formant frequencies. Faucalization is also often described as one of the physiological bases of emphasis; it would be interesting to know what specific acoustic or perceptual results correlate with this articulatory feature. Glottal closure has also been cited as a concomitant articulatory process in emphasis (alluding perhaps to the historic relationship between Arabic pharyngeals and Ethiopic glottalics). However, as I have tried to illustrate in this paragraph, precise phonetic characterization of emphasis that would tie together this phenomenon on articulatory, acoustic and perceptual levels is lacking.

The phonological categorization of emphasis is also problematic. According to LEHN [1963, pp. 38–39], emphasis is not merely the secondary articulation of a single consonant phoneme, but a 'phonologic component with the syllable as its structural domain'. The implication is that emphasis, as a sort of suprasegmental phoneme, affects the following syllable and may even cross syllable boundaries and affect the entire word. Most Arabists agree that while Arabic orthography recognizes and symbolizes four pharyngealized consonants (d., t., s., ð.) the vowel following a pharyngealized consonant provides the crucial clue. EDWARD STEVENSON and CHARLES FERGUSON, in separate unpublished studies, cut taped productions of emphatic and nonemphatic CV syllables and spliced together nonpharyngealized sonsonants and pharyngealized vowels. Their results indicated that native speakers perceive the nonpharyngealized consonant-pharyngealized vowel sequence as emphatic but not vice versa. Thus, the perceptual domain of emphasis is at least CV, not just C.

Phonetic variation of emphasis has been attested on a stylistic as well as phonological level. According to HARRELL [1957], 'The evidence for the gradient nature of emphasis is not merely phonetic. There is strong cultural and behavioral evidence.' This variation is

reflected in the way men and women use emphatics. According to HARRELL, 'The general attitude seems to be that if one's normal pronunciation of a morpheme is emphatic, the nonemphatic seems affected and effeminate. If one's usual pronunciation is nonemphatic, the emphatic form may seem variously overly formal, pompous, or crude and hick-like.' FERGUSON [personal commun.] has noted that Damascan men assimilate emphasis throughout a word whereas Damascan women not only do not assimilate emphasis, they also substitute [k] for [q].

First Study

I taped four informants, all natives of Cairo, Egypt, and all students at the University of Michigan. Two men and two women read from a list of minimal pairs of one and two syllable words randomly arranged. At the end they read a connected paragraph covering the same materials to check their 'list pronunciation'. The words were all taken from the colloquial dialect. I asked each informant for an opinion regarding the difference in men and women's pronunciation of Arabic. I ran sonographs of the pairs ti:n/t.i:n ('figs'/'mud') and se:f/s.e:f ('sword'/'summer') for each speaker as well as some other words for individual speakers. I then measured the first and second formants at a fixed time of 80 msec from the release of the consonant.

The formant values which were obtained are presented in table I and agree with AL-ANI [1970]. The first formant rises across the board

Table I. Formant values for vowels following emphatic and nonemphatic consonants as pronounced by Egyptian speakers (experiment 1)

Speaker	Formant	Vowels			
		i	i.	e	e.
W_1	F_1	300	400	500	500
	F_2	3,000	2,300	2,300	2,000
W_2	F_1	450	500	550	600
	F_2	2,550	2,450	2,200	1,700
M_1	F_1	250	250	500	600
	F_2	2,250	1,500	2,200	1,500
M_2	F_1	250	300	550	500
	F_2	2,500	1,700	2,200	1,700

except in one case, and the second formant is lowered without exception in the vowel following a pharyngealized consonant. In order to directly compare these figures to FANT's [1966] formant values, the emphatic vowel was compared to a Swedish vowel whose formant values most resemble it, and the nonemphatic formant values were compared to another similar Swedish vowel. The comparison should indicate whether the difference between men and women's articulation of emphasis is anatomically predictable or not.

The differences between the emphatic vowels of men and women as reflected by F_1 and F_2 values are significantly higher than FANT's [1966] k sex factor values[1] for correspondingly placed Swedish vowels. Furthermore, the fact that 'k is significantly lower in back vowels than front vowels'[2] indicates a completely opposite trend in the pharyngealized versus nonpharyngealized vowel articulations in men and women than in the backed vowel differences caused by male-female anatomical differences. In other words, the difference is far greater than would be predicted from anatomy and in an opposite direction. F_2 values are proportionately much more lowered for men in emphatic vowels as opposed to nonemphatic vowels than they are in the opposition of women's emphatic to nonemphatic vowels. Thus k_2 for this experiment is significantly *higher* in back (or pharyngealized) vowels than for other vowels.

The results of this experiment seemed to validate HARRELL's [1957] observations. Less pharyngealization sounded more 'feminine' to the Cairenes. The native speakers, for the most part, tendered this observation when asked to cite *any* differences in the way men and women speak. However, the sampling was small and without controls. Therefore, I ran a second study with a larger group of informants.

Second Study

I taped a total of 21 informants on an Ampex 351-2 in an extremely sound-proofed room. Each informant was instructed to read a list of 20 randomly arranged minimal pairs taken from MCCARUS and

[1] F_1 sex factor: k_1 $\left[k_n = \left(\frac{F_n, \text{female}}{F_n, \text{male}} - 1\right) \times 100\%\right]$.

$k_1 = 30\%$ /a/ and /c/; $k_1 = 5\%$ rounded half-open back vowels.

[2] k_2 is significantly lower in back vowels than in front vowels. k average of entire Swedish vowel system $F_1 = 11.5\%$, $F_2 = 16.5\%$, and $F_3 = 17.5\%$.

RAMMUNY [1964] for emphatic versus nonemphatic consonants and two sentences. The majority of the speakers were college-educated. They fell into four categories of approximately equal number: (1) male native Arabic speakers; (2) female native Arabic speakers; (3) American male second-year Arabic students, and (4) American female second-year Arabic students. The last two categories consisted of students who had been primarily exposed to native Arab *male* teachers and who consequently could be expected to model their pronunciation after a male speaker.

The numbers of native Arabic speakers (all different from experiment I) representing different dialect regions are as follows: Egyptian (1); Palestinian (2); Lebanese (1), and Kuwaiti and Saudi Arabian (6). However, since most of the speakers were educated in modern standard Arabic, the pronunciation differences were somewhat neutralized. Most of the Americans in the study spoke Midwestern English.

At the beginning of each taping session, each speaker was told that this was a general experiment on Arabic phonetics and that he or she was to read the words just as they were written (in modern standard orthography). At the end of the taping I asked each speaker for his or her opinion on *any* (I did not specify which) differences they may have noted between Arab men and women's speech. Lexical differences were most often cited.

I ran broad band sonograms of the pair sa:r/s.a:r and then did sections of the two sibilants for each speaker. I also ran broad band sonograms of the pair dal/d.al. For each broad band sonogram, I measured the frequency in Hz of the first and second formant. For the sections, I measured the lowest frequency at which the section began and the frequency at which there was maximum amplitude. The first and second formants in the broad band spectrograms were measured again at a fixed time of 80 msec from the release of the consonant in order to standardize the amount of bending from the consonant.

Results from the Second Study

Formant values for the pharyngealized and nonpharyngealized vowels are presented in table II. Differences in formant values were calculated only within speakers. Presumably there are fairly determinate loci for formant values of emphatic and nonemphatic vowels in Arabic. However, due to the relatively small sample and large variations within the sample, it seemed advisable to consider the

Table II. First and second formant values (Hz for s/s. and d/d. (before /a/) and emphasis factor (E) = $(F_2 - F_2e) + (F_1e - F_1)$ (where e = + emphatic)

	s		s.	d		d.
Male Arabs						
1	700		800	700		700
	1,500		1,200	1,300		1,300
		400			0	
2	800		800	800		800
	1,600		1,300	1,800		1,800
		300			0	
3	800		1,000	750		700
	1,400		1,400	1,800		1,800
		200			650	
4	800		800	700		800
	1,600		1,400	1,700		1,300
		200			500	
5	800		900	700		700
	1,700		1,400	1,800		1,400
		400			400	
Average		300			310	
Female Arabs						
1	1,000		1,100	1,000		1,000
	2,000		1,600	2,100		1,800
		500			300	
2	800		1,000	1,000		900
	1,900		1,500	2,000		1,500
		600			400	
3	600		800	800		1,000
	1,600		1,600	2,000		1,600
		200			600	
4	800		800	900		850
	1,600		1,400	2,000		1,600
		200			350	
5	800		1,100	900		900
	2,500		1,600	2,300		1,600
		1,200			700	
Average		540			470	
American males						
1	700		800	800		900
	1,700		1,300	1,400		1,500
		500			0	
2	700		800	700		800
	1,500		1,300	1,900		1,200
		300			800	

Table II (continued)

	s		s.	d		d.
3	800		700	800		700
	1,200		1,100	1,500		1,100
		0			300	
4	900		950	700		800
	1,600		1,300	1,800		1,300
		350			600	
5	800		1,000	800		800
	1,200		1,200	1,600		1,300
		200			300	
6	800		800	700		700
	1,600		1,100	1,800		1,200
Average		370			433	
American females						
1	1,000		800	900		1,000
	1,800		1,700	1,600		1,500
		−100			200	
2	700		700	800		800
	1,400		1,300	2,000		1,300
		100			700	
3	800		900	800		900
	1,500		1,400	1,800		1,400
		200			500	
4	700		900	800		800
	1,500		1,300	1,800		1,400
		400			400	
5	1,000		900	800		800
	1,600		1,350	1,900		1,400
		150			500	
Average		150			460	

Figures are given for each speaker for F_1, F_2, and E in that order; then an average E is given for each speaker category.

acoustic values as measured by the E factor *within* an individual speaker's repertoire. Presumably the *degree* and direction of that individual contrast can then be averaged and compared across speakers. (Since, as has already been stated, emphasis is an extremely

variable phenomenon, it seems advisable to measure it as existing as the contrast +emphatic/-emphatic for an individual speaker rather than as an absolute phonetic entity.) Comparisons within a speaker's repertoire were made using the formula for the emphasis factor given in the preceding table. The 'difference values' in the formula [(F_1e-F_1) and (F_2-F_2e)], which are not necessarily causally related in the articulation, are added (not as absolute values) to give a total acoustic difference for each speaker.

Surprisingly, Arab women in this study show significantly ($p < 0.05$)[3] more total acoustic difference in cues for emphasis than do Arab men. This acoustic difference is in completely the opposite direction of the difference expected from anatomical difference. The difference, or the E factor between American male and female speakers is less than half the E factor difference between the sexes for Arabs. Another interesting result is that the overall formant values for Arab women are higher than for American women. Since American and Arab males show very similar formant values, it would seem to rule out a sex-independent anthropometric difference between Arab and American vocal anatomy.

The results of the frequency sections were extremely inconsistent verifying OBRECHT [1968]. JAKOBSON [1957, p. 107] states that the 'flat phoneme ... /s./ displays a noticeably lower pitch than the English /s/' and that the Arabic plain /s/ is 'of higher pitch than most allophones of English /s/'. My results from the sibilant sections are at variance with JAKOBSON's claim. For many of the speakers in this study, the emphatic /s./ showed a concentration of energy at higher frequency levels than the unemphatic /s/. This could be due to differences in the apical articulation which may tend to cancel out the second formant lowering expected from the pharyngealized tongue body position.

Discussion of Second Study

The acoustic data from the second study reiterates the findings of AL-ANI [1970] and the results of the first study. Even the nonnative speakers show the characteristic lowering of the second formant and raising of the first to indicate +emphatic. The evidence that Arab women differentiate their emphatics from their nonemphatics more dramatically and that they have higher overall formants points to a cultural as opposed to an anatomical variance. Their speech appears

[3] Statistics with courtesy of J. BERNSTEIN and S. HERMAN.

more stylized as well as more conservative than Arab men (in classical Arabic these emphatic distinctions are made more clearly than in some of the dialects). Informal data from Middle Eastern ethnologists tends to substantiate these findings. A similar phenomena has been noted for Japanese where female speakers allegedly speak in higher pitched voices. Female English speakers modeling themselves on Japanese women have noticed that they automatically raise their pitch when switching from English to Japanese.

Conclusion

The first study of Cairenes indicates that women have less acoustic cues for emphasis and the second study indicates that they have significantly greater cues than Arab men. The difference in results may be due to improved methodology or perhaps to the effect of dialect variation. The second study used only one Egyptian (a woman who had lived in both Cairo and Alexandria). Since HARRELL's [1957] remarks on the stylistic use of emphasis were limited to colloquial Egyptian, perhaps that dialect is quite different with respect to emphasis.

The informants (subjects) of the second study were preponderantly Saudi Arabians. With their more conservative language (closer to classical Arabic) and their more conservative attitude toward women, it is perhaps logical that the women should be more linguistically conservative. JESPERSEN [1922] cites numerous instances of the conservatism of women's speech in a number of languages.

In attempting to relate a number of rather diverse areas, we look at various levels of investigation of Arabic emphasis and find that the data from these two studies is basically acoustic and along the lines of AL-ANI [1970] and OBRECHT [1968]. AL-ANI [1970] uses ten informants (nine men and one women) from two dialect areas and OBRECHT [1968] uses fewer informants still. Neither author describes any dialect or other deviation in the production of emphatics. Presumably everyone approaches the unidentified 'norm'. My study questions the validity of approaching emphasis or any other phonetic effect as a standard phenomena. The results presented here indicate a wide range of formant differences in the production of emphatics that are correlated to the variables of sex and dialect. Unfortunately I was unable to

discover any previous studies which adequately describe the pronunciation of emphasis in the various dialects. Due to my small and somewhat geographically skewed sample, I chose not to completely analyze the results. Statistically, however, there is a substantial difference between the Egyptian and other dialects.

In the search for an adequate acoustic defining feature of emphasis, this study reiterates the conclusion from AL-ANI [1970] and OBRECHT [1968]. The second formant is lowered and the first formant is slightly raised in the vowel following the emphatic consonant. This seems to partly correspond to the acoustic definition of flattening of JAKOBSON *et al.* [1957], but it does not correspond exactly to any feature in their system. Furthermore, the results of the frequency sections for the sibilants indicate a complete reversal of what JAKOBSON *et al.*, had predicted for /s/ and /s./.

Inferences can be drawn from the acoustic data to suggest areas for further articulatory and perceptual study. For instance: native and nonnative speakers produced amazingly similar acoustic results; are they similar articulatorily? Would native Arabic speakers be able to identify artificially generated emphatic syllables as 'male' or 'female' on the basis of the formant differences alone? Does the production of emphasis vary according to semantic content or emotional coloring by the speaker, or is it purely phonological?

In the area of social variability, it would be interesting to see if other basic linguistic phenomena are differentiated along sex lines. The overall higher formant levels of the Arab women suggest that this is so. What data can be accumulated from the languages of the world to ascertain whether the sexes tend to exaggerate the already existing anatomical differences? What cultural variables can corroborate these differences in linguistics?

Studies of vowel systems of language other than Swedish and American English may point toward a continuum of nonphysiological variation depending on cultural sex-typing. Is FANT's [1966] k_n nonuniform scaling factor too limited in perspective? Perhaps nonanatomical sex-typed variation is a universal feature of language. Even if the variation is not phonemic, it does involve phonemic overlapping. In any case, its effect on communication (and thus language) in society cannot be ignored. Speaking like a member of the opposite sex or like a member of one's own sex can adversely label or limit the lives of all speakers.

Zusammenfassung

Arabische emphatische Laute: Der Nachweis, dass kulturelle Elemente die phonetischen Unterschiede der Geschlechter bestimmen

Zwei Studien vergleichen die Produktion von arabischen emphatischen (pharyngalisierten) Konsonanten bei Männern und Frauen. Die Resultate der ersten Studie zeigen, daß sich emphatische und nicht emphatische Segmente bei Frauen akustisch bedeutend weniger unterscheiden. Die Resultate der zweiten Studie zeigen, daß, während arabische Männer und Frauen sich in der Produktion von emphatischen Konsonanten deutlich unterscheiden, amerikanische Männer und Frauen, die Arabisch von Sprechern männlichen Geschlechtes gelernt haben, einander in der Aussprache von emphatischen Konsonanten sehr viel ähnlicher sind.

Unter Arabern war das Ausmaß der Formantenfrequenzunterschiede zwischen Männern und Frauen viel größer als die auf Grund der anatomisch fundierten Voraussagen von Fant zu erwartenden, und die Richtung der geschlechtsbedingten Formantenunterschiede war Fants Voraussagen entgegengesetzt. Die Resultate dieser zwei Experimente weisen auf nicht-physiologische Grundlagen für die Variationen der Vokalformanten bei Männern und Frauen hin.

Résumé

Les emphatiques arabes: preuve du rôle joué par les éléments culturels dans la détermination des différences phonétiques entre les deux sexes

Deux études comparent la production des emphatiques arabiques (consonnes pharyngalisées) chez les hommes et chez les femmes. Les résultats de la première étude faite à partie de locuteurs du Caire indiquent de façon significative que la différenciation acoustique entre segments emphatiques et non emphatiques est moins marquée chez les femmes, alors que hommes et femmes arabes diffèrent sensiblement dans la prononciation des emphatiques. Les résultats de la seconde étude indiquent que des locuteurs américains des deux sexes ayant appris l'arabe avec des locuteurs hommes ont une prononciation des emphatiques bien plus homogènes entre elles.

Parmi les arabes, l'amplitude des différences de valeurs entre les fréquences de formants entre hommes et femmes s'est révélée beaucoup plus grande que l'amplitude prédite (sur des bases anatomiques) par Fant et la direction des différences entre les valeurs de formants en relation avec le sexe du locuteur est contraire à celle que Fant prédit. Les résultats de ces deux expériences vont dans le sens de données nonphysiologiques pour expliquer les variations des valeurs de formants des voyelles entre hommes et femmes.

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