F_1 Locus and Place of Articulation

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1. Introduction

The aim of this research is to verify if the F_1 locus has a distinctive function in relation to the place of articulation of the consonant. The locus theory, formulated in the fifties by Cooper, Delattre, Liberman, Borst and Gerstman (1952) and Delattre, Liberman and Cooper (1955) on the basis of research with synthetic speech restricted to the labial, dental and velar stops, was formulated in order to account for the fact that in a CV context all the transitions of the second formants of the vowels tend to one point on the frequency scale as a function of the place of articulation of the consonant. The F_1 transition, on the contrary, is connected with the manner of articulation of the consonant, because it always shows the same rising trend for all the CV contexts depending on its voiced character. The onset of this transition is fixed at about 240 Hz but in order to get the best degree of perceptibility of the three consonants under consideration, this value can be lowered on the frequency scale. We must notice that notwithstanding the restriction to the labial, dental and velar places of articulation, Delattre (1955:773) and Stevens and House (1956:584) tend to generalize, the former affirming that the locus of the first formant is at 240 Hz 'for all the voiced stops', the latter fixing F_1 locus at zero Hz 'for all stop consonants'.

According to the acoustic theory developed by Chiba and Kajiyama (1958) and Fant (1960) these statements are explained by the fact that these places of articulation occur in proximity to an anti-node of velocity, all of them taking place in the oral cavity. In particular Fant (1960:210) finds that F_1 decreases if the oral constriction is narrowed, in accordance with the statements of the above mentioned works, but on the other hand, that F_1 increases if the constriction located in the posterior half of the vocal tract is narrowed.

From the mid-sixties a series of studies tend to criticize Delattre's observations about F_2 transitions, because in these studies no unique locus for every consonantal class is found. In particular Öhman (1966:167) underlines that 'the terminal frequencies of the formants in VCV utterances depend not only on the consonants but on the entire vowel context', so he concludes that 'the stop-consonant loci are, therfore, not unique'. In our opinion this conclusion is not justified because the apparent plurality of loci, found by spectrographic analysis of eal speech, is only the effect of the plurality of places of

articulation within the same consonantal class. However, the distinctive function of F_1 transitions, as cues of manner of articulation has never been questioned. These experimental studies have been confined to the functional role that the oral articulations play inside the systems of western languages. However, a language system having a large variety of pharyngeal and glottal articulations, as for instance Arabic, allows the verification of the importance of F_1 transitions for the identification of the place of articulation of the consonant.

2. Analysis

The spectrographic and radiographic data gathered in our previous study Giannini and Pettorino (1982) on Iraqi Arabic showed that the shifting of place of articulation from the velarized dental /l̪/ to the pharyngealized dentals /t̪ḍs̪ẓ/ is reflected by the raising of F_1 locus from 250 Hz to 600 Hz, whereas F_2 locus remains in both cases at 1000 Hz. Furthermore, the difference between the uvular fricatives /ḫġ/ and the pharyngeal fricatives /hʿ/ correlates with the raising of the F_1 locus from 500 Hz to 1000 Hz, whereas F_2 locus remains at 1400 Hz in both cases.

The spectrographic analysis shows that the articulation of /ʿ/ is realized as a voiced pharyngeal fricative only in an intervocalic context and as a voiceless stop in other phonological contexts. This is also noticed by Al Ani (1970) but, even though he associates /ʿ/ with the glottal stop /ʾ/ (1970: 59), he purposely avoids to define the place of articulation of /ʿ/ (1970: 62). If we compare the spectrograms of /ʿ/ with those of the glottal stop, we can notice that they are articulated differently because even though both of them are voiceless stops, they show a very different trend in the formant transitions. In fact, the formants of a vowel next to a glottal stop, that is a vowel with an abrupt ending or beginning, have neither positive nor negative deviation from the target value of the vowel. As regards /ʿ/, however, both F_1 and F_2 show noticeable deviations, whose points of convergence have been spectrographically located at about 1100 Hz and 1500 Hz, respectively (Fig. 1). F_1 locus at about 1100 Hz is related to a constriction occurring in the proximity

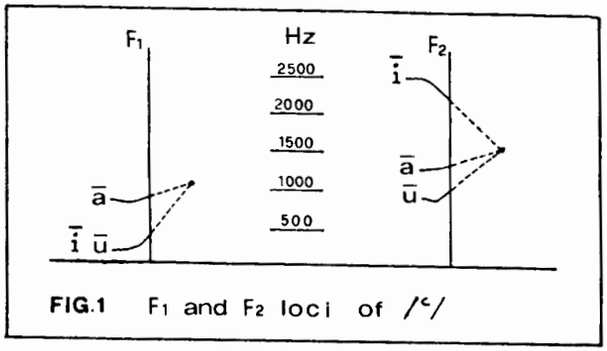

FIG.1 F1 and F2 loci of /ʿ/

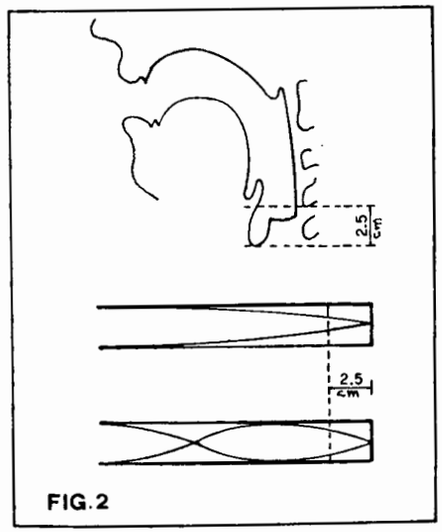

FIG.2

of the node of velocity that is at the glottal level; F_2 locus at about 1500 Hz is related to a constriction occurring at a point intermediate between a node and an anti-node of velocity. As shown in Fig. 2 these acoustic data, from an articulatory point of view, correspond to a constriction occurring at 2.5 cm above the glottis. The closure must be effected, therefore, by the epiglottis which, lowering on the arytenoid cartilages, closes the laryngeal opening; it is, in other words, a laryngeal stop. The acoustical and radiographic data of this study confirm the hypothesis formulated by Laufer and Condax (1979) who, from a fibroscopic analysis, assert that /ʿ/ is not characterized by the retraction of the root of the tongue towards the posterior wall of the pharynx but by the action of the epiglottis acting as an articulator.

3. Conclusions

In conclusion, our data show that there is a fixed relation between F_1 locus and place of articulation but that is is arbitrary to give to this acoustical cue a specific distinctive function, as this function varies in relation to the pair under consideration. However, the case of /ʿ/ shows that if we limit our attention to a single articulation, avoiding any reference to pairs constituted a priori, both F_1 and F_2 loci come out to be indispensable elements for the identification of the place of articulation of the consonant.

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