EFFECTS OF THE SECOND FORMANT ON THE PERCEPTION OF VELARIZATION CONSONANTS IN ARABIC

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by

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PREFACE

This investigation is an attempt to assess the role of the second formant transitions in cueing discrimination of velarized and non-velarized consonant pairs in spoken Lebanese Arabic. The velarized members are commonly called the emphatic consonants, though they do not include all of the consonants sometimes called emphatic.

The project was sparked by an article published in *Language* 32:3, 446-452, by Charles A. Ferguson, "The emphatic *l* in Arabic", and by questions raised but necessarily left unanswered at the 1956 Summer Institute of Linguistics at the University of Michigan. Further questions were raised by Jakobson, Fant and Halle,[1] and in a number of articles from the Haskins Laboratories.

The course of the study involved work with informants in Easton, Pennsylvania and in Rochester, New York, synthesis at the Haskins Laboratores, New York, and further testing in the field, in Beirut and Cairo. Final tests were constructed in the Phonetics Laboratory, Department of Languages and Linguistics, University of Rochester.

Later stages of the project involved the testing of acoustical features other than the second formant, though the present report is basically limited to discussion of that feature. Results of the later work will appear. Thus, the present work is largely limited to discovering the behavior of the second formant in cueing the Arabic velarized/non-velarized distinction, and to specifying some perceptual boundaries as revealed by synthetic speech study of the results of second formant variations. In this connection it is worth mentioning that the use of synthesized speech in one form or another seems to be the only practical way of exploring in a tightly controlled and economical way the effect of a given formant. Analysis of spectrograms is difficult, time-consuming, and full of inherent deficiencies, and the location, selection and matching of real speech samples adequate to the task posed by the present set of problems is excessively formidable. The writer is fully aware of the defects of speech synthesizers, and of the difficulty of equating possible 'machine thresholds' with human ones, and of the questions concerning the applicability of machine-speech perception to real speech. In view of the fact that the present task would have been effectively impossible with real speech, the risks of using synthetic speech were gladly accepted. Further, it is by now quite clear that experimentation with synthetic speech

[1] R. Jakobson, G. Fant, M. Halle, *Preliminaries to Speech Analysis*, (= *Technical Report* No. 13), Second Printing (Cambridge, Mass., Massachusetts Institute of Technology, 1952), 50.

has been enormously revealing and suggestive, having made possible in a reasonable time results and types of investigations which would either have gone undone and undiscovered, or which would have been delayed by many years in the absence of synthesizers. No one suggests that a synthesizer is equivalent to a native speaker, nor that data developed in connection with synthetic speech tests are necessarily perfectly correlatable with the actual (whatever that may mean) internal language organization of a human speaker. Yet it is quite clear that linguistics and speech research would be much the poorer for the lack of the research based on synthetic speech or incorporating its results and considerations.

The present study apparently represents the first large-scale attempt to take laboratory-made synthetic speech perception tests into the field; that is, to introduce acoustic phonetics into linguistic field work, as well as one of the first sizeable efforts to perform this kind of testing in a non-Indo-European language. Results to be reported elsewhere also have a bearing on distinctive features theory and on dialectology.

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BACKGROUND AND DESIGN OF THE EXPERIMENTS

Various projects at the Haskins Laboratories and elsewhere have dealt with the perceptual attributes of different portions of the speech signal. These have concerned primarily the formant structure, including the frequency specification, the rate and direction of change, and the like. To the relatively rapid and characteristic changes lying at the presumed 'boundary' between consonant and vowel, the name TRANSITIONS has been given.[1] It has been shown that these vocalic portions carry a great deal of the information leading to listener identification of the adjacent consonant.[2] The earlier work of Potter, Kopp and Green[3] identified the characteristic behavior of the vowel formants in the vicinity of specified consonants, as part of the effort to enable persons to read speech directly from a spectrographic presentation. The work at the Haskins Laboratories and elsewhere has added a considereable degree of precise knowledge of this behavior and its effects, and the work has built up a fund of recognized available techniques. In general, then, the procedure to be followed in the present study was clear.

By its nature, this study involved a number of unusual problems and difficulties as well as unusual opportunities. For example, most such studies examine an extremely limited set of phonemic oppositions, covering a small range of phonetic categories, or a single category, while the nature of the emphatic/non-emphatic opposition required the present work to span the classes of stops, sibilants, nasals, laterals and flaps.

Although there is sometimes a modest physical separation between the laboratory involved in the preparation of such tests as these and the test subjects, perception experiments employing altered natural or completely synthetic speech are normally essentially a laboratory-based exercise, involving easy access to necessary equipment during the course of experimentation, so that progressive refinement of the tests is possible. The present study involved an apparently unique effort to take perception testing into the field, involving in this case a separation between testing ground and

[1] Alvin M. Liberman, Pierre C. Delattre, Franklin S. Cooper, and Louis J. Gerstman, "The role of consonant-vowel transitions in the perception of the stop and nasal consonants", *Psychological Monographs: General and Applied*, 68, 8.
[2] Liberman, Delattre and Cooper, "The role of selected stimulus-variables in the perception of the unvoiced stop consonants", *The American Journal of Psychology*, Vol. LXV (October, 1952), 497-516. And others.
[3] Potter, Kopp and Green *Visible Speech* (New York, D. Van Nostrand and Company, 1947).