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PHONOLOGICAL VARIATION

by

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The purpose of this note is to introduce a certain class of phonological studies into a SUR context. Until now, questions of dialect and style have been carefully avoided under the assumption that they are not important factors for the initial SUR systems. However, we feel that style and dialect are relevant. For example, the phonemics of a spontaneous style of speech may differ from the phonemics of a read or otherwise controlled style of speech. Even the phonemic inventory may differ so that speakers have contrasts in one style which are not present in another style or the phonetic realizations of the phonemes may differ in both their target positions and in their trajectories.

The effects of dialect and style on the phonology of a speaker are quite systematic but they cannot properly be accounted for by changes in the phonemic spellings in the dictionary. They are not lexical effects. For example, dialects often affect the conditioning environments in phonological rules. One case is the pronunciation of /æ/ which is raised in certain environments. These environments form an "implicational scale" so that a raised /æ/ before a voiceless stop may predict a raised /æ/ in other environments. But the raising of /æ/ is a probabilistic phenomenon in many dialects so that the likelihood of /æ/ raising is

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partly a function of the place of the conditioning environment along the implicational scale. For example, a word such as "flash" whose /æ/ is in an environment which is undergoing change is especially likely to be subject to dialect and stylistic variation.

The study (Labov, Yaeger and Steiner, 1972) upon which this note is partially based involved extensive acoustic analysis. It attempted to characterize the systematic variation of stressed vowel nuclei for a number of dialects. It did not, however, attempt to fit a statistical, variable rule model to the data. Neither did it fully explore such issues as formant trajectories and unstressed vowel targets.

I. Linguistic Background

For people who are not directly involved in theoretical linguistics, it may be helpful to place the discussion of variable rules in context. There is no longer a single opposition between generative phonology and the "Bloomfieldians" and generative phonology itself is not longer a monolithic school.

Abstract generative phonology as represented by Chomsky and Halle (1968) is probably most familiar to the SUR group. This monumental tour de force is characterized by very abstract underlying forms and long derivation chains. Its basic theoretical model is that of a homogeneous speech community. Changes within dialects, relationships between dialects and statistical fluctuations are not a central part of its theoretical foundations. Like Chomsky's Aspects, Chomsky and Halle is a seminal work but should no longer be taken as the "latest word" in linguistics.

Many generative phonologists over the last few years have been

increasingly concerned with a phonetic motivation for their generative rules. While for some, their "phonetics" is still at a rather abstract level, the trend has been to propose underlying forms which are closer to surface forms and to look for rules which reflect "natural" or articulatorily motivated processes. Studies of low-level, fast speech rules have generally been motivated by those, such as David Stampe, who are interested in so called natural phonology.

While there has come to be a great diversity among generative phonologists on many issues, the following represents a commonly held position. A language description should be based on an idealized, homogeneous speech community. A dialect is a set of people who speak the same way and different dialects are described by differences in lexical entries and differences in rules. This is the model which has been adopted by the SUR group.

Such a view has been strongly challenged by a new group of phonologists who approach phonology from the study of dialect variations. In their model, a language varies along regional, social and stylistic dimensions. A sound change may start in a particular phonetic environment, for a particular age range in a particular social class for a particular regional area. This change may then gradually extend to other phonetic environments, social classes, etc. For speakers who are undergoing a sound change, there will be a statistical fluctuation in the use of the old and new forms. A single sound change may result in a "chain shift" which affects the structure of the speakers' entire phonological system. Under this model, it does not make sense to design a SUR system for a single dialect since to some extent dialects and style shifts are correlated

and since even a single speaker may shift his phonological system during a single dialogue.

Three developments in this model of language have been implicational scales, variable rules and the analysis of acoustic phonetic parameters. C.-J. Bailey first noted that the environments for certain phonological rules could be ordered in such a way that, if the speaker applied the rule in a particular environment, then he would apply it in all less highly marked environments. Thus the environments for the rule form an implicational scale. More recently, a similar concept has been developed in the area of syntax by Haj Ross and called by him "syntactic squishes."

The theory behind variable rules is that some phonological rules (as well as other rules) are probabilistic with the probability of a rule application being determined by phonological and other features in its environment. In general, a probabilistic rule would look like

$$A \rightarrow B / E_1 E_2 \cdots E_n$$

where $E_i = \left\langle \begin{matrix} E_{i1} \\ \vdots \\ E_{in_i} \end{matrix} \right\rangle$. E is a set of exhaustive, mutually exclusive conditioning environments. Associated with each environment E_{ij} is a weighting factor E_{ij}. One variable rule model would claim that the probability of rule application P is

$$(1-P) = (1-E_{1i_1})(1-E_{2i_2})\cdots(1-E_{ni_n})(1-P_o)$$

where P_o is a factor which can represent how much the rule is used by a particular individual at a particular time. This model has been used

successfully to fit data on the variation in several phonological rules (Cedergren and Sankoff, 1973). It appears that when speakers are ordered according to their P_o for a particular rule, there is usually a factor such as social class or age which accounts for the ordering.

Another model might be that the effect of a rule rather than its likelihood of occurrence is random. For example, B could be a random variable such as the degree of /æ/ raising. The value of B might be a probabilistic function of the environment E. The rule would claim that the degree of /æ/ raising rather than its likelihood is a function of the environment.

When the environment is restricted to one dimension E (where $E_i \geq E_j$ for $i \geq j$), the variable rule model is somewhat like a probabilistic model of implicational scales. However, the probability function would have a different form. David Sankoff has developed a FORTRAN program for estimating the weighting factors in the variable rule model.

From our perspective, adding probabilities to a linguistic model may not seem revolutionary. However, probabilities represent a very radical and controversial proposal which is rejected, for example, by such linguists as Derek Bickerton.

Implicational scales and variable rules represent the introduction of scalar phenomena into a field that had traditionally dealt primarily with categorical relationships. In Labov et al, vowels are represented in an acoustic formant space. This use of continuous acoustic phonetic parameters represents a further step in the direction of scalar analysis. These developments are controversial but we feel that they represent a better framework for SUR than some of the more abstract models in phonology.

II. /æ/ Raising

Much of Labov et al is devoted to /æ/[1] raising -- the raising of what was historically a tense $\bar{A}$. This is a process whereby the nucleus of the vowel in bat, bad and ask is raised gradually from [æ^{ə}] in the direction of [I^{ə}]; in a parallel manner in some East Coast dialects, historical $\bar{ɔ}$ rises from [ɔ^{ə}] toward [U^{ə}]. We will use information about this change to exemplify some more general principles which have been derived from variable rule analyses.

For many dialects, including what Labov terms "Northern Cities" (SUR's "General American") dialect, an implicational scale can be formed for the environments in which /æ/ tenses and rises.

1.	/- k	
2.	/- p	
3.	/- t	before voiceless stops
4.	/- $\overset{v}{c}$	
5.	in weak words	in words such as the modal "can" which can be reduced or contracted
6.	/- f	before /f/
7.	/- K	before voiced stops
8.	/- F	before other fricatives
9.	/- N	before nasals

Speakers of these dialects are most likely to raise /æ/ before nasals and least likely to do so before /k/. If they do raise /æ/ in one environment, they are more likely to do so in all higher numbered environments. The degree of raising, as measured by the first formant lowering, is also affected by the position of the environment along the implicational scale.

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[1] Labov uses the symbolization ( ) to indicate a variable phonological unit. For (aeh)- which is the arpabet /ae/, the phonetic realization will usually be followed by a centralizing off glide as in [æ^{ə}], [ɛ^{ə}], [e^{ə}], or [i^{ə}].

In addition, there are social determinants of raising. Younger and more innovative speakers (and women) are more likely to raise /æ/. In general, a dialogue which is language oriented rather than task oriented will tend to elicit the speaker's norms, especially for sounds which are in a state of flux. Labov claims that task oriented speech is the most systematic and that language oriented speech (and formal styles) is the most irregular and unpredictable.

If /æ/ followed by a voiceless consonant raises for a particular speaker, then it is likely that the "short o" of hot (/a/) will front and then rise, first to [a] and then toward [ɛ] following the hole left open by the movement of /æ/. This process of one sound "pulling" another is called a chain shift. For some dialects, those in which even the /æ/ in weak words rises, the /ɔ/ (as in caught) is also part of this chain shift.

If /æ/ is not raised in weak words, but is raised in certain other environments -- as, for example, in New York dialects -- then the nucleus of /ɔ/ is likely to rise so as to have about the same F_1 as /æN/. It thus becomes something like [o^{ə}] or [u^{ə}].

The above is a very rough sketch of some of the processes which are gone into in greal detail in Labov et al. They are intended primarily to illustrate a type of analysis which has been made for the vowels of some American English dislects. The basic idea is that there are sound changes in progress, even in the "Northern Cities" dialect, and these changes affect phonetic variability.

III. Flo D.

The figure (Labov et al Fig. 18) illustrates the vowel system for

a speaker of the Northern Cities dialect, an area which includes most of the cities along the Great Lakes. Flo D. is a 40 year old speaker from Buffalo, N.Y. The data represent formant positions for the vowel steady state of stressed monosyllables taken from her spontaneous speech. The phonemicization is that of Labov and cannot be directly related to the ARPABET.

Flo represents a dialect with far fewer problems than most. In spite of this, notice that the /æ n/ nucleus overlaps /i/ and that /æ/ in other environments overlaps /ey/. Furthermore, /ɛl/ overlaps /ʌ/ and, although it is not shown, /ɛ/ in other positions overlaps /a/. Since all of these units must be kept separate, a simple target position model will not be adequate for our work. Formant trajectory information may often be used to separate these overlaps for fully stressed positions. For /æ/, different targets for separate phonological environments must also be recognized.

A great deal of data is needed from speakers of a dialect before the patterns and generalizations become apparent. Even more data is needed to estimate the probabilities for the variable rules. One function of a data base should be to make such data available to easy analysis. Unfortunately, in the controlled style in which most SUR test sentences are collected, the regularities are often obscured. There is substantial evidence for the hypothesis that the style for task oriented interactions will differ from that for language oriented speech. We feel that spontaneous dialogues from one or two dialects should be investigated in at least the detail represented by Labov et al as part of the SUR project.

References

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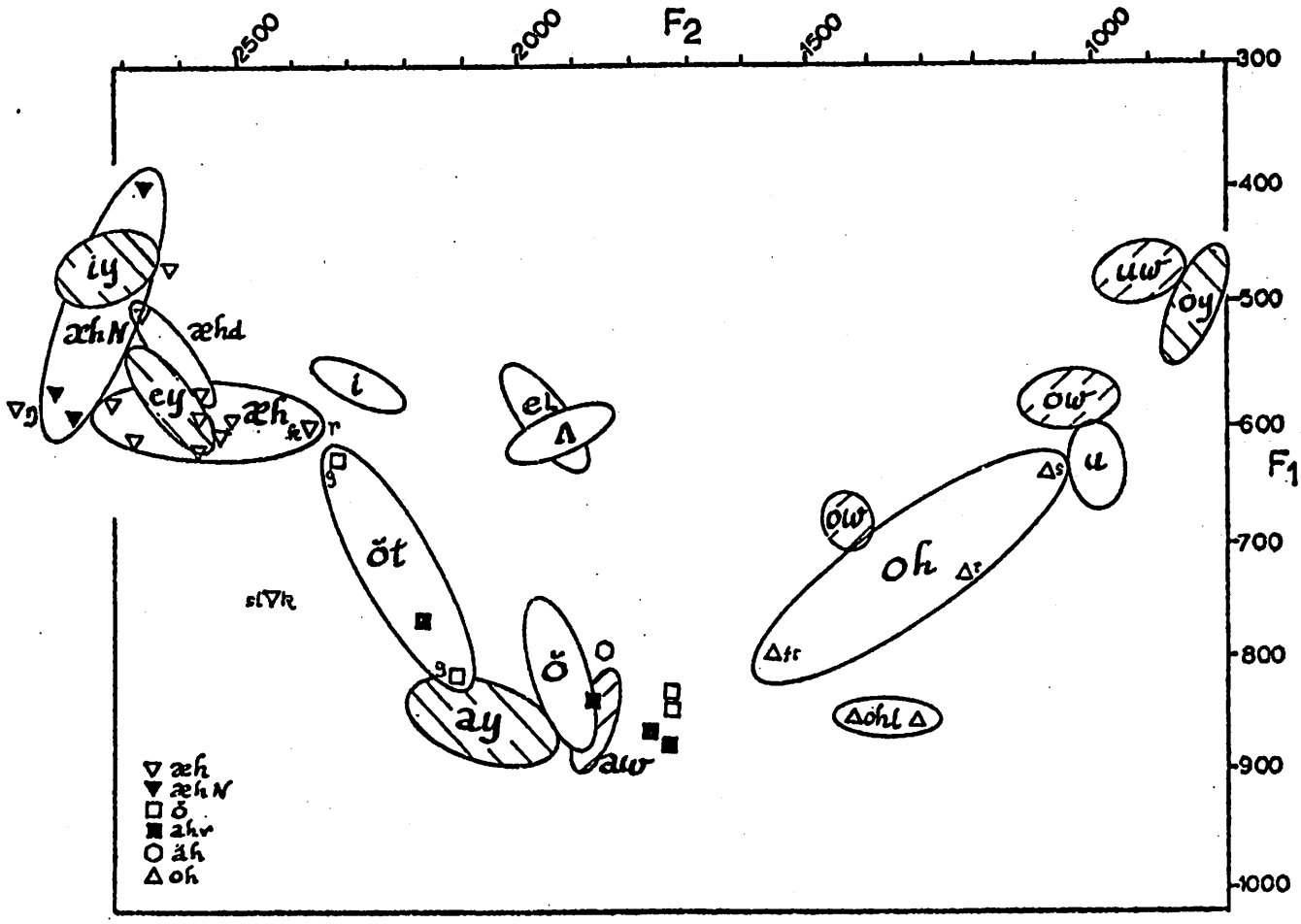

Figure 18. Flc Danowski, 39, Buffalo.