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On universal phonological features

Human language may be thought of as consisting of a number of simultaneous and interrelated levels, all of which contribute to the process of human communication. One of these levels, and certainly the most prominent from the standpoint of an outside observer, is that containing the sounds of speech. In the hands of linguists, this level becomes known as phonetics, and the study of the audible or phonetic properties of human language has long been one cf the focal points of linguistic science. In particular, the study of phonetics has brought with it a search for those physiological, psychological, and acoustic aspects which characterize the communicative possibilities of human speech. Over the years, much scholarly labor has been expended in describing in great detail the phonetic structures of a large number of the world's languages, and almost from the very beginning it became apparent to investigators that certain traits and observations occurred again and again among the chaos of sounds represented by these languages. It was noticed, for instance, that consonants and vowels tend to cluster about certain points of articulation, and that some features, such as voicing, nasality, aspiration, etc. were often used to distinguish phonetic segments. Following the discovery of these and other recurring properties among various languages, it was only a natural step to instigate the search for a set of *universal* phonetic traits, from the midst of which could be selected particular traits which would sufficiently describe *any* phonetic segment which might be encountered. It is the purpose of this paper to explore several theoretical and substantive aspects of the search for a universal set of phonetic features, particularly as reflected by proponents of generative phonology and other modern theories of phonological investigation."

When a modern phonetician, whatever his background, encounters a new segment which he wishes to describe, he brings with him a number of preconceived notions about the universality of phonetic traits, based largely on his knowledge of his own language and other languages he has studied. LADEFOGED (1969) has noted, to this end: „At this stage we should perhaps note that we do not gain anything by attempting to define features in perceptual terms. It is impossible to speak of the perception of phonetic events by an unbiased observer, unless we are considering a new born infant. Anybody who speaks a language will perceive sounds in terms of his own particular experience; and an infant's innate endowment for perceiving all possible speech sounds cannot be tested."

Thus, for example, a Spanish phonetician hearing a sound basically resembling his own [x], will, immediately classify it as a'voiceless velar fricative', even though in finer detail the new sound may be quite different from his own voiceless velar fricative.[1] The more languages this phonetician has studied which contain dorsal fricatives, the more accurate his description of the new sound is likely to be, but the major classificatory features will be basically the same in all instances. It is this fundamental similarity between sounds in widely differing languages which has led to the formulation of comprehensive „standards" for phonetic description, such as those proposed by the International Phonetic Association. Such classification standards make no claim of universality in the strict sense, but merely provide a set of target points about which can be clustered any sound occurring in the real world. As more languages are investigated, it is often found that the existing target points do not adequately account for certain sounds, and hence new target points are added. From this it may be seen that it will always be theoretically possible, although methodologically useless, to arrive at a completely universal set of phonetic traits merely by ennumerating all the sounds found in all the world's languages. In fact, this list may be extended to its absurdly logical limit by including every utterance of every speaker, throughout this and all previous generations. This situation is vaguely reminiscent of NIETZSCHE's theory of eternal recurrance, which states in effect that, if one assumes the universe to be of finite mass, then sooner or later any particular combination of this mass will recur again, in fact, infinitely many times.

A list such as the one mentioned above, although unwieldy and in fact unattainable in practice, would be finite, and would assume infinite proportions only if one included the utterances of all future speakers. This, however, would be removing the investigation from the domain of science and transferring it to that of metaphysics. It is evident, nonetheless, that such is the only method of acheiving universality in its most restricted sense. In practice, however, the number of „universal" categories must be greatly reduced, in order to secure a system of manageable dimensions. It is this search for a meaningful reduction in the number of phonetic traits which may be taken, in the practical sense, as defining the search for a 'universal phonetic system.'

In practice, the number of phonetic categories is immediately reduced by the general limitations on human aural acuity, which places a constraint on the fineness of resolution which may be obtained between phonetic variants. These limitations, then, roughly serve to define a system of „narrow phonetic transcription", whose rudiments have been outlined in such publications as the various IPA handbooks, and which has been further elaborated in more specific studies. Formulating such a narrow phonetic system basically consists of tabulating all the perceptibly different sounds occurring among the world's languages; a formidable enough task, but one which nevertheless must be completed in order to ensure accurate and unambiguous phonetic transcriptions. Such is the position taken, in effect, by CHOMSKY and HALLE (1968: 294–5) when they state: „The total set of features is identical with the set of phonetic properties than can in principle be controlled in speech: they represent the phonetic capabilities of man." However, neither in CHOMSKY and HALLE's study, nor in any other similar work, has this goal been seriously approached, although a number of interesting and useful partical system have been proposed.[2]

For many aspects of linguistics, even the reduction in size of the set of phonetic variants afforded by a system of narrow phonetic transcription is too cumbersome, with

[1] For a discussion of this particular case, see HARRIS (1969: 191–193).
[2] A good example is offered by LADEFOGED (1966).

its hundreds of potential categories. Since a large number of linguistic investigators are interested not in the fine phonetic aspects of speech, but rather in isolating those aspects which are most relevant for the purpose of communication, it has been felt that a further reduction in the number of necessary criteria would be desirable. The communicative function of human speech is basically a process of combining members of a finite set of segments in various ways so as to arrive at different meanings; this is, in effect, the *double articulation* of Martinet (1965). Thus, for purposes of studying the ways in which individual meaningful units are built up from sounds, it is merely necessary to ferret out those particular traits or *features* inherent in these sounds which are responsible for signalling difference in meaning; i. e. the *distinctive features*. It is the search for these distinctive features which has occupied the time and efforts of many linguists, particularly since the turn of the century. Surprisingly enough, for a relatively long period of time, this search was undertaken on a language-by-language basis, with little explicit attention being given to the possibilities of finding a universal set of distinctive features. The main reason for this apparent lack of interest with universality seems to be the tacit assumption, on the part of most linguists, that the features they were working with *were* universal, since they were applied again and again in a variety of languages. Once attention was specifically directed toward the actual universality of distinctive features, however, it became increasingly clear that the existent theories were inadequately formulated, being basically a collection of language-specific observations, and hence it was felt by some to be necessary to get at the root of the problem concerning exactly what features serve to distinguish human utterances.

Again, the problem of isolating the universally available traits seems on the surface to be a fairly simple one: one simple combines the results of a phonological analysis of all known languages and extracts from this total accumulation each feature which serves, in one or more languages, to effect a difference in meaning. Preciesly this task was undertaken by many investigators, in an imperfect but nonetheless useful way; the most noteworthy example being provided by Trubetzkoy (1939). Under such early „universal" systems, one classified vowels in terms of such features as *front*, *back*, *round*, *nasal*, etc., while consonants were categorized by features like *stop*, *fricative*, *labial*, *velar*, and so forth. Once this was done, one could go on to investigate the manner in which these „distinctive features" were combined to form that minimal distinctive element known as the phoneme. Trubetzkoy found, for example, that most phonemic oppositions could be divided into major categories, according to the extent to which other groups of phonemes in the same language shared the same distinctive features. These ideas were further elaborated by Martinet (1955) in his theory of „phonological economy", which stated that oppositions which recurred at several points in a language; i. e. which formed a „correlation", would become aligned in such a fashion as to make maximal use of the distinctive traits among themselves. Some of Martinet's epigones carried these notions to even further extremes: for instance Dorfman (1968) proposed that the major correlations align themselves under ideal conditions so as to form a square. While there are many difficulties inherent in a Martinet-like wiew of phonological structure, such a system does have the noted merit of formulating and making explicit certain important aspects of phonology. Perhaps the single most important fact noted by adherents of structuralist phonology is the existence of at least a partial hierarchy among the distinctive traits or features involved.[3] Thus, for example, vowels and consonants were first of all separated and treated as two fundamental classes, although often related in various ways. Within these classes, further hierarchization generally took place, although generally along language-specific lines. For instance, one language may contain voiced and voiceless stops, but only voiceless fricatives (i. e. Spanish); in these cases one would assume that a correlation of closure was higher in the hierarchy of distinctive features than that of voicing. Similarly, in a language which distinguished five different points of articulation for obstruents, but only three for nasals, it would be deduced that nasality was lower down on the distinctive hierarchy than place of articulation. Such structural interpretations do not, however, lend themselves easily to questions of universality, since by their very nature they are concerned with phonemic interactions within a given language. Whereas some of the features or correlations involved seem to be undisputably of a universal nature, such as voicing, nasality, vocalicity, etc., in finer points it is not immediately apparent that it is possible, even in theory, to arrive at universal notions within the structuralist theory, except in the trivial sense listed above. For linguists of structuralist persuasion, this is not necessarily a serious drawback, since describing the traits of individual languages is a legitimate and rewarding pursuit in its own right; furthermore, it often appears, in examining various structural descriptions, that there is a certain limit beyond which universality is impossible.

Whether there is indeed a limit on the amount of universality which can be extracted from phonological descriptions of languages is at the present time unknown, although it seems likely that given the interest exhibited by scholars in various disciplines the answer will eventually be uncovered. It should be noted, however, that the possibility of finding a non-trivial and meaningful set of features which may be considered effectively universal must be regarded as a scientific hypothesis, to be subjected to intensive search, and to be evaluated in the light of each new piece of information that comes forth.

It is perhaps an unfortunate fact that many modern linguists have accepted as axiomatic the premise that there exists a small class of at most a couple dozen distinctive features which may be considered for all intents and purposes universal. Thus, for example, Chomsky and Halle (1968) speak repeatedly of „universal phonetics", although at no point is any comprehensive attempt made to justify the use of such a term, either theoretically, or substantively. Their feelings, however, are typical of a great number of contemporary linguists, who feel that a 'universal'phonetic (or phonological) system as outlined above is much too cumbersome and „uneconomical" for use in describing human language and who have opted instead, for no other explicitly apparent motive than descriptive simplicity, for a small set of (as yet undiscovered) features or traits which represent true phonological universals.

A key point in this connection is exactly what intrinsic phonetic content the distinctive features are presumed to have. For many investigators the distinctive features have been regarded as totally abstract and arbitrary classificatory devices, which merely served to signal oppositions between phonemes, but which did not necessarily have a meaningful interpretation in the real world. Thus Bloomfield (1933: 129–30) remarked: „A list or table of the phonemes of a language should therefore ignore all non-distinctive features . . . . such lists or tables are usually made on the

[3] See also the discussion in Ladefoged (1968: 285).

basis of practical-phonetic classifications . . . tables like these, even when they exclude non-distinctive features, are nevertheless irrelevant to the structure of the language because they group the phonemes according to the linguist's notion of their physiologic character, and not according to the parts which the several phonemes play in the workings of the language."

As an additional example, Nida (1949: 31) found it quite unobjectionable to classify the four-member Mazatec vowel system as:

	front	back
high	i	o
low	e	a

More recently, such a position has been taken by Fudge (1967) who notes (p. 7): „If there are no other bases for establishing such [i. e. phonemic] relationships, acoustic similarity will be considered, though any other type of patterning which is indicated will be taken as more important."

It is immediately evident, however, that if one accepts the notion that distinctive features have no intrinsic phonetic content; i. e. that they have no measurable physical correlates, there is virtually no way to constrain the theory so as to eliminate a seemingly infinite number of bizarre and arbitrarily constructed „correlations". For example, given any random collection on n phonemes, one could define a number of suitable features which would formally distinguish them, without giving the slightest clue as to their actual relationships in the language in question. Even arguments based on phonemic patterning leave an excessive degree of freedom, for, especially among the consonants, it is possible to discover entire groups of segments which are only slightly phonetically related, but which exhibit an identical behavior with respect to patterning. It is only by requiring the additional criterion of phonetic similarity that absurd and meaningless descriptions may be ruled out; and precisely this fact is noted by Fudge, as cited above. Once phonetic criteria are brought to bear, however, all arguments as to the totally abstract status of distinctive features vanish, and it becomes necessary to assign physical correlates to the features being employed. For this reason, it seems, in fact, that the complete abstractness of distinctive features is somewhat of an overidealization, and consequently that whatever system of features is employed will have to reflect observable data in the real world.

This view has been sustained, at least superficially, by most proponents of the theory of generative phonology, which assumes as one of its basic tenets the existence of a small set of universal distinctive features that may be used in formulating phonological rules for any language. Halle (1954: 203–4) states: „In conformity with our requirement that our terms be empirically meaningful, the „questions" [i. e. distinctive features] of the preceding paragraph are of a kind to which answers can be provided by physical measurement; i. e. they are questions regarding the presence of certain definite physical properties."

Similarly, the study of Jakobson, Fant and Halle (1951) provides an elaborate, although in the long run inconclusive, attempt at defining the physical correlates of one proposed set of features. On the other hand, an overabundance of phonetic detail can lead to an overcomplicated system in which true phonological processes become hidden in the midst of redundant phonetic detail. Chomsky and Halle (1968: 296) note, to this effect:

„We therefore can represent lexical items neither in phonetic transcription nor in an arbitrary notation totally unrelated to the elements of the phonetic transcription. What is needed is a representation which falls between these two extremes."

Finding such an intermediate representation is clearly easier said than done, however, as one may easily observe by looking over the various proposals concerning feature systems which have appeared in the last few years. In fact, as noted above, the basic premise that there exists such a level of representation which may be discovered in an empirical fashion is itself in need of justification. Such a justification has generally not been forthcoming; but instead a curious sort of duality toward this question has been manifested by many linguists. For example, Halle (1962) spends the greater portion of his paper attempting to justify his choice of distinctive features and then concludes his study by saying in effect that all this doesn't matter anyway, since at the distinctive level the features have only a classificatory status. This statement is apparently in conflict both with Halle's earlier remarks quoted above, and with the previously cited statement from the *Sound Pattern of English*, and it demonstrates the general level of insecurity concerning the existence of a smallset of universal phonological features.

Another question which must be addressed, given the apparently necessary assumption that distinctive features must have a certain measure of intrinsic phonetic content, is whether this phonetic content be specified in acoustic or articulatory terms, or perhaps as a combination of both. In early schemes, exemplified by those of Trubetzkoy, Martinet and Pike, primary attention was paid to articulatory parameters, these being most easily accessible, although it was implicitly admitted that the features also had acoustic correlates, since most phonetic investigation was doen by listening to spoken speech. As early as 1938, however, Jakobson (1939) was advocating a phonological system based on perceptual (i. e. acoustic) parameters. Certain features, such as voicing, nasality, friction, etc. seem to serve equally well as either articulatory or acoustic features. With regard to finer distinctions, however, there has so far been no method of accurately specifying a one-to-one correlation between articulatory and acoustic features to describe the production of consonants and vowels.

Due largely to Jakobson's pioneering work, a new era of phonetics was ushered in, where acoustic features were assumed to predominate at the phonological level. Perhaps the best-known attempt at defining a set of acoustically-based distinctive features is offered by Jakobson, Fant and Halle (1951). In this work an effort is made to establish for each proposed feature a set of physical correlates, based either upon the acoustic properties of speech as displayed on a spectrograph, or upon the physical properties of the vocal tract, considered as a resonant cavity. Such an investigation is rendered extremely difficult by the fact that, acoustically speaking, speech is a continuum of sound which may not be readilly segmented into discrete units such as phonemes. Such, in fact, is noted by Halle (1954: 197), who then goes on to add: „Although the view of language as a continuous phenomenon is simple and straightforward from a strictly physical standpoint, it has certain inherent difficulties which make it undesirable as a basis for descriptions, and investigators of language . . . have usually preferred to describe language as a sequence of discrete events. Furthermore it is not necessary that a physical phenomenon be actually discontinuous in order to break it up into a sequence of discrete events. It is possible to divide it into segments if we can show exactly how it is to be done."

In retrospect, it seems as though the acoustic features proposed by Jakobson, Fant and Halle did not do an adequate job of unambiguously segmenting the chain of speech, as many subsequent investigators were quick to point out. For example, the feature *flat* was supposed to stand for a whole group of secondary articulations, including rounding (for vowels), labialization (for consonants), retroflexion, velarization, pharyngealization, etc. These added traits show few if any similarities, either acoustically or articulatorily, other than the rather vague fact of being „articulated with a secondary constriction in the periphery of the vocal tract". Furthermore, difficulties arose in trying to apply other localization features, such as *grave*, *diffuse*, and *compact* to both consonants and vowels. For vowels, such features may be specified (although not necessarily with concomitant perceptual justification) in terms of relative formant frequencies. Most true consonants, however, especially stops, have no inherent formant structure, and one has to deal instead with formant shifts indicating the transition between a consonant and a vowel. These shifts, however, generally do not group consonants with vowels in the manner predicted by the Jakobson-Fant-Halle features; furthermore, they are highly dependent on the contiguous vowels.[4] Thus, in order to justify the classification of vowels and consonants by means of a single set of features, one must make reference to the various physical configurations assumed by the vocal tract (as is done, for example, by Halle 1962), which in effect presents a return to articulatory criteria.

Observing the obvious inadequacies inherent in the system of acoustic features as proposed in *Preliminaries*, many linguists began advocating a return to articulation-based distinctive parameters. Ladefoged (1966: 295) notes that the use of a set of articulatory features allows an intrinsic portrayal of „impossible" feature combinations, while in a wholly acoustic framework these restrictions must be stated explicitly, in addition to the basic definitions of the features: „this is because all traditional phonetic charts are arranged so as to preclude a number of possible combinations of states of the glottis and manner of articulation". Kim (1966) proposed an articulatory framework, vaguely reminiscent of the IPA-type articulatory phonetics, in which to portray all possible phonological combinations. These same concepts were further refined in various details in Kim (1968, 1970), and have been neatly summarized, along with some pertinent physiological data, in Kim (1971). The extent to which the reevaluation of phonological features in terms of articulatory correlates has taken hold among contemporary linguists may be seen by the fact that, in the most recent manifesto of phonological theory, Chomsky and Halle (1968: Chap. 7) have returned to a fundamentally articulatory framework. They state (p. 303) that: „the complete identification of vowel and consonant features seems in retrospect to have been too radical a solution." In the discussion which follows this statement, Chomsky and Halle proceed to outline some of the difficulties encountered by the Jakobsonian acoustic features, most of which had already been pointed out by other writers.[5]

Looking over the linguistic scene of the past thirty years or so, there seems to have been a sort of Zipfian oscillation between articulatory and acoustic feature systems.

[4] See, for example Fischer-Jørgensen (1954), Liberman *et al* (1956), Malmberg (1955). These works also include references to other pertinent studies.

[5] A comprehensive critique of some of the early distinctive features is offered by McCawley (1967).

Each new attempt at supplying a different feature system was realized by means of a sort of technological one-upmanship; and given the advancing state of the art, there is no reason to doubt that the current Chomsky-Halle articulatory features will one day be overthrown in a *coup d'état* by some enterprising linguists (perhaps even Chomsky and Halle themselves), armed with an impressive array of new acoustic data. In fact, even utilizing the presently available data, one may discover a number of difficulties in either framework. This fact has apparently led Hall (1969: 211) to doubt the overall validity of distinctive features in general. Such a position, however, represents a bit of an overreaction, since it appears obvious to most investigators that the concept of distinctive features may be quite useful in many cases. In an extremely perceptive article, Delattre (1967) has given a comprehensive review of investigations pertaining to both the articulatory and the acoustic correlates of distinctive features, with a number of interesting conclusions. It is shown, for example, that certain phonetic phenomena, such as velar articulation in stops, exhibit articulatory correlates which are simpler and more nearly 'invariant,' while other phenomena, including distinctive vowel nasalization and the various types of *r*-sounds in American English, exhibit fairly constant acoustic characteristics, but considerable articulatory variability. From this, Delattre concludes that neither acoustical nor articulatory data should be used in defining the distinctive features, but rather that the features should be considered only at the „perceptual" level. These conclusions are presented in a passage worth quoting at length (pp. 23–4): „If it cannot be shown that distinctive features are closer to one sort of objective correlate than to the other, it is perhaps that invariance exists neither at the acoustic nor at the articulatory level. Then if there are such signals as invariants by means of which distinctive features function in the process of speech recognition, these invariants must function only at the perceptual level and must mediate between a distinctive feature and its objective correlates. Whether the invariants are named in acoustical, in articulatory or in perceptual terminology is of little importance. They would perhaps fare best as numbers, and the distinctive features as letters of the alphabet. But there should be no objection to occasionally using consecrated terms such as nasality or voicing for the distinctive features, as long as they are not misleading, and to using either an articulatory term or an acoustic one, whichever is simpler, for the invariants."

Delattre's remarks are rather difficult to evaluate, since the term „perceptual" as he uses it appears to be undiscoverable. If distinctive features cannot be discovered by applying either acoustic or articulatory criteria, it is hard to imagine exactly what *does* determine the intrinsic content of the features. Using a diagram to illustrate his theory, Delattre suggests (p. 24) that „the objective acoustic and articulatory correlates are related to a distinctive feature only indirectly, by means of subjective invariants." In effect, this statement necessitates that we state, for example, that a speaker recognizes the phoneme /d/ simply because he perceives it as /d/, which places us right back in the pre-distinctive feature days. Part of the conceptual impasse engendered by Delattre's proposals stems from the failure to consider the *relative* aspects of speech perception. It has been sufficiently demonstrated, by Delattre and others, that it is well-nigh impossible to establish an *absolute* set of correlates for most distinctive features, using either acoustic or physiological data. A large area of speech perception, however, is concerned with isolating a given sound *relative* to other sounds in the spoken chain. Thus, for example, Ladefoged (1967) has shown that the perception

of vowel phonemes is dependent upon having heard enough of the discourse to be able to establish the relative positions of the phonemes with respect to one another. Similarly, it has been shown that the formant transitions associated with stop consonants are largely dependent on the surrounding vowels, with certain characteristics being obliterated in the environment of certain vowels.[6]

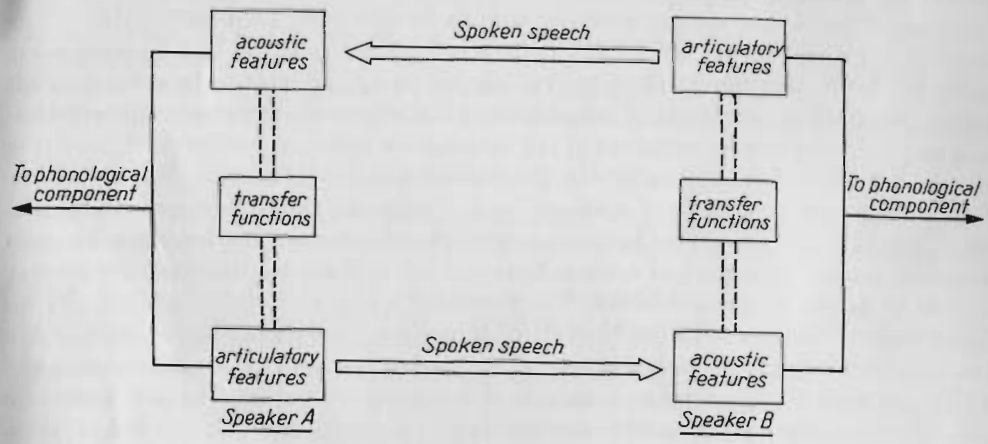
It is quite possible that, in the long run, Delattre's pessimism about the feasibility of finding an exclusively articulatory or exclusively acoustic set of correlates for distinctive features will turn out to be justified. However, before completely abandoning the investigation, it is useful to consider the possibility of two simultaneous coexistant sets of features, one primarily articulatory and one predominantly acoustic. This would not be particularly surprising in view of the fact that the process of human communication consists of two fundamental phases: that of speaking and that of listening. Therefore, it might be surmised that a speaker would use one set of features, based on articulatory parameters, when speaking, and another set of features, this time acoustically defined, when listening to the speech if others. This possibility seems to be hinted at in the first few pages of Fudge (1967), where the articulatory and the auditory components are separated for discussion. It turns out, however, that Fudge seeks to acheive synthesis between the two modes of speech in a different fashion; namely by making all the features totally abstract: „The logical conclusion of this is that phonologists (above all, generative phonologists) ought to burn their phonetic boats and turn to a genuinely abstract framework. By so doing they will escape the fate of not only falling between two stools . . . but also ending up sitting in the very place which they have expended such strenuous and well-justified efforts to avoid." (p. 26)

Fudge's conclusions notwithstanding, the possibility of two simultaneous sets of features should be pursued further. First of all, let us assume, intuitively enough, that when a speaker produces an utterance he utilizes a set of articulatory features. Due to the inherent auditory feedback present in all normal individuals, he will be able to hear his own speech as he is producing it. This auditory feedback mechanism is presumably part of the same component used in listening to the speech of others, and hence presumably relies on predominantly acoustic features. Between the auditory and the articulatory features, then, there must exist a series of transfer functions which map between the acoustic and the articulatory components. These mappings are not generally one-to-one, nor are they necessarily onto mappings. For example, the speaker may be able to produce the same acoustic result by means of several different articulatory gestures. Similarly, he may encounter a sound for which he has no articulatory analog; i. e. which does not exist in his own speech. In the act of speaking, then, the articulatory features will serve to form the utterance, while the acoustic features inherent in the auditory feedback mechanism will serve to „monitor" the produced speech.

In the act of listening, the above situation may be considered as reversed. The received sounds are processed in terms of their acoustic features, but for most individuals there seems to exist a (sometimes quite imperfect) feedback to the articulatory features. Thus, in listening to a person speaking with a lisp, many people testify to actually being able to 'feel' the anomaly in their own vocal apparatus. Once again, the conversion of acoustic to articulatory features is not a perfect one; thus, upon hearing

[6] Cf. Delattre (1967) and the references given therein.

a given sound, there is often doubt in the listener's mind as to how it was produced. The model of speech production and recognition proposed above may be schematically represented roughly as in Figure 1.



As it stands, the above model is purely hypothetical, since little investigation has gone into the possibility of using both acoustic and articulatory parameters to describe the same situation. In view of the fundamental duality inherent in human language, however, it appears certain that some such situation will have to be envisaged in order to account for the problems encountered in using strictly physiological or strictly acoustic features. One very promising area for future research along these lines could be the domain of language change. Considering, for the moment, only those sound changes which are apparently spontaneous; i. e. which do not result from morphological or analogical contamination, borrowing, substrata, etc., one might hope to discover sound changes whose primary motive was acoustic in nature, while other changes would appear to have been triggered by physiological factors. A prime target for investigation would be changes involving consonant clusters. For example, early Vulgar Latin had both the medial cluster *-tl-* (as in *vet(u)lus*) and the medial cluster *-cl-* (as in *oc(u)lum*). Now the acoustic differences between *-tl-* and *-cl-* are quite small, whereas from an articulatory standpoint no particular difficulty seems to be involved in either case. In late Vulgar Latin, however, the cluster *-tl-* became *-cl-*; thus *vetlus* > *veclus*. It may be due to the same factors that the modern Romance languages do not contain the cluster **tl* in native words, although *pl*, *cl*, *fl*, etc. freely occur.

The reduction of certain Latin consonant clusters in Italian seems to point to a pressure in terms of articulatory parameters. To cite a single example, the Latin clusters *-pt-* and *-ct-* merged in Italian as the geminate *-tt-*; hence *scriptum* > *scritto*, *octo* > *otto*. etc. Acoustically, the clusters *-pt-*, *-ct-*, and *-tt-* are quite distinct, and may be easily perceived by speakers of modern Italian. From a physiological standpoint, however, a considerable economy in articulatory effort was acheived by changing clusters with two differing points of articulation into a single geminate with a constant point of articulation.

Many scholars, including Anderson (1965), Pulgram (1970), Klausenburger (1972), etc. have expended great efforts to demonstrate that the emergence of new

consonant clusters in a language is largely determined by the structure of the already existing clusters. More specifically, they have attempted to demonstrate that potential new clusters; i. e. clusters that do not occur but which might occur due to such factors as syncope, tend to be 'dissolvable' in terms of the structure of the given language. That is, the cluster must be able to be split into an initial consonant (or consonants) which occurs word-finally plus a second consonant(s) which occurs word-initially. The motivation for these restrictions seems by and large to be articulatory in nature, since many potential but non-dissolvable clusters are acoustically quite distinct and may be perceived by speakers of the language in question without difficulty. For example, Spanish has, among others, the following potential nondissolvable clusters: **vl*, **pf*, **gb*, **kf*, etc. Spanish speakers can distinguish these clusters without problem, and most can even utter them, in meaningless nonsense syllables. These clusters, however, do not form part of spoken Spanish, nor is there any indication that they will do so in the forseeable future. The reasons for this seem to be articulatory, as noted above. This is not to say that there is any inherent physiological difficulty in uttering such sequences; rather it seems that due to the set of neuromuscular habits which the Spanish speaker has acquired, these clusters seem strange and foreign to him. Of course, the role of acoustic features in this respect cannot be overlooked, since acoustically these clusters are classified as strange by Spanish speakers. The fact remains, however, that is generally easier for a speaker of any language to perceive sequences of sounds which are foreign to him than it is for him to actually utter these sequences.

It may well be, then, that the separation of physiological and acoustic features may be verified by observing language change. Such an enterprise is not an easy one, for dealing with historical linguistics brings forth a host of indeterminacies which often cause even the best analysis to founder. Presuming, however, that the partial separation of the two sets of correlates can be determined, by whatever means, there still remains the problem of determining the nature of the functions which map between the articulatory and the acoustic features. At this stage of the investigation, such functions are merely a sort of undetermined transfer mechanism, much like the various „black boxes" which inhabited much of Chomsky's early work. One fact that does seem obvious, at least at the present time, is that these functions must be language-specific. This is so since, although there may very well be a universal set of features, each language chooses from among these features, and combines them in a unique fashion. This is to say that each language has its own set of oppositions, both articulatory and acoustic, and likewise each language involves a set of features which may be considered properly redundant. To further complicate the problem, each individual speaker seems to exhibit a slightly different behavior with regard to distinctive features, which suggests that investigation of the conversion functions between physiological and acoustic parameters might best be covered by the domain of individual psychology. In any event, the possibility of using two simultaneous sets of features should be left open, since therein lies the promise of resolving many of the problems which distinctive feature theory has encountered to date.

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