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ABSTRACT

Since the beginning of man's awareness of his language capabilities and language structure, he has assumed that speech is composed of discrete entities. The linguist attempts to establish a model of the workings of these distinctive sounds in a language. Utilizing an historical basis for discussion, this general survey of the distinctive feature principle illustrates the formation of the concept of these phonemic entities (the distinctive features) and their refinement and incorporation into structuralist and transformational-generative phonology. It is suggested that the development of the principle sheds light on the question of how a language utilizes sound matter, the adaptation and utilization of certain sounds in the workings of a language, as well as their representation in language models and theories. The phonological assumptions of Jakobson, Fant, Halle, Bloomfield, Chomsky, et.al. are discussed in an attempt to understand the concept of "sounds" as utilized by linguistic theory since its origin as a modern-day science. (Author/ CFM)

THE DEVELOPMENT OF DISTINCTIVE FEATURE THEORY

by

Peggy L. Meyer

PREFACE

The purpose of this general survey of the distinctive feature principle is to illustrate the formation of the concept of the distinctive feature and its refinement and incorporation into structuralist and transformational-generative phonology. I will not attempt to argue for the relevance of the principle to modern linguistic theory, since the matter is not in current dispute. In utilizing an historical basis for discussion, then, I will focus on the chronological development of the principle as initally presented by Jakobson, Fant and Halle in Preliminaries to Speech Analysis, and as ultimately incorporated into the linguistic models of the transformationalists. The fact that the transformationalists felt it necessary to modify and rearrange the intial principle in order to adapt it to their theory is an interesting and relevant study, although it is but briefly touched upon here. For I cannot attempt a discussion of the overall merits of the transformational model, nor of any other viable model, although these matters are certainly in need of careful analysis. My purpose, rather, is to shed light on the question of how a language utilizes sound matter, the adaptation and utilization of certain sounds in the workings of the language, and their representation in language models and theories. I simply assume here that the procedures which have been suggested for phonological analysis by Jakobson, Bloomfield, Chomsky and Halle, et.al., represent potentially productive linguistic theories, and I will attempt to examine their assumptions without advocating any one theory over the other. Furthermore, in understanding the concept of "sounds" as utilized by linguistic theory, it must be emphasized that the "physical" reality of the distinctive feature components in language structure are distinct from their "psychological"

incorporation into a "grammar" of a language, which at the present time, is nothing more than a hypothetical model representing a speaker's competence. It is primarily because of this distinction, that detailed proposals regarding the implicit, if not explicit, recognition given to the distinctive features as incorporated into a particular linguistic theory would be premature here. But in attempting to understand the theoretical justification for them in linguistic theory (accompanied by empirical evidence), we may serve to direct the revision and development of future theories.

I. In The Beginning: The Phoneme

The phoneme is not a new invention, nor a uniquely American one. In fact, Europeans in the late 19th century were well aware of the importance of the phoneme-type unit in linguistic analysis, and had already developed several sound phonological theories. But the idea of the phoneme itself was developed much earlier. In fact, by its very nature, it had to have been realized at the time when people first began recording their language using an alphabet instead of a pictorial system. They were able to abstract from the total number of speech sounds of which their language was composed, a certain number of significant ones which served to distinguish meaning in that language. This phenomenon was possible because native speakers have an intuitive knowledge of what sound features in their language are distinctive (i.e., capable of differentiating words). The American linguist, Edward Sapir, called this ability "phonemic intuition". That is, people instinctively know which differences in the speech sounds of their language are capable of distinguishing words. Thus, it is natural that the first attempts at recording language by means of an alphabet were done so "phonemically".

In the late 19th century, the Polish philologist, Jan Baudouin de Courtenay, was the first to formulate a theory of phonemes and to point out the basic distinction between a "phone" (any discriminable speech sound) and a "phoneme" (a distinctive speech sound in a language). Henry Sweet in England and Paul Passay in France were also working with the idea. But the most notable non-American contributions to the area of phonemics have been made by the Cercle Linguistique de Prague. The Prague School was made up of linguists who may be

regarded as followers of Nikolai Troubetzkoy, Roman Jakobson, and André Martinet. This school formulated its principles at a congress of Slavic scholars in Prague in 1929. It is not clear whether American linguists at this time were aware of these developments in Europe, but it appears that they were beginning to think along the same lines. "Edward Sapir, in his book, Sound Patterns in Language (1925), does not use the term phoneme in the sense in which later linguists used it, but he talks about variations in a sound 'dependent on the phonetic conditions' in which it occurs. These positional variants which do not serve to distinguish meaning in the language, but which are determined by their phonetic environments, correspond to what are called today, the "allophones" of a phoneme. Thus, it is with Sapir that we can date the beginnings of American investigations of the phonemic principle." [1]

The word "structuralism" is used to designate the various trends in modern linguistics which came into existence in the first half of the 20th century. The structuralism of the Prague School linguists and of Leonard Bloomfield in America have several features in common, but they differ considerably from one another in their principles and procedures. Both schools agree in rejecting the psychological or mentalist approach to phonological established by the Neo-grammarians (i.e., when the phoneme is considered an "imagined" phenomenon mentally equivalent to its acoustic properties) and tend to regard the phoneme as a physical unit of the sound system of the language. But while the Prague group stresses the analysis of the phoneme into the relevant features which constitute it (the soon to be "distinctive features"), the Bloomfieldians lay their emphasis on its distributional features in words or in utterances.[2] It is

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[1] Valerie Becker Makkai, Phonological Theory, p.3.

this basic distinction in the history of the structuralist movement that we shall be concerned with here; for major differences arose as linguists began a scientific examination of the role of the sound elements in a particular language.

II. Distinctive Features -- BAH, HUMBUG!

It is a fact that Leonard Bloomfield considered the existence of sub-phonemic detail an almost worthless study[3] because it was so subject to mistakes and false interpretations due to the phonetician's experience and training in transcription; whereas phonemic contrasts could be determined by objective procedures, free from such interference. Bloomfield was well aware that phonemes were composed of smaller units of sound features which are lumped together in bundles, but maintained that the investigation of these features was purely the work of the phonetician who was to study "the speech event without reference to meaning, investigating only the sound-producing movements of the speaker, the sound-waves, and the action on the hearer's drum."[4] For Bloomfield, then, the

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[2] Eli Fischer-Jorgenson (1952) has noted that "Spair might have been the first to suggest that phonemes be grouped into categories according to their possibilities of combination with other phonemes in the speech chain. But Bloomfield maintained that phonemes are distinguished purely on the basis of their distrubutional properties and that classification by distinctive features is irrelevant because it is simply a physiological description. In contradistinction to Bloomfield, Troubetzkoy considers the internal description of phonemes as consisting of a definite number of distinctive features and their classification according to these features as the most important task. He mentions the classification based on different possibilities of combination, but emphasizes that it is not possible in all languages to give each phoneme a unique definition in this way."

The implicit vs. explicit recognition given to the phoneme by the different linguistic schools will be emphasized in some detail later in this paper.

[3] These sub-phonemic units were recognized by him as the "phonetic" structures of the language, i.e., a combination of both the distinctive and non-distinctive features.

[4] Leonard Bloomfield, Language, p. 74.

term "distinctive feature" was reserved for those specific features from among the total gross acoustic features which make a difference in meaning in that language. These distinctive features occur in bundles, along with other non-distinctive features (which are analogous to Jakobson, Fant and Halle's "redundant features") which comprise a phoneme. Furthermore, he stated that "the speaker has been trained to make sound-producing movements in such a way that the phoneme features will be present in the sound-waves, and he has been trained to respond only to these features and to ignore the rest of the gross acoustic mass that reaches his ears."[5] At this point in history then, both Bloomfield and the Prague School linguists propounded the theory that phonemes are composed of smaller units of sound features, some of which are "distinctive" (i.e., the acoustic-articulatory properties which characterize a particular significant contrastive unit of sound--the phoneme) and others are "non-distinctive" (i.e., those phonologically irrelevant properties for that particular language, as determined through contrast with the other features in the language). These features are lumped together into bundles; but the phoneme is not the sum of sounds of its component features, for it is not identical with an actual physical sound. Rather, the phoneme can only be equated with its psychologically relevant properties, that is, its distinctive features. It is at this point in the development of a complete phonological theory that the paths of the American descriptivists and the Prague structuralists diverged. The fundamental discrepancy lies with the incorporation of those distinctive features into their respective theories.

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[5] Ibid., p. 79.

> To recognize the distinctive features of a language, we must leave the ground of pure phonetics...since we can only recognize them when we know the meaning of utterances.[6]

As is evident from Bloomfield's statement, the smallest distinctive unit to be reckoned with in a theory of language is the phoneme. In his macro-view, he assumes that the classification of phonemes by distinctive features is irrelevant to the structure of language and he preferred to distinguish phonemes on the basis of their distributional properties. For him, two positional variants may be considered one phoneme if they are in complementary distribution, never otherwise.[7] And conversely, in identical environments two sounds are assigned to two phonemes if their difference distinguishes one morpheme from another.[8] According to Bloomfield, although the range of phonetic similarity of various occurrences of a phoneme might be considered important, it was the criterion of distribution that would unequivocally determine whether a given sound was to be classified in the range of one phoneme or another.

Troubetzkoy, on the other hand, studied the phonetic features which would serve to contrast certain sounds. "He set up certain phonetic criteria: localization and degree of the obstacles to passage of air; 'co-articulation' features such as palatalization; resonance chamber, etc. It is in these terms that he lists phonemic contrasts."[9] Troubetzkoy did not ignore the relevance of distributional

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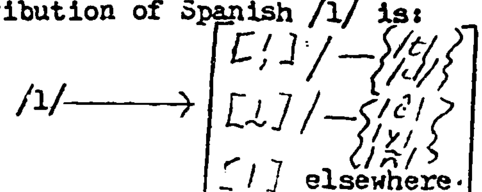
[6] *Ibid.*, p. 77.

[7] Represented graphically using an example from Spanish, a rule for the allophonic distribution of Spanish /l/ is:



[8] In Spanish, /r̄/ ≠ /r/ because "carro" (car) ≠ "caro" (expensive).

[9] Zellig Harris, "Review of Grundzüge Der Phonolgie", In Makkai's *Phonological Theory*, p. 303.

contrasts since he specifically noted that "if two sounds of a given language, related acoustically or articulatorily, never occur in the same environment, they are to be considered combinatory variants of the same phoneme."[10] This rule is analogous to Bloomfield's conception of complementary distribution, but unlike him, Troubetzkoy places his major emphasis on phonetic contrasts for determining the phonemic inventory of a language. Thus, Troubetzkoy maintains that every phoneme "contains several acoustic-articulatory properties and is differentiated from every other phoneme not by all but only by a few of these properties."[11] These distinguishing properties are the phonologically relevant or "distinctive" features. The particular distinctive features of a phoneme are distinguishable in a language primarily because they are in "opposition" to other bundles of features in that language. In light of this, the phoneme may well be defined as the sum of distinctive features found by considering "oppositions" (i.e., contrasts). Thus, each speech sound in a language is composed of both the "phonologically relevant" properties that make it the realization of a specific phoneme, and also of quite a number of "phonologically irrelevant" features whose combinations of occurrence and distribution designate the phonetic variants (or allophones) of that phoneme. And it follows that these non-distinctive features cannot serve to differentiate lexical meaning. This is indicated by the commutability without loss of intellibility of /l̃/ for /l/ in "alto" (high, tall) or of /b̥/ for /b/ in "la bota" (the boot). All optional phonetic variants, then, owe their existence to the fact that only part of the articulatory properties of each speech sound is phonologically relevant. The remaining articulatory properties can vary from case to case without loss of intelligibility or meaningful distinctions in the language.

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[10] Nikolai Troubetzkoy, "Phonemes and How to Determine Them", in Fudge's PHONOLOGY, p. 63.

[11] Ibid., p. 52.

As we will soon discover, Troubetzkoy's method of phonemic patterning can be viewed as basic to the development and incorporation of distinctive features into modern linguistic theories. He was the first linguist to clarify and stress that phonemes are not absolute, but relative; and that no feature or group of sounds was relevant in itself, but only if contrasted with another feature or a group of sounds. Secondly, he selected certain phonetic criteria with which to compare and contrast phonemes (e.g., palatalization, nazalization, voicing, etc.). It is in these terms that he lists phonemic contrasts. "E.g., English [t] and [d] contrast unidimensionally in respect to voicing, the other phonologically relevant phonetic features being common to both of them."[12] Thus, for Troubetzkoy and his followers, the phonemes of a language could be classified by studying the network of contrasts among sounds. Troubetzkoy's careful notation of those features which served to distinguish one phoneme from another served as the basis for the fully explicit theory of distinctive features to be developed decades later by Jakobson, Fant and Halle.

In the 1930's and 40's in America though, it was widely held that the only types of scientifically relevant linguistic records were those that recorded the total number of gross acoustic features (i.e., both the distinctive and non-distinctive features) or a record of the inventory of phonemes, distinguished by the parts they played in the working of the language. A mechanical record deliniating only the gross acoustic features would not tell which ones were significant (distinctive). Only by finding out which utterances are alike in meaning and which are different, could one learn to recognize phonemic distinctions. The American descriptivist's central proposal was that phonemes, the significant units of the phonological system of a given language, can subsume a variety of different actual sounds. The actual sounds subsumed by a single phoneme, however,

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[12] Zellig Harris, op.cit., p. 303.

had to be phonetically related and in such a distribution in the language as not to contrast. This noncontrastive distribution included two types: complementary distribution and free variation. Complementary distribution meant distribution in mutually exclusive environments. Free variation referred to occurrence in the same environment without signalling any significant difference. So the fronted [g̟] of English "geese" is in complementary distribution with the backed [g] of "goose" because the former occurs only before front vowels, while the latter never occurs there. Further, the unaspirated [k] and unreleased [k̚], which can both occur in final position in varying pronunciations of such words as "sack", "pick", and "wreck", are said to be in free variation, since the difference between them can never signal a different utterance. A third, more recent principle, that of pattern congruity, has been added to require that the assignment of sounds to phonemes results in a symmetrical system of sounds; so that if three voiced stops have been established for a particular language, two of which have easily recognizable voiceless correlates, we may expect to find a third voiceless correlate also. And so, phonetic contrasts within and among phonemes, such as that proposed by Troubetzkoy and the Prague School linguists, were not viewed as being capable of distinguishing the phonemes of a language. That the sounds of a language could be classified in terms of a binary set of distinctive features was inconceivable to the American descriptivists in the first half of the 20th century...but it was Roman Jakobson who proposed just that.

III. Putting the SOUND back into PHONOlogy

Roman Jakobson first formalized a theory of distinctive features based on the realization that phonemes are not simple constructs, but rather are composed of simultaneous, independent, yet relational properties. Having been exposed to

the Prague School's innovative work in phonetics and phonology, Roman Jakobson, Gunnar M. Fant and Morris Halle proposed a full distinctive feature theory in 1952 in their book entitled, Preliminaries to Speech Analysis: The Distinctive Features and their Correlates. It was a major linguistic development in 1952 when the claim was made that there exist a limited number of distinctive features (12 were initially established) which can be used to describe all the phonemes of all the languages in the world.

Leonard Bloomfield had stated in 1933 that:

> The important thing about language, is not the way it sounds. The speaker's movement, the disturbance in the air, and the hearer's ear-drum vibrations are, in themselves, of very little moment.... The importance of the phoneme, then, lies not in the actual configuration of its sound-waves, but merely in the difference between this configuration and the configurations of all the other phonemes of the same language....Only the phonemes of a language are relevant to its structure--that is, to the work it does. A description of the non-distinctive features might be of great interest, but for this it would have to be more complete and more copious than any that have so far been made....A list or table of the phonemes of a language should therefore ignore all non-distinctive features."[13]

We have already mentioned the fact that for the descriptivist theorists the only effective means of determining the inventory of phonemes of a language (as distinguished from all other non-significant sound units) was through a distributional analysis, a procedure based on a comparison and contrasting of minimal pairs, and principles of complementary distribution and free variation. In this type of phonological analysis, no explicit recognition at all was given to the features known to comprise the phonemes, yet implicit recognition was given to them by the use of phonetic charts summerizing the manners and points of articulation of the various phonemes in the system. Table 1 charts a partial phonemic inventory of the consonants of the Spanish language.

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[13] Leonard Bloomfield, op.cit., pp. 128-129.

TABLE 1*

THE CONSONANT ALLOPHONES OF SPANISH

Articulation

MANNERS OF ARTICULATION	Bilabial	Labio-dental	Inter-dental	Dental	Alveolar	Palatal	Velar	Bilabio-velar	Glottal
STOPS	p b			t d			k g		
SLIT FRICATIVES	β	f v	θ ð		ɹ̥ ɹ	ç ʝ	x ɣ	w	h
GROOVE FRICATIVES					s ś z ź	š ž			
AFFRICATES						ĉ ĵ			
NASALS	m	ɱ		n̪	n	ñ	ŋ		
LATERALS				l̪	l	l̃			
TAP					ɾ				
TRILLS					r̥ r̄		R̥ R		

*Taken from John B. Dalbor, Spanish Pronunciation: Theory and Practice, p. 279.

But even tables like these were irrelevant according to Bloomfield because they were purely physiological and unrelated to the mechanistic structure of the language.

Since linguistic analysis views the phoneme as an abstraction rather than as a strictly observable entity, it seems natural to seek a further description of the phoneme in terms of defining attributes. Bloomfield did so, (albeit reluctantly), in articulatory terms, but other linguists have sought to provide a greater degree of systematization in the use of components and have therefore attempted to find an explicit place for them in the general theory of language. Jakobson has proposed such a principle based on contrastive dimensions. In a forthright attempt to repudiate Bloomfield's "phonemic" conception of language structure, Jakobson, Fant and Halle explicitly state:

> If the word bill were to appear in the sequence one dollar bill or as a single word said to a waiter after a meal, the listener would be able to predict its appearance. In such a situation, the sounds which compose this word are redundant to a high degree, since they 'could have been inferred a priori'. If, however, the word is deprived of any prompting context, either verbal or non-verbal, it can be recognized by the listener only through its sound-shape. Consequently, in this situation the speech sounds convey the maximum amount of information.[14]

The authors' justification for emphasizing the component sound features of language is based on the listener, who in the absense of help from the situation or context, needs the distinctive features in order to recognize and distinguish all morphemes, except homonyms. As the phonemes of a given language are considered to form a system of sequences (morphemes, words, phrases, sentences, etc.), so the system of phonemes is theoretically formed by their constitutents, the distinctive

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[14] Roman Jakobson, Gunnar Fant, and Morris Halle, Preliminaries to Speech Analysis, p. 1.

features. Further, the authors propose that the process of decomposing the phonemes into their distinctive features allows the same tested devices as the division of morphemes into phonemes--this being comparable to the analysis done by Bloomfield himself. In any minimal distinction, "bill" and "pill" for example, "the [illegible]ener is obliged to choose either between two polar qualities of the same [illegible] such as grave vs. acute, compact vs. diffuse, or between the presence and absence of a certain quality, such as voiced vs. unvoiced, nasalized vs. non-nazalized, sharpened vs. non-sharpened (plain)"[15] in order to distinguish the morphs. Hence, the phonemes of a language might be described as possessing certain properties, the occurrence and distribution of which is unique only to them. These components have been termed "distinctive features" because each feature describes one of a number of activities carried on in the vocal tract upon articulation of the phoneme, or some discriminable auditory property associated with it. According to the authors; "It is not important whether the term (describing the stage of the speech event) refers primarily to the physical (i.e., physiological) or perceptual level, as long as the feature is definable on both levels."[16] It is proposed that these twelve inherent distinctive features, along with the prosodic features (the qualities of pitch, loudness and duration which are superimposed upon the "inherent" distinctive features, and together comprise the phoneme) are sufficient for executing the phonological analysis of all languages. And in addition to a description of the various acoustical and/or articulatory properties involved in the production of sounds, the distinctive features also provide a cross-classification of the phonemes in a particular

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[15] Ibid., p. 3.

[16] Ibid., p. v.

language, where each sound segment is identified, and therefore, contrasted with every other sound segment.

Jakobson, Fant and Halle propose that English phonemes can be characterized in terms of a set of twelve distinctive features. A list of these features is presented in Table 2. Jakobson has attempted to set up a universal inventory of such binary features from which he sees all languages of the world selecting. This claim has since become the major justification given for the superiority of the distinctive feature approach. His system has a further advantage in that many of the same features can be used to describe both the vocalic and the consonantal system of a language. The "classical" place-and-manner-of-articulation approach to phonology as exemplified in Table 1 could distinguish the vowels from the consonants, but could not compare them. Strict minimal pairs in Spanish cannot be found to contrast consonants and vowels, and because they are rarely phonetically similar [17] are thus considered to occupy fundamentally different places in the total structure of Spanish utterances. In the traditional system of phonology, consonants are described in terms of points and manners of articulation; whereas vowels are described in terms of the so-called "vowel triangle" -- an arrangement of sounds according to tongue heighth and lip rounding. In the distinctive feature system, on the other hand, these two classes are handled by the same features, "diffuse" and "grave". The recognition of similarities among seemingly distinct sounds is taken up later in this paper in the discussion of Generative Phonology.

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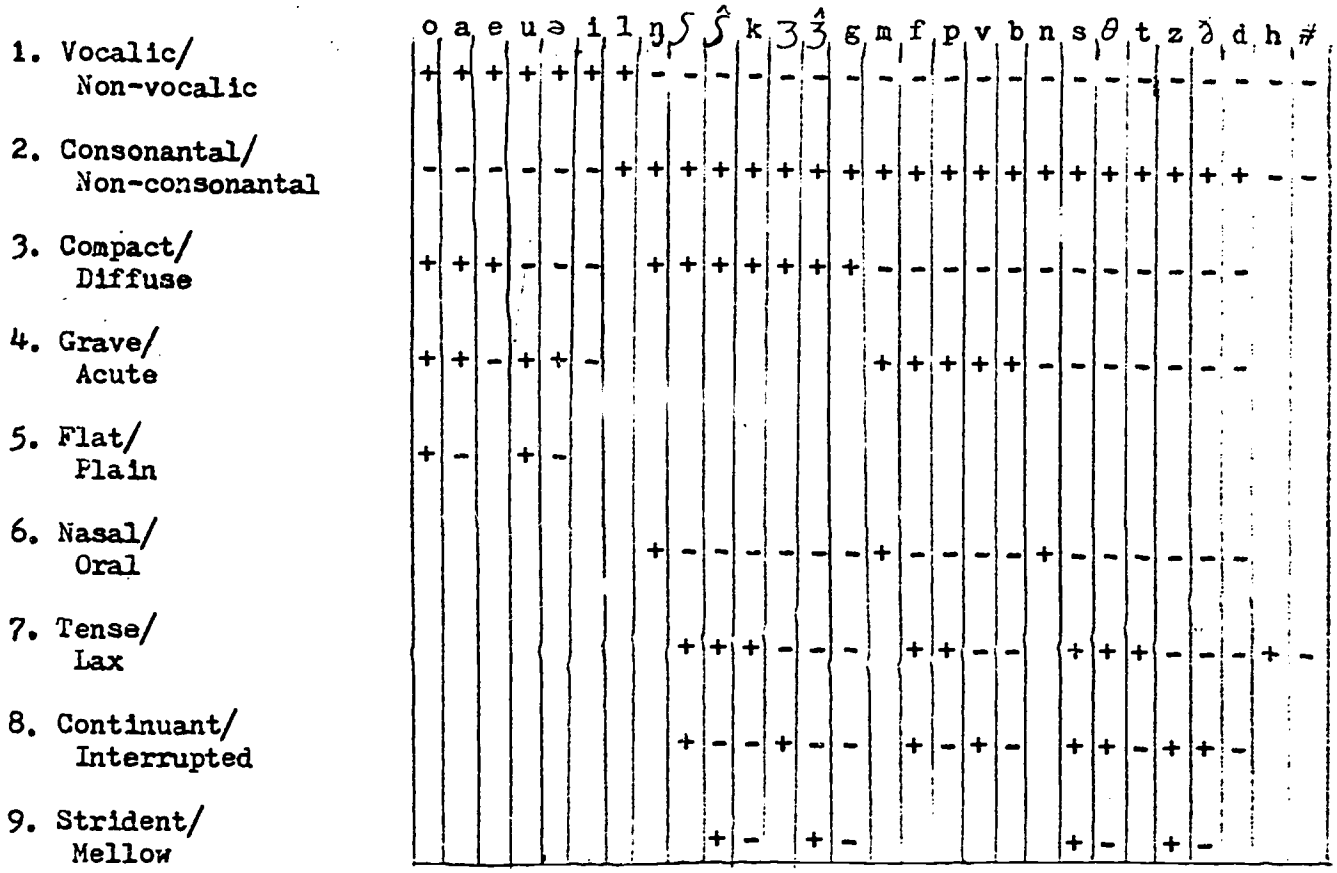
[17] The ambiguity of the traditional approach becomes apparent in realizing that /y/ shows a real phonetic similarity to /i/ (as does /w/ to /u/) and can be in complementary distribution. The descriptivists alleviate the situation by stating that there is a group of [i] or [y]-like sounds which contrast with consonants ("yerro" and "perro", for example) and thus constitute a member of the

TABLE 2*



*Taken from Jakobson, Fant and Halle, Preliminaries to Speech Analysis, p. 43.

ARTICULATORY CORRELATES OF THE DISTINCTIVE FEATURES**
(Partial List)

Vocalic-Nonvocalic: vocalic sounds are produced with a periodic excitation and with an open oral cavity, i.e., one in which the most extreme degree of narrowing is a "constriction"; nonvocalic sounds are produced with an oral cavity narrowed at least to the degree of an obstruction or with an excitation that is not periodic.

Consonantal-Nonconsonantal: consonantal sounds are produced with "occlusion" or contact in the central path through the oral cavity; nonconsonantal sounds are produced with lesser degrees of narrowing in the central path of the oral cavity.

Diffuse-Nondiffuse: diffuse sounds are produced with a narrowing which in degree

**Taken from Morris Halle, "On the Bases of Phonology", pp. 325-326.

TABLE 2 (continued)

equals or exceeds that of a "constriction" and is located in the front part of the vocal tract; nondiffuse sounds are articulated with narrowings which are either of a lesser degree or are located in the back part of the vocal tract. The dividing line between "front" and "back" is further retracted for vowels than for other sounds: for the vowels, "front" includes almost the entire oral cavity, while for other sounds, the dividing line between "front" and "back" runs between the alveolar and palatal regions.

Compact-Noncompact: this feature is restricted to vowels. Compact vowels are produced with a forward flanged oral cavity which contains no "constrictions" or narrowings of higher degree; noncompact vowels are produced with an oral cavity that is not forward flanged.

Grave-Nongrave: grave sounds are articulated with a primary narrowing located at the periphery of the oral cavity (i.e., at the lips or in the velar or pharyngeal region); nongrave sounds are articulated with a primary narrowing located in the central (i.e., dental-alveolar-palatal) region of the oral cavity.

Flat-Nonflat: flat sounds are produced with a secondary narrowing at the periphery of the oral cavity; nonflat sounds are produced without such a narrowing.

Nasal-Nonnasal: nasal sounds are produced by lowering the velum, thereby allowing air to pass through the nasal pharynx and nose; nonasal sounds are produced with a raised velum which effectively shuts off the nasal pharynx and nose from the rest of the vocal tract.

Voiced-Voiceless: voiced sounds are produced by vibrating the vocal cords; voiceless sounds are produced without vocal vibration.

Continuant-Interrupted: continuant sounds are produced with a vocal tract in which the passage from the glottis to the lips contains no narrowing in excess of an "occlusion"; interrupted sounds are produced with a vocal tract in which the passage from the glottis to the lips is effectively closed by "contact".

Strident-Nonstrident: this feature is restricted to consonantal sounds. Strident sounds are produced by directing the air stream at right angles across a sharp edged obstacle or parallel over a rough surface, thereby producing considerable noisiness which is the major acoustical correlate of stridency. Nonstrident sounds are produced with configurations in which one or several of the factors mentioned are missing.

The feature matrix in Table 2 places the phoneme symbols across the top and the names of the features along the side. The value of each feature for each particular segment is shown at the intersection of the appropriate row and column. The presence of a feature is indicated by a plus sign (+), the distinctive absence of the given feature is indicated by a minus (-). Thus, in viewing the phoneme /m/ as a minimal significant contrastive un in the phonological structure of English, it is comprised of the following features: (1) non-vocalic, (2) consonantal, (3) diffuse, (4) grave, (5) nasal, (6) lax, and (7) interrupted. Since in English /interrupted/ implies a /non-vocalic/ /consonantal/ sound, feature (7) is redundant. Similarly, (6) is redundant as implied by (5) and is therefore not recorded on the chart. Redundant features are those non-distinctive features which convey no new information in the analysis, and are therefore predictable.

In Preliminaries to Speech Analysis the authors felt that the entire list of features could be reduced if the ± sign was used to indicate the presence of both of the features in one phoneme. Thus, in actuality the system as proposed is "ternary" rather than "binary". At the writing of this book, Jakobson was not aware that the absence of a feature as noted in Table 2 might be efficiently utilized to indicate redundancy. (The blanks in Table 2 simply represent the inapplicability of a particular feature to a given phoneme.) In showing only the significant information carried by a phoneme, he indicated the predictable (redundant) features by placing them in parentheses. Thus /n/ was analyzed as:

	/n/
1. Vocalic/ Non-vocalic	(-)
2. Compact/ Diffuse	(-)
3. Grave/ Acute	-
4. Nasal/Oral	+

consonantal system of English. And there is another group of /i/ or /y/-like sounds which contrasts with vowels (e.g., "fino" and "fono"), and which therefore, constitutes a member of the vocalic system. Thus, in spite of the fact that they are in complementary distribution, the phonetically similar sounds, /i/ and /y/, are considered by the descriptivists as separate phonemes with entirely distinct distributional patterns within the system.

Here, /ŋ/ is shown to be distinctive from all the other phonemes in English since the "nasality" feature affects uniquely the nasal consonants, and the "gravity" feature distinguishes the phone under consideration from /m/, which is /+grave/, and from /ŋ/, where the feature is considered irrelevant.

In 1953, E. Colin Cherry, Morris Halle, and Roman Jakobson in their article, "Toward the Logical Description of Languages in their Phonemic Aspect", did away with the ± sign, as well as the parentheses indicating redundancy. In so doing, a zero (0) was added to the system to indicate <u>either</u> plus (+) or minus (-) for a particular phoneme. The English phoneme /d/, for example, was represented by the chain of features:

- vocalic
+ consonantal
- compact
0 diffuse
- grave
- nasal
- continuant
+ voiced
- sharp
- strident
0 stressed

Each of the zeroes can either be replaced by a plus or a minus without affecting its uniqueness from among the other chains of features in the matrix. According to the authors, the redundancy that is an obvious result of the replacement by + or - signs "should not be taken to imply wastefulness; it is a property of speech (and, in fact, of every system of communication) which serves a most useful purpose. In particular, it helps the hearer to resolve uncertainties introduced by distortion of the signal or by disturbing noises."[18] And so, a 0 marked for a feature in the revised system is capable of being replaced by either a plus or a minus, but the inclusion of such a specified value is assumed to have no phonemic significance (i.e., it is not necessary for the identification of the sound segments under consideration). As we move from the era of structuralism,

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[18] E. Colin Cherry, Morris Halle, and Roman Jakobson, "Toward the Logical Description of Languages in their Phonemic Aspect", p. 326.

whose various forms dominated linguistic research until the middle of the present century, we will see yet another treatment of redundancy in the distinctive feature principle as the influential Noam Chomsky develops a transformational-generative grammar and systematic phonemics.

IV. Systems of Sounds: A New Phonology

The analysis as described by Jakobson, et.al, permits us to distinguish all phonemes in a language systematically in terms of distinctive features by a process of comparing minimal distinctions (i.e., how "pat" differs from "bat", "cat", "hat", etc.). This method of identification concentrates on differences between phonemes and not on properties common to all utterances of a given phoneme. Thus, the procedure for phonemic analysis done in terms of distinctive features has a different focus than the distributional analysis of phonemes and their allophones advocated by the descriptivists. In explaining certain phonological phenomena utilizing the descriptivist approach (which makes use of meaningful differences among minimal pairs and principles of phonetic similarity, complementary distribution and the symmetrical patterning of sounds) as contrasted with the distinctive feature approach (which defines a phoneme in terms of a set of segments with identical features), it becomes evident that the "micro-analysis" of the phoneme has certain advantages over the descriptivist's "macro-view" in making certain claims about language in general.

From the work of Zellig Harris it can be seen quite clearly that as the field of linguistics developed in the United States in the 1950's, goals for linguistic theory were beginning to change to a more mentalistic conception. Harris' goal, though, was still the perfection of a set of "procedures" by which the linguist could discover the structure of a language. Many other Neo-Bloomfieldians

adva[illegible] this goal far less explicitly than Harris, though their orientation was still procedural in nature. As a student of Harris, Noam Chomsky was strongly exposed to this orientation. His reaction was to maintain that language is not of such a nature that its structure may be discovered by the mechanical processing of data alone. He further insisted that the goal of linguistic theory should not be the perfection of a "discovery procedure", but considered the alternative goal of an "evaluation procedure", which given data and two different grammars of one language, would be able to make the relative judgment of which grammar is better. His divorcement of linguistic theory from discovery procedures is what marks the breaking point between structuralism and transformational grammars. Since linguistic form is abstract and unobservable, it seems reasonable to assume that its structure cannot be discovered by the classification and segmentation of data alone.

Contemporary aims of theoretical linguists revolve around formulating universals of language (to be discussed in detail later in this paper). From this postulate, it follows that the structure of a grammar for a particular language should make certain claims about the nature of human language. This goal was not realized by the earlier structuralist theorists who rejected the "mentalistic" conception of language and concentrated solely on data that was directly observable so as to be scientifically verified. (These linguistic theories developed from theories of behaviorism and behavioral psychology widespread in the 1920's.) Chomsky, on the other hand, intended his grammar to be a partial theory of the human mind. In his phonological theory, he provides empirical evidence as justification for the distinctive feature principle. It's incorporation and adaptation into generative phonology is not a random choice; rather, it is "descriptively adequate" in that it involves a claim about the nature of human language and the "competence" or linguistic intuition of the native speaker.

We discussed earlier in this paper the fact that Bloomfield considered phonetic transcriptions a worthless study because they were so subject to the phonetician's skill in distinguishing and recording all the discriminable speech sounds in a language. Other theorists also cited their lack of interest in phonetics. Chomsky agrees that certain problems do arise in this type of analysis, but that these can be avoided if the phonetic transcription is simply thought to represent what the "ideal speaker-hearer" of a language interprets as the phonetic properties of an utterance, given his knowledge of the surface structure and the phonological rules which relate the surface structure to its physical actualization. Thus, in "systematic phonemics"[19], linguists are not concerned with recording facts observed in actual utterances (i.e., the acoustic and physiological aspects of speech), but rather, they view the structure of language as a representation of the competence of its speakers. The focus is thus on the speaker's "interpretation" rather than on directly observable properties of the signal. That there are discrepancies, then, with a one-to-one correspondence between a physical signal and its phonetic transcription is logical if one assumes that "his (the speaker-hearer's) interpretation may involve elements which have no direct physical correlates, since what is perceived depends not only on the physical constitution of the signal but also on the hearer's knowledge of the language as well as on a host of extra-grammatical factors."[20]

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[19] A term coined by Noam Chomsky which suggests the integrated relationships between the morphological, syntactic and phonological levels of the grammar in determining the sound structure of an utterance. The "systematic phonemic" representation is converted by an ordered series of transformations to a "systematic phonetic" representation, which utilizes a universal phonetic alphabet developed from Roman Jakobson's original set of distinctive features.

[20] Noam Chomsky and Morris Halle, The Sound Pattern of English, p. 294.

In light of Chomsky's work, phonetics has been elevated to a plane of genuine importance in Generative Phonology. A phonetic transcription in terms of Chomsky's theory is represented by a sequence of discrete units, each of which is a bundle of (phonetic) distinctive features (either physically-defined features, such as "voicing", tongue height, degree of lip-rounding, etc., or phonetic junctures). Any phonetic representation, for example, (Note /in/ in Table 3) can be regarded as a phonetic matrix, the rows of which correspond to the physical properties (i.e., the phonetic features) of the utterance, and the columns representing successive segments of the utterance. At this level of representation, "the entry occupying a particular square of the matrix will be an integer specifying the degree to which the segment in question is characterized by the corresponding property."[21] Matrices composed of such entries are the "output" of the phonological component. The "input" to this component is a string of morphs (formatives) which are subdivided into their Immediate Constituent Structures (i.e., "labeled bracketings") which represents the surface structure of the sentence or utterance.

In order to understand the processes involved in the generative analysis of sounds, we must ascertain what information is contained in the surface structure and how the rules of the phonological component use this information to specify the phonetic matrix just cited. Consider again the lexical item /in/ shown in Table 3. The phonological matrix corresponding to "in" will contain two segments in which the columns stand for the phonemic segments and the rows for the categories. Each square will represent a pair of opposed categories in terms of + or - values. "The rules of the phonological component will convert the phonological specification in terms of + or - values into the more detailed phonetic specification given in terms of integers, in which the value of each segment with respect to the

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[21] Ibid., p. 165.

TABLE 3*

(1) Phonological Matrix

	/t/	/n/
consonantal	-	+
vocalic	0	0
nasal	0	+
tense	-	0
stress	0	0
voice	0	0
continuant	0	0

(2) Phonetic Matrix

	/t/	/n/
consonantal	-	+
vocalic	+	-
nasal	2	+
tense	-	-
stress	1	-
voice	+	+
continuant	+	-

The value /+/ indicates that the segment under consideration possesses that category; /-/ indicates that the feature is not possessed by the segment; 0 indicates redundant information.

Note that only the Phonological Matrix excludes specification of values for redundant information. The Phonetic Matrix is fully-specified.

*Taken from Chomsky and Halle, The Sound Pattern of English, pp. 165-166.

phonetic features...is indicated to whatever degree of accuracy is required by the presupposed theory of universal phonetics, and with whatever range of variation is allowed by the language."[22] Redundant segments are retained in the phonetic matrix, but are not necessary in the phonological matrix. The segments in the phonological matrix are called "archi-segments" because they are not fully-specified. The function of the phonological rules is to extend the "incomplete" phonological matrices to "complete" phonetic matrices. (That is, they will determine the phonetic shape of "in" given the morphemic content and syntactic structure of this lexical item as specified by the syntactic component.) The important difference between these two matrices is that the latter is fully-specified, while the former is not. "We see, then, that the distinctive features of the universal phonetic system have a classificatory function (which is to specify the set of categories to which it belongs) in the underlying phonological matrix constituting part of the surface structure, and a phonetic function in the matrix constituting the phonetic representation of the sequence in question. Only in the former function are the distinctive features uniformly binary[23]; only in the latter do they receive a direct physical interpretation."[24]

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[22] Noam Chomsky, Language and Mind, pp. 128-129.

[23] In Generative Phonology, the phonological features are classificatory and hence, binary, as are all other features in the lexicon. Chomsky states that this is the logical way of stating whether a particular feature belongs to a particular segment. The phonetic features are not binary, but are scales indicated by integers which represent the different degrees of intensity which the feature in question manifests the utterance. Chomsky notes (The Sound Pattern of English, p. 297) that "failure to differentiate sharply between abstract phonological features and concrete phonetic scales has been one of the main reasons for the protracted and essentially fruitless debate concerning the binary character of the Jakobsonian distinctive features."

[24] Noam Chomsky, op.cit., p. 129.

It is a basic tenet of Generative Phonology that distinctive features be an integral part of the universal apparatus of linguistic description if phonological processes are to be adequately described. The example of "fronting" noted by J. P. B. Allen and Paul Van Buren in their book, Chomsky: Selected Readings clearly illustrates the primary justification for the distinctive feature theory.

In a structuralist description of the two morphs /kip/ ("keep") and /kat/ ("cat"), the two distinct [k] sounds are allophones of the same phoneme /k/. That the [k] in "keep" is fronted is shown by the following rule:

$$(1)\quad [k] \longrightarrow [\underset{+}{k}] / \text{——} \begin{Bmatrix} i: \\ i \\ ei \\ \varepsilon \\ æ \end{Bmatrix}$$

But the rule describes the fronting phenomenon with no explanations as to why the phoneme /k/ is realized as its "fronted" variant in these environments, but not in others. Although seemingly a random phenomenon, native linguistic intuition tells us that there is a common property (namely "frontness") to all of the vowels listed in brackets in Rule (1) which would cause the fronting of /k/. "The fact that Rule (1) fails to state explicitly what it is that all the vowels have in common in order to cause the fronting of /k/ is evidently a weakness of rules of this type...."[25] Thus, such a rule as (2):

$$(2)\quad /k/ \longrightarrow [+\text{front}] / \text{——} \begin{bmatrix} +\text{vowel} \\ +\text{front} \end{bmatrix}$$

precisely explains that it is the presence of a front vowel which causes the phonetic fronting of /k/ in this environment. The justification for the use of phonetic (distinctive) features is thus inherent in such a rule as (2). "If we assume that

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[25] J. P. B. Allen and Paul Van Buren, Chomsky: Selected Readings, p. 74.

phonological processes are non-random, and that we can state them in the form of rules which utilize phonetic properties such as [+front], [+vowel], it follows that an explanatorily adequate theory must be constructed on the basis of a set of all those phonetic parameters, or "distinctive features", which are relevant to the formulation of the phonological rules. Accordingly, Chomsky uses a 'universal phonetic alphabet' of distinctive features to represent those phonetic parameters which are relevant to his theory, and Chomsky's phonology is therefore dependent on phonetics in this strong sense."[26] The distinctive feature theory has thus been incorporated in a specific way into Generative Phonology, allowing the necessary "abstractness" for the rules and organizations of abstract phonological processes.

If phonemes work within a system, then in the course of a distinctive feature analysis, it will turn out that specific features are not necessary for the unique identification of a given phoneme. That is, a phonemic representation need not specify all of the features, but only those which serve to distinguish one morpheme from another. This is possible because phonemes are influenced by their phonetic environments. Consider the words "sea" and "ski". In the traditional articulatory approach, these would be represented as /si/ and /ski/ phonemically. Since the symbol, /s/, appears in both phonemic representations, it implies that the /s/ is phonemically the same in "sea" and in "ski". But it is clear that the /s/ is different in these two words at the phonemic level, even though the same "phonetic" sound does occur. A phonetic transcription, though would still not distinguish between the initial two phones of /si/ and /ski/.[27] In Table 4

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[26] Ibid., p. 74.

[27] The terms "phonetic" and "phonemic" take on different meanings in the Generative Phonology as developed by Chomsky. For the present example, the terms

TABLE 4

PHONETIC FEATURES	SOUND SEGMENTS	
	/s i/	/s k i/
Vocalic	-	-
Consonantal	+	
Voice	-	
Strident	+	
Coronal	+	
High	-	

it is noted that for the lexical item, "sea", the initial segment must be specified by six features in order to distinguish it from all other similar possible words in English. For "ski" however, the first sound segment need only be represented by one feature, /-vocalic/. This is due to the fact that in English, whenever a word begins with a sequence of two consonants and the second is /-continuant/, (/k/), the first can only be /s/. Since the difference between the /s/ in "sea: and the /s/ in "ski" is associated with different contexts, it is a non-distinctive, predictable or "redundant" feature since the true distinction is actually carried by the subsequent phones. In spite of their differing feature matrices, as long as these two /s/ sounds do not occur in the same contexts, they cannot represent two different phonemes. The redundant features are thus conditioned by the adjacent bundles of distinctive features constituting the phonemes in the sequence.

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will refer to traditional taxonomic (descriptive) phonemics where a phonetic transcription represents all discriminable speech sounds, but the phonemic will signify only the significant ones). Chomsky rejected the "phonemic" level, usually classed as intermediate between the phonetic and the morphophonemic levels, because the term "phoneme" is incompatible with the assumption that a phonemic representation is one from which all predictable information has been eliminated. His justification is that in a descriptively adequate grammar, the rules of the phonological component are ordered, and their gradual application will lead to many distinct representations between the level of systematic phonemics (often called "morphophonemics) and systematic phonetics. Hence, there is no definable level which can be classified as "phonemic" in the autonomous sense of the word.

By omitting the features fully predictable from the phonemic environment, the amount of redundancy (which is not necessary for the reliability of speech communication at this level of phonemic representation) in an analytic transcription can be reduced. These omitted redundant features are subsequently recalled through the operations of the phonological rules, which are purportedly a part of the grammar of English. That is, the speaker of English knows a rule predicting all of the phonetic features of /s/, except [-vocalic], when [s] appears at the beginning of a word before a [-continuant] sound segment. In other words, he knows that the only [-vocalic] sound which can appear in such an environment is [s].

In the grammar of the language, then, it seems plausible to employ some method of marking redundancy (either by parentheses as in Preliminaries to Speech Analysis, by utilizing "0" to indicate either + or -, or by leaving the cells blank) in order to eliminate those features which are predictable solely from other features specified in the same segment (i.e., a redundant feature) and those features predictable in terms of other segments in the environment (i.e., a contextually-determined feature). In this representation, then, the number of distinctive features needed to classify the segment as distinct from all others would be very small. The generality and economy afforded by the distinctive feature analysis in systematic phonemics are overlooked in tradtional articulatory phonemics. Yet, a complete grammar of a language must logically possess rules capable of differentiating the [s] in "ski" from the [s] in "sea". The traditional abbreviatory symbols obscure this difference and taxonomic phonemics is incapable of explicitly predicting the occurrence of [s] before a [-continuant] segment in English.

V. Distinctive Features Gaining Ground

A further, and more important, inadequacy of the taxonomic phonemic approach to the theory of "sounds" is its failure to describe the classes of sound segments that play important roles in the sound systems of human languages. As we know, Chomsky has proposed that the set of phonetic features utilized within a grammar must be universal. That is, it must include all the independent activities that the human vocal tract can carry out in the production of sound segments. However, he points out that the speakers of a language know certain generalizations about the sound segments in their particular language. These segments are organized into various groups called "natural classes" of sounds because each member of a particular class will share one or more phonetic features with every other member of the class. Thus, in English /s, z, š, ž, č, ǰ/ constitute a natural class of sounds which are all /+strident, +coronal/. In traditional articulatory phonetics, there is no simple, general way of describing this class such that each segment shares a set of features shared by no segment that is not a member of the class. In order to describe it, one has to resort to descriptions such as "the alveolar fricatives", "the palatal fricatives" and "the affricates" of English. But the articulatory phonetic features "alveolar" and "palatal" fail to show explicitly that these two positions of articulation are similar, and that sounds articulated at either point may operate as a single class in the sound system of a language. In systematic phonetics, on the other hand, the term /coronal/ does make this fact explicit. Using the features of systematic phonetics, the natural class of sound segments /s, z, š, ž, č, ǰ/ can be identified as all, and only, those sound segments of English which are /+strident, +coronal/.

If the properties in terms of which segments are characterized in transformational-generative grammars are the "phonetic features", the choice and

justification of the proper set of these features for phonological analysis should be of primary concern to modern theoretical linguists. Their choice and justification is empirical in nature and should allow us to capture certain significant linguistic generalizations. The natural class of sounds referred to above is such a generalization. Every English speaker possesses an internal linguistic rule which allows him to correctly produce the plural forms of the morphs and words in his lexicon. The occurrence of the three plural morphemes "/z/","/əz/" and "/s/" is not a random phenomenon. There are two phonological rules in the transformational grammar of English which apply to the phonemic representation of the "plural" morpheme represented as /-voice, +strident, +coronal, -high/ when this segment appears in certain phonetic environments, yielding either /əz/ or /z/. It happens that "plural" is always phonetically /əz/ when preceded by one of the segments in the natural class of sounds /s, z, š, ž, č, ǰ/. As previously stated, this class of sounds can be identified by the phonetic features /+strident, +coronal/. The phonological rule which predicts the occurrence of /ə/ in the representation of the "plural" morpheme is illustrated below.

$$(1)\quad \emptyset \longrightarrow /ə/ \;/\; \begin{bmatrix}+\text{strident}\\+\text{coronal}\end{bmatrix} \text{——} \begin{bmatrix}-\text{voice}\\+\text{strident}\\+\text{coronal}\\-\text{high}\end{bmatrix}$$

A second phonolgical rule changes the value of /voice/ in the "plural" morpheme from /-/ to /+/ when the sound segment immediately before it is /+voice/. Thus:

$$(2)\quad /\text{-voice}/ \longrightarrow /\text{+voice}/ \;/\; /\text{+voice}/ \begin{bmatrix}\text{——}\\+\text{strident}\\+\text{coronal}\\-\text{high}\end{bmatrix}$$

In this rule, the feature /voice/ in the "plural" morpheme assimilates to the feature /+voice/ as influenced by the preceding segment. Therefore, /s/——> /z/ as influenced by voiced /ə/.

These phonological rules capture the linguistic generalization that inserts

/əz/ after the natural class of sounds /s, z, š, ž, č, ǰ/. As shown here, the phonetic features allow us to refer to the specific properties of /+strident, +coronal/ in this group of sound segments, rather than listing separate segments which are unanalyzable into features, as if they had no common defining properties. Consequently, the phonological rules (1) and (2) provide empirical evidence for analyzing segments into their phonetic features (i.e., their distinctive features), and also for the decision to include "stridency" and "coronality" as among the universal set of features.

In Generative Phonological theory, the phonemes of a language are identified in terms of their phonetic features, while their properties of occurrence can be specified by a series of rules. Noam Chomsky, in collaboration with Morris Halle, (in working out their detailed phonological theory as expounded in The Sound Pattern of English, 1968), adapted the set of phonetic features from those distinctive and redundant features proposed by Jakobson, Fant and Halle in 1952. Besides the "naturalness condition" and the explanatory adequacy afforded to Generative theory by the use of the distinctive features, another major reason for the incorporation of these features was the recognition that there are similarities among consonants and vowes in terms of their positions of articulation. These similarities were ignored in the traditional approach, which utilized different articulatory features in characterizing the strictures in vowels and consonants. The "high", "mid", "low" and "front", "central", "back" positions characteristically used to describe the vowels were considered irrelevant dimensions for describing the consonants. As stated by Chomsky and Halle:

> ...The disadvantage of this method is that it fails to bring out the obvious parallels between vocalic and consonantal strictures. Thus, the difference between palatal and velar

> consonants clearly parallels that between front and back vowels, for in both cases there are the same differences in the position of the body of the tongue.[28]

Jakobson is praised for having captured this parallel in using the same three features, "gravity", "compactness" and "diffuseness", to describe both vowels and consonants. Chomsky and Halle have slightly revised this framework and in so doing have changed the original terminology. The shortcomings of the Jakobsonian framework were purportedly overcome by the modified system which follows:[29]

(1) Features specifying the position of the body of the tongue are now the same for vowels and consonants.

(2) In the characterization of vowel articulations, the features "high," "low," "back" correspond to the earlier "diffuse," "compact," and "grave," respectively. In consonants, the same three revised features correspond to palatalization, velarization and pharyngealization in the manner discussed above.

(3) The feature "anterior" mirrors precisely the feature "diffuse" in consonants.

(4) The feature "coronal" corresponds most closely to the feature "grave" in consonants but with opposite value. Except for the palatals (/k$_1$/, etc.), consonants that were classified as nongrave in the earlier framework are coronal in the revised framework, whereas those that were classified as grave are noncoronal. The palatals, which in the earlier framework were nongrave, are noncoronal.

Thus, in the new feature system, "coronal" segments correspond to sounds where the tongue blade is raised above its prespeech position. The segments previously termed "dental," "alveolar," and "palatal" in the articulatory description of English are /+coronal/ in systematic phonetics. The vowel segments of English all share the feature /-coronal/ because the blade of the

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[28] Noam Chomsky and Morris Halle, op.cit., p. 303.

[29] Ibid., p. 306.

tongue is never raised above prespeech position. (For [æ] and [ɑ], the blade is lowered, not raised.)

"Anterior" sounds are characterized by an obstruction before the palato-alveolar region in the mouth. Therefore, all vowels in English are [-anterior], as they lack constrictions. "Labials," "dentals" and "alveolars" would be classified as [+anterior].

The feature [coronal] corresponds to the movement of the blade of the tongue: three other features, [high], [low] and [back] refer to movements of the body of the tongue. The characterization of the vowels in terms of these features resembles the traditional articulatory description. As for the consonants, though, the palatals, velars, uvulars, and pharyngeals also involve movement of the body of the tongue. Note that for a segment to be [-high, -low, and -back] it is only necessary that the body of the tongue not move; the blade of the tongue may be raised without affecting the body--as in the production of segments such as [θ, ð, t, d, n, s, z].

The revisions noted here were made for several reasons. Firstly, the term "diffuse", as utilized by Jakobson, Fant and Halle covered too broad a range. It was used to characterize not only the distinction between open and close vowels, (i.e., "high" and "non-high" in Chomsky and Halle's terminology), but also between the velars and palatals (which were [-diffuse]) and the labials, dentals and alveolars ([+diffuse]). Because the term handled so many distinctions, it was quite complex and Chomsky and Halle introduced the features [anterior] and [high] to subdivide and clarify the usage of the older term [diffuse].

Another important reason for the revised versions of Jakobson's "diffuseness", "compactness" and "gravity", resides in the fact that the former terminology failed to capture generalizations in analyzing phonetic occurrences in other languages.

Chomsky and Halle in modifying their theory have attempted to provide a universal set of phonetic features, that is, to "list the individual features that together represent the phonetic capabilities of man....regardless of whether they play a role in the phonetics of English."[30]

James Harris in his book entitled, Spanish Phonology, provides us with a detailed examination of the Spanish language in light of the phonological component of a transformational-generative grammar. His observations are enlightening in that they lead to some interesting theoretical issues, one of which concerns the appropriateness of the set of distinctive features proposed by Chomsky and Halle in their Sound Pattern of English.

If we follow the logic of Harris evidenced in the examples below, we can see that the data as presented provides strong support for Chomsky and Halle's revisions of Jakobson's initial distinctive feature principle.

In a common structural analysis of Spanish, the distribution of nasal consonants may be represented by rules (3), (4) and (5).[31]

(3) /n/ → [[m] / ——/f/ ; [n] [ɲ] / word-final ; [n] elsewhere]

[em-fér-mo] /em-fér-mo/

[ál-bun] /ál-bum/

[ɾá-ma] /ɾá-ma/

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[30] Ibid., pp. 298 and 299.

[31] Taken from John B. Dalbor, Spanish Pronunciation: Theory and Practice, pp. 116-117.

(4) /n/ → [[m] / —— {/p/, /b/} ; [ɱ] / —— /f/ ; [n] / —— /n/ ; [ɳ] / —— {/t/, /d/} ; [ñ] / —— {/č/, /y/} ; [ŋ] / —— {/k/, /g/, /x/, /w/} ; [n] word-final ; [n] elsewhere]

[um-pá-to] /un-pá-to/
[um-bé-be] /un-bé-be/
[eɱ-fér-mo] /em-fér-no/
[kom-mí-go] /kon-mí-go/
[eɳ-trár] /en-trár/
[aɳ-dár] /an-dár/
[páñ-čo] /pán-čo/
[iñ-yek-sión] /in-yek-sión/
[eŋ-ká-ma] /en-ká-ma/
[poŋ-go] /pón-go/
[moŋ-xa] /món-xa/
[uŋ-wé-bo] /un-wé-bo/
[el-páŋ] /el-pán/
[fí-no] /fí-no/

(5) /ñ/ → [ñ] [á-ño] /á-ño/

It is evident from these rules that preconsonantal nasals in Spanish assimilate to the point of articulation of the following consonant. In limiting ourselves here to this characteristic of nasals occurring before consonants, rules (3), (4) and (5) can be collapsed in terms of distinctive features to rule (6).[32]

(6) [+nasal] → [+grave, αdiffuse] / —— [+obstruent, +grave, αdiffuse] [33]

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[32] James W. Harris, Spanish Phonology, p. 10.

[33] In contrast to a descriptivist analysis, Harris makes the claim that the nasal that occurs before palatal [č] and [y] is not palatal [ñ]. Rather, he feels it is auditorily and articulatorily closer to alveolar [n] in these positions and, thus, utilizes the symbol [n̆] to signify this. Therefore, in Rule (6), [+grave] is specified rather than [-grave] in order to prevent the assimilation of /n/ → [ñ] before a palatal consonant.

If we now consider the following set of words, it is evident that a rule

consu[m]ir	consu[ns]ión	consu[nt]o
to consume	consumption	consumed

must be formulated which will account for the final [m] of the stem "consum-" assimilating to alveolar [n] before [s] and dental [n] before [t], since Rule (6) does not specify the obstruents [t,d,s] (i.e., [+obstruent, -grave, +diffuse]). Rule (7) does show this phonetic phenomenon occurring as a result of the affixation.

$$(7)\quad m \longrightarrow n \;/\; \text{——} \begin{bmatrix} +\text{obstruent} \\ -\text{grave} \\ +\text{diffuse} \end{bmatrix}$$

In order to generalize the applicability of this rule to all of the nasal consonants, the following revision must be considered:

$$(8)\quad [+\text{nasal}] \longrightarrow \left\{ \begin{array}{ll} [-\text{next rule}] \;/\; \text{——} \begin{bmatrix} -\text{diffuse} \\ -\text{grave} \end{bmatrix} & \text{a.} \\ \begin{bmatrix} \alpha\text{diffuse} \\ \beta\text{grave} \end{bmatrix} \;/\; \text{——} \begin{bmatrix} +\text{obstruent} \\ \alpha\text{diffuse} \\ \beta\text{grave} \end{bmatrix} & \text{b.} \end{array} \right.$$

(a) here excludes the assimilation of /n/ $\longrightarrow$ [ñ] before palatals and (b) handles all other nasal assimilations. "There are, however, at least two difficulties with rule (8). First, use of the device [-next rule] is rather suspect on theoretical grounds. Second, and perhaps more important, (8) does not rule out [mč], [ñč] and [ŋč], which not only do not occur but are in fact impermissible sequences rather than fortuitous gaps."[34] Another rule could be formulated to alleviate these problems, but Harris states that it would include a set of extremely complex "if-then" conditions. Thus, the kinds of problems that arise with Rule (6) become evident when exceptions to the rule must be dealt with.

If we compare the feature specifications in terms of the traditional

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[34] James W. Harris, op.cit., p. 11.

distinctive feature framework with the revised framework as proposed by Chomsky and Halle in The Sound Pattern of English (note Table 5), it is quite obvious that the two Jakobsonian features, "diffuse" and "grave", do not serve to distinguish all of the phonetic variants from one another. They simply designate four points of articulation of consonants (i.e., labial, dental, palatal and velar), but do not make the phonetic distinctions that the data here demands. By using Chomsky and Halle's revised set of features, though, (which include the terms "coronal", "anterior", "back", and "distributed"), "we are not only able to distinguish bilabial [m̥] from labiodental [ɱ̊] and dental [n̪] from alveolar [n], but we may also distinguish an alveolopalatal [n̠] from both alveolar [n] and palatal [ñ]. Moreover, [n̠] has the same point-of-articulation features as [ć],...thus leaving no doubt that this nasal should be assigned the features listed for [n̠] in Table 5"[35]

In using the new features, Rule (9) may be formulated:

$$(9)\quad [+\text{nasal}] \longrightarrow \begin{bmatrix} \alpha\text{cor} \\ \beta\text{ant} \\ \gamma\text{back} \\ \delta\text{distr} \end{bmatrix} \Big/ \text{——} \begin{bmatrix} +\text{obstr} \\ \alpha\text{cor} \\ \beta\text{ant} \\ \gamma\text{back} \\ \delta\text{distr} \end{bmatrix}$$

This rule describes all of the phonetic distinctions in the process of nasal assimilation without the theoretically suspect device of [-next rule] or the complex "if-then" conditions. And one of the most revealing factors, deriving from its organizational economy in handling the complete data of Spanish nasal assimilation, stems from the realization that Chomsky and Halle when making their theoretical revisions in the set of distinctive features, did not consider data from the Spanish language. The example as noted by Harris thus provides

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[35] Ibid., p. 12.

TABLE 5*

(1) The Obstruents of Spanish which occur after the Nasals listed in (2).

		p,b	f	t,d	s	č,y	k,g,x
	vocalic	-	-	-	-	-	-
	consonantal	+	+	+	+	+	+
a.	diffuse	+	+	+	+	-	-
	grave	+	+	-	-	-	+
b.	coronal	-	-	+	+	+	-
	anterior	+	+	+	+	-	-
	back	+	-	-	-	-	+
	distributed	+	-	-	+	+	+

(2) The Phonetically-distinguished Nasals of Spanish

		m	m̲	n̲	n	ǹ	ñ	ŋ
	vocalic	-	-	-	-	-	-	-
	consonantal	+	+	+	+	+	+	+
a.	diffuse	+	+	+	+	+	-	-
	grave	+	+	-	-	-	-	+
b.	coronal	-	-	+	+	+	-	-
	anterior	+	+	+	+	-	-	-
	back	-	-	-	-	-	-	+
	distributed	+	-	-	+	+	+	+

empirical justification for the revised theory.

Any proposed theoretical linguistic innovation begins with a hypothesis which has only to be proved through hard-fast empirical evidence. Chomsky and Halle have included in their Generative Phonological theory a revised set of distinctive features which, unlike the original Jakobsonian features, are purported

*Taken from James W. Harris, Spanish Phonology, p. 12.

to be universal to all human languages. Their prediction has been borne out in Harris' description of the generative process of nasal assimilation in Spanish, but it has yet to be applied to a large number of other distinct languages. Until further investigations have assured us that the revised theory has actually captured linguistically significant generalizations, the sceptic might consider the proposed revisions as simple ad-hoc adjustments. Even so, the examples cited in this paper have illustrated the manner in which the distinctive feature theory has been incorporated into the phonological component of Chomsky and Halle's systematic phonemics, and the justification proposed for it. We have seen that the transformationalist is interested in features that occur systematically in language, not in aspects of sounds that occur randomly, are never noticed by the language users, or are unnecessary in producing or recognizing an utterance. The symbols of the phonetic alphabet as used by the descriptivists for describing phonological phenomena are currently considered simple abbreviations for full descriptions of the independently, controlable features of sounds in a language. The transformationalists have isolated what they see as the proper set of acoustic and/or articulatory features of which these sounds are composed which will maximize the number of phonological rules that operate in terms of natural classes. However, the features as proposed have been the subject of much current linguistic debate. The optimal set of distinctive features has, thus, yet to be established as it is so dependent on data from a wide range of languages currently under investigation.

VI. The Distinctive Feature Principle and Universals of Language

According to Chomsky, "the most interesting aspects of contemporary work in grammar are attempts to formulate principles of organization of language which, it is proposed, are universal reflections of properties of mind; and the attempt to show that on this assumption, certain facts about particular languages can be explained. Viewed in this way, linguistics is simply a part of human psychology: the field that seeks to determine the nature of human mental capacities and to study how these capacities are put to work."[36] Because Chomsky has returned to a mentalistic conception of language, he has attempted to establish a Universal Grammar composed of a Universal Phonetics, a Universal Semantics and a Universal Syntax which purport to explain the nature of all human languages. In concerning himself with universals of language, he has come to the realization that there exists great diversity among the sounds used in different human languages, but has also astutely noted that there are certain general patterns common to all languages. For example, all sounds must result from a limited number of vocal tract activities. These articulatory properties, as well as acoustic and perceptual properties, can be isolated from speech and probably exceed no more than 35 in number (although at the writing of The Sound Pattern of English--1968--the number was 28). In claiming that the set of such phonetic properties is universal, it follows that every language must make use of some of the components in this set and no others, although not all languages use all of the components. Thus, Chomsky, in developing a theory of Universal Phonetics, has incorporated the principle of distinctive features as the convenient method of accounting for the

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[36] Noam Chomsky, Language and Mind, p. 103.

universal set of "primitive sound elements" from which all languages in the world must draw. In addition to this system of phonetic properties, a universal phonetic theory would also establish certain laws or phonological rules governing permitted sequences and uses of these features for a particular language. "For example, Jakobson has observed that no language uses both the feature "labialization" and the feature "velarization" for distinguishing nonrepetitions (i.e., separate phonemes), and he has suggested a more general formulation in terms of which these two features can be regarded as variants of a single, more abstract feature. Generalizations of this sort--particularly when they can be supported by rational argument--can be proposed as laws of universal phonetics."[37]

Erik C. Fudge in a recent article (1972) entitled, "On the Notion 'Universal Phonetic Framework'", presents an interesting argument concerning the meaningfulness of a theory of universal phonetics, such as that alluded to by Jakobson, Fant and Halle (1952), and Postal (1968), and the one formally proposed by Chomsky (in Language and Mind, 1968). Fudge suggests that three separate universal frameworks be made explicit; one for articulatory phonetics, another for acoustic phonetics, and a final for perceptual phonetics; in order to account for Jakobson, Fant and Halle's statement: "It is not important whether the term (i.e., the distinctive feature) refers primarily to the physical (i.e., physiological) or perceptual level, as long as the feature is defined on both levels."[38] According to Fudge, in order to define the features on these different levels, it must be explained how they work on each level. Only in this way then, can the following assertion also be made explicit: "...The same acoustical phenomenon may be

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[37] Ibid., p. 123.

[38] Roman Jakobson, Gunnar M. Fant, and Morris Halle, op.cit., p. v.

obtained by altogether different (articulatory) means. Similarly, any given attribute of the auditory sensation may be the result of different physical variables."[39] Obviously, such a statement would have major significance in determining and categorizing the attributes of the meaningful sound units of which a language is composed. In the generative phonologies proposed by Chomsky and Halle, and Postal, phonetic properties have been implicitly equated with "articulatory" properties. But they have not concerned themselves with the fact that some articulatory properties of an utterance are at times ignored in perception; and yet, often several features, for example, "rounding", "retroflexion" and "pharyngealization" are grouped within a single feature "flat". Thus, any justification given for selecting an optimal universal set of distinctive features must be capable of distinguishing which one, or what combination of these three phonetic properties are actually involved, and on what level. Certain properties may be required on the articulatory level that are not pertinent to perception, and vice versa. Fudge concludes that work must be initiated for establishing distinct universal frameworks. He feels that the work begun by Jakobson in the perceptual field might be adequate in formulating a Universal Perceptual Phonetics; whereas the kind of information available from spectrograms may serve toward understanding the acoustic phenomenon of sounds; and further, proposes Chomsky and Halle's revised set of features as adequate in describing the articulatory basis of speech sounds.

The revised universal framework suggested by Fudge seems fundamental to an understanding, not only of how a language utilizes sound matter, but how the properties of the human mind, which organize and perceive these sounds, allow for

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[39] Ibid., pp. 12-13.

the remarkably complex process of human communication. In light of Fudge's innovative assumption, the following section of this paper will deal with the phoneme as it relates to the different levels of reality.

VII. The Reality of the Phoneme

All of our discussion of the phoneme and distinctive features in this paper have been based on the assumption that the stream of speech is somehow divided into segments. For many years it was thought that perceived segments (i.e., phonemes) correspond one-to-one to the physical flow of speech. It was in this way that the continuously variable flow of speech information was thought to be reduced by the hearer into a set of discrete finite categories. These units were viewed by the linguist mainly in articulatory terms and classified as "phonemes". But it may seem paradoxical to the layman to realize that speech is not a linear sequence of discrete sounds at all. It was not until very recently (after World War II with the invention of the spectrograph) that it became widely known that upon examination of an actual physical representation of an utterance (provided graphically by the spectrogram), there are no obvious segmentations that could be said to correlate one-to-one with the phonemes that a linguist might say compose the utterance. In spite of this formidable obstacle, some definite progress has recently been made in the area of Acoustic (Experimental) Phonetics in isolating the relationships between the articulation of sounds and their acoustic counterparts. For example, it is known that the vocal organs produce sound waves with varying intensities, different durations and distinct spectral components. But it is a relatively recent speculation that all of the components available to the acoustic phonetician on a speech spectrogram are not all essential to recognition.

The sound spectrograph is a machine which analyzes a complex wave form in order to discover its relative amplitudes and component frequencies. It provides a visible record of the formant structure (i.e., the characteristic concentrations of energy) of speech sounds over time. As such, its formant patterns were initially thought to correspond to distinct articulatory points of production. And it was found that sounds characterized by linguists as voiceless stops (in English) are represented graphically by a "gap" (i.e., a blank space) in the overall pattern of the spectrogram, but that upon its release, there is aspiration which occurs in the pattern as "spike fill" (i.e., narrow bands of heavy horizontal lines). Voiced stops, on the other hand, are shown by a "voicing bar" (i.e., a heavy solid horizontal bar) followed again by the "spike fill." And so on, for the voiced and voiceless fricatives, the vowels, and semi-vowels (/l, r, j, m, n, ŋ/) and combination sounds (the affricates and diphthongs), each having a graphically-distinct spectrogram structure. In spite of the precise nature of these results which correlated the acoustics of a sound with some particular characteristic of its articulation, the findings were only relevant for identifying distinctive sounds spoken in <u>isolation</u>. Like the earlier speech scientists, speech was still erroneously considered a sequence of distinct stationary configurations: but in the normal flow of speech, the speech wave has very few segments whose principal features remain even approximately stationary. The articulators spend most of their time in a state of transition. Thus, with the realization that speech is a continuously varying process, it was proposed that vowel sounds cannot solely be characterized by their three or more distinct concentrations of energy, called "formants."[40] Considerably more movement was

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[40] The formants are resonances of the vocal tract whose frequencies depend on the particular shape of the tract. When sounds were viewed as static entities, the positions of the first three formants were usually considered adequate for recognition (perception) of the particular vowel.

characteristically found in the second formant of a vowel than in Formant 1 or Formant 3. The acoustic phoneticians theorized that it is the movement of this second formant (called the "hub") which in relation to the first and third formants is what distinguishes the different vowels from each other. Further, it was found that a consonant is identified by its relationship to the transition of the second formant of a preceding or following vowel. In other words, it was found to be the "transition" of the second vowel formant which carries the necessary clues for consonant recognition. Once these factors were made explicit, it was possible to characterize individual sounds, and they were done so in terms of the distinctive features (analogous to Jakobson's original set). For once it was found that the basis for the "categories" of sounds does not lie in a one-to-one correspondence with the physical signal, the segments had to be re-defined in terms of acoustical, articulatory, as well as psychological criteria. The distinctive features as noted by Jakobson, et.al, seemed the most convenient and logical manner of representing these properties. Detailed perception tests were developed to test the results of these findings. They allowed the phoneticians to characterize and differentiate classes of sounds in English through distinct graphic representations on the spectrogram. Thus, if two consonants are noted to have the same second formant transition (hub), they are likely to be perceived as consonants with the same place of articulation.

A test carried out by Miller and Nicely in 1955 have actually shown important correlations between Jakobson's classification of sounds in terms of the number of features they have in common with actual acoustic perceptions. In their experiment, four female subjects were presented orally with one of 16 phonemes and asked to make a judgment as to which of the 16 they heard. Thus, if the phoneme

/f/ were presented, the subject was asked to try to identify it. Uncer certain conditions--where these phonemes were played against a background of noise, or certain frequencies of the sound wave were filtered out--, subjects often made errors. A detailed examination of these errors showed that subjects often confused phonemes that differed only in terms of a single distinctive feature (such as /f/ and /θ/, /p/ and /t/, etc.), and only rarely confused phonemes having relatively few features in common (for example, /f/ and /d/, /p/ and /ð/, etc.). Such results seem to provide support for Jakobson's notion of distinctive features, where "the listener is obliged to choose either between two polar qualities of the same category, such as grave vs. acute, compact vs. diffuse, or between the presence and absence of a certain quality, such as voiced vs. unvoiced, nasalized vs. non-nasalized, sharpened vs. non-sharpened (plain)."[41] An articulatory analysis of the confusions of the listeners resulted in the compilation of a list of five distinctive features; voicing, nasality, affrication, duration, and place of articulation. It was found that two or more phonemes differing with respect to only one feature were most often confused. Such a result provides good support for Jakobson's set of "minimal," "duple" or "triple" distinctions. As discussed in Preliminaries to Speech Analysis: "A distinction is called minimal if it cannot be resolved into further distinctions which are used to differentiate words in a given language....Wider differences may be termed duple, triple, etc., according to the number of minimal distinctions of which the total difference is composed. Duple distinctions are the result of two minimal distinctions."[42] It is in this way that the phoneme /p/ is more likely to be confused with /t/ under

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[41] Roman Jakobson, Gunnar M. Fant and Morris Halle, op.cit., p. 3.

[42] Ibid., p. 2.

a variety of distortions because the sounds differ only in their points of articulation, i.e., a minimal distinction; whereas /b/ and /t/ would less likely be confused, as their difference involves the duple distinction of voicing and place of articulation. The "confusion matrices" of identifiable features provided by Miller and Nicely's perceptual analysis of English consonants, further substantiates the "Prague School" notion that phonemes are composed of a number of smaller distinctive entities. These "distinctive features" are widely recognized by contemporary linguists as the systematically organized and independently controlable components of the phonological system of every language.

We see that some progress has been made in pinpointing the individual acoustic and articulatory features that contribute to the recognition of particular speech sounds, but psychologically there has been no clear statement on the matter. Yet psychological processes are known to be involved in the production and recognition of phonemes, and Chomsky, for one, has attempted to incorporate this concern into his theory. He hopes to shed light on the nature of language and ultimately on the nature of human thought processes which provide the competence inherent to a speaker's potential utilization of the infinite possibilities of his language. That is, in demonstrating the psychological reality of a phoneme, Chomsky is really concerned with the "descriptive adequacy" of his theory; and his grammar is justified to the extent to which it describes linguistic competence. But, as of yet, an adequate psychological definition correlated with the perception of the phoneme type unit has yet to be formulated.

Modern phoneticians know that speech is an acoustic phenomenon, but they are puzzled by the fact that phonemes are not of any sort of physical reality that can be strictly discernible by instrumental techniques or direct observation.

Some of the acoustic features are obviously spectral (for example, the frequencies of the formants which can be graphically-depicted). Other features, like formant transitions, are concerned with the relationship of spectral features at different instants of time. Important clues are also provided by duration and intensity of the speech. But experiments in speech recognition and production have shown that these cues are highly variable. A wide range of formant frequencies is recognized as the same vowel, and ranges appropriate for each vowel, overlap. Experiments with filtered and distorted speech have also shown that acoustic cues are not only ambiguous, but that many of them can be eliminated without loss of intelligibility of speech. It is currently conclusive from these experiments, then, that the acoustic features of the speech wave are not the only cues available for speech recognition. Yet, in spite of all this evidence pointing to the fact that language is a continuous flow of unbroken sound, the linguist has not been encouraged to abandon the concept of the phoneme. Since the beginning of man's awareness of his language capabilities and his own language structure, he has assumed that his speech is a sequence of discrete entities. Morris Halle has stated that:

> ...Although there are no (instrumental) procedures for isolating these (phonemic) entities....there are numerous precedents in science for such a position....For example, the status of the phoneme in linguistics is analogous to that of electrons in physics, where Helmholtz postulated that electric current is a flow of discrete particles without having isolated or even having much hope of isolating one of these particles.... In this sense, then, the phoneme is as real as any other theoretical entity in science.[43]

At the state of our knowledge today, then, the phoneme can simply be defined as a feature of language structure, i.e., an abstraction from the psychological, acoustical and articulatory patterns which enable the linguist to describe the

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[43] Morris Halle, "On the Bases of Phonology", in Makkai's Phonological Theory, pp. 393-394.

observed repetitions of things which seem to function within the system as identical. The phoneme, as well as the distinctive features, are in short, linguistic features only. They are the intellectual creation of the linguist who examines his language for definable and repeatable characteristics that can help him to explain and generate other linguistic phenomena. Having accepted the theoretical reality of a phoneme as the individual abstract units which compose an utterance, we may view the distinctive feature as the simultaneous, yet partly independent abstract properties which combine to form a phoneme. Although these attributes are the theoretically-existing creations of an observant linguist, they cannot be created at will. There must be some adequate basis on which to describe the attributes, properties or units of which the sounds in a language are composed. The linguist in his attempts to establish a model of the workings of the sounds in a language, must find one which most adequately fits the observable facts. The language imposes real limitations and often quite narrowly circumscribes the freedom of the linguist to set up his model. The true reality of the phoneme lies within these limitations.

Since the appearance of the article by Y. R. Chao on "The Non-uniqueness of Phonemic Solutions of Phonetic Systems" (1934), it has been recognized that the systems of sounds of any language may be subject to several equally satisfactory "phonemic solutions." In recalling the distinctions made earlier in this paper, it was concluded that the emphasis of the structuralists for defining and identifying the inventory of phonemes in a language was concentrated primarily on the properties which all repetitions of a given phoneme may possess in common (i.e., in determining those physical properties that are invariant in several utterances that enable them to be identified as the same: whereas the followers of the

Prague School linguists focused on all properties which differentiated each repetition of a given phoneme from all other possible phonemes which might have been uttered in its stead. (The focus was thus directed toward the distinctive differences instead of the similarities.) It has been proposed that because the latter method is more economical (in that it requires less features to explain more phenomena--note Householder's argument below), it may seem to be the more reasonable approach. Roman Jakobson, et. al., has attempted to provide a unique analysis of the set of discrete units which compose the utterances of a language by stating:

> By successively eliminating all redundant data...the analysis of language into distinctive features overcomes the "non-uniqueness of phonemic solutions". The present approach establishes a criterion of the simplicity of a given solution, for when two solutions differ, one of them is less concise than the other by retaining more redundancy.[44]

The sole criterion that the authors propose for evaluation of a phonemic solution is "redundancy." That is, the phonemic system for a language is the one with the minimal average number of features necessary for specifying each phoneme. If this were true, then all of our problems would be solved. Unfortunately, the continuing controversies over the naturalness of the binarity condition, clarification of the nature of the relation between distinctive feature analysis and the physical facts of speech, and the optimal inventory of features for describing human languages, has yet to be resolved. If one considers that the disagreements that have ensued among linguists with regard to "phonemic" analysis have been considerable, they are but trivial when compared with disagreements in regard to the analysis of minimal features. Jakobson considerably limits

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[44] Roman Jakobson, Gunnar M. Fant, and Morris Halle, op.cit., p. 7.

the number of possible solutions by his postulate of binary opposition. Even in his initial workks, the principle is not validated since he included the possibility of complex features of sounds (designated by the symbol ±). So, it is evident that the initially proposed principle has not led to any sort of logical conclusion for the classification of sounds in a language, nor to a unique analysis. The number of possible analyses follows directly from the principle of "discreteness" in language. So long as the linguist is tied to an analysis of the abstract discrete entities of language, he is bound to come to a decision over borderline cases.

A phonemic solution which is arbitrary and unmotivated, allows for alternatives. Chomsky and Halle have attempted to rid their analysis of arbitrary alternatives to phonemic solutions by relying on a mentalistic conception of language. They have depended basically on two principles of description: simplicity and (descriptive and explanatory) adequacy.

Halle states that the simplicity criterion, which is equated with the concept of "brevity" of the description, is measured by the number of discrete symbols employed. And it is on this basis[45] that alternative grammars can and should be evaluated. According to their theory, a complete description of a language will include a list of all the morphemes, i.e., a lexicon or dictionary. Being subject to the simplicity criterion it is required that:

a. Phonological rules be stated completely in terms of features.

b. A grammar should be evaluated by minimizing the total number of features specified in the lexicon and in the phonological rules.

By minimizing the total number of features contained in the grammar, it follows that one may be able to determine the optimal organization of the distinctive

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[45] Chomsky and Halle consider the simplicity criterion to be internal to linguistic theory. This notion has been argued and recieves further consideration in the following pages.

feature matrix (i.e., the particular features to be specified and their order of occurrence) and consequently of the dictionary. The simplicity criterion helps to determine the particular feature matrix which is not only non-redundant, but which can also serve as the basis of the simplest possible description of the language. This procedure seems to remove the justification for the objection voiced by Householder[46] that the distinctive feature matrix is arbitrary with regard to the decision of which features should be specified in the matrix as distinctive and which as redundant. Chomsky and Halle are justified in that the presentation of a particular feature matrix which is non-redundant is not only economical, but also reduces the complexity and arbitrariness of the entire grammar. It is evident, then, that the elimination of redundancy is not arbitrary once the simplicity criterion is in operation.

But Householder, in"Phonological Theory: A Brief Comment" (1966), voices yet another argument against the notion of "economy" as purportedly afforded by the distinctive feature notation. He doubts that "our brain storage has any great use for economy" assuming instead that an "extravagant" amount of redundancy is an inherent feature of our brain's capacity, which "has no need for economizing storage space."[47] With this assertion, he rejects a grammar which claims that the brain has only to store one feature (/-vocalic/) for /s/ in "ski"[48], thus eliminating all redundant, predictable features which may eventually be regenerated. He does not argue for the complete rejection of distinctive features in linguistic theory "as they are useful for all sorts of things," but feels that they do not

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[46] F.W. Householder, Jr., "On Some Recent Claims in Phonological Theory", in Makkai's Phonological Theory, p. 450.

[47] F.W. Householder, Jr., "Phonological Theory: A Brief Comment", in Makkai's Phonological Theory, pp. 486-487.

[48] Note Table 4, p. 26.

justify the notion of the simplicity criterion as he understands it. Although he does not offer a concrete alternative to the specification of elements in terms of features, he implies a preference for a theory allowing separate status to the traditional phonemic notation. These units he feels would save in "ink" and "physical bulk in printing", while also being easier to read. But it is obvious that through such rationalization as this, he is reducing himself to the base criteria of "convenience" which, alone, is certainly devoid of any theoretical linguistic significance. Whether he believes that our brains can or cannot economize by eliminating certain phonetic features, is at the current time an untestable notion. Unfortunately, unless Householder explicitly shows us how equally good or better results could be achieved by a theory utilizing segmental segments of some sort or another, his argument against the economy afforded by the distinctive features cannot be proved or disproved.

Even more fallacious though, is his assertion that Chomsky and Halle's proposed phonological theory "bears little or no relation to what goes on in the speaker's brain."[49] A linguist does not possess super-human powers, (although at times, his assertions are mistaken for God's truth). None of the grammars that has so far been proposed in linguistic theory can be considered anything more than schematicized versions of a speaker's competence as inferred from a severly limited amount of tentative language data. That is, a grammar of a language is simply a "theory" of a speaker's competence, and bears no relation (or else a very abstract one) to the physical functioning of the brain itself. The grammars for individual languages, as proposed by Chomsky, et.al., are structural analyses of the language, not analyses of brain structures, although they may quite

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[49] F.W. Householder, Jr., "Phonological Theory: A Brief Comment", in Makkai's Phonological Theory, p. 487.

incidentally shed light on "certain organizing principles in the mind which make it possible for a speaker to use language creatively."[50] Householder's arguments certainly indicate that he is unaware of these facts.

As outlined in this paper, the incorporation of the distinctive features into the generative theories of phonology has been based largely on the principles as initially proposed by Noam Chomsky and Morris Halle (1968). Their arguments are summarized below:

> ....We showed that for a wide range of linguistic data, which otherwise would have to be treated as isolated fact without systematic import, we could offer partial explanations if we consistently formulated all rules and representations (both systematic phonemic and systematic phonetic) strictly in terms of features. Systematic reliance on features thus permits a deepening insight into the nature of linguistic competence and makes possible an analysis of the notion 'linguistically significant generalization,' a notion which underlies all descriptive practice but has, so far, resisted clear and general formulation.[51]

If all linguistic work, then, is to be guided by certain assumptions related to the nature of linguistic structure and linguistic intuition, the adequacy of a particular solution can be tested only by determining whether the descriptions to which they lead are in accord with every speaker's inherent knowledge about his language. Dealing with the character of mental processes and linguistic intuition, though, is in itself a dubious process. Data obtained solely from a native speaker's intuition is highly inconclusive, since it varies unpredictably from speaker to speaker and within the same speaker from time to time. It is on on these grounds that Householder argues for a complete account of the hard facts,

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[50] H.P.E. Allen and Paul Van Buren, op.cit., p. viii.

[51] Noam Chomsky and Morris Halle, "Some Controversial Questions in Phonological Theory", in Makkai's Phonological Theory, p. 458.

i.e., for procedures which correctly observe, describe and test the corpus of data on which a grammar is based. He insists that a level of Observational Adequacy is a necessary prerequisite to justifying a grammar on the basis of levels of Descriptive and Explanatory Adequacy. As we remember, a grammar meets the level of Descriptive Adequacy to the extent that it correctly accounts for a speaker's inherent linguistic knowledge. It meets the level of Explanatory Adequacy to the extent that it provides a "principled" basis for the selection of a descriptively adequate grammar. Householder is very wary of the validity of arguments based solely on "intuition," and thus emphasizes the primacy of the level of Observational Adequacy. But what he seems to be ignoring here is that some notion of linguistic intuition or "tacit competence" is quite apparent in all linguistic work. Even Bloomfield's original phonemic analyses were structured with respect to the meaningful differences and similarities found in language. The "meaningful" units, which he termed "phonemes", were developed from an informant's intuitive knowledge of his native language: and the patterns that the grammarian established for the structure of his grammar were based on such notions as "phonetic similarity," and "symmetry" in the language. That these properties were isolated in the first place, and ultimately tested for, is direct evidence that the linguist was relying (implicitly) on his native linguistic intuition. Certain obscure and "strange" patternings of language structure were rejected, not on the basis of available data alone (we have already stated that there may be several completely different theories all consistent with empirical evidence), but because they "seemed" wrong. In other words, the ultimate criterion for developing procedures and structures of linguistic analyses and theories, has always been guided by an innate reliance on the tacit knowledge of the native speaker. In the final analysis, it is only he who can judge what is "right" or "wrong" -- and he is solely justified on the basis that it "sounds good" to him.

Returning now to the notion of a unique phonemic solution, it seems reasonable to assume (as Householder does) that there may not be one "correct" descriptively adequate grammar. It is highly propable that several linguistic theories, all consistent with empirical evidence, could be constructed which would fully satisfy the notion of descriptive adequacy. Householder insists that the day may come when linguists are faced with "two inconsistent and irreconcilable descriptions of a language, each perfect in its own right by conveying some important 'intuition' about the language not conveyed by the other."[52]

The assumption implied here by Householder is that the science of linguistics will eventually come to a complete standstill. Yet, the notion of a permanent stalemate is inconsistent with the history of any serious field of scientific study, since such a "static" situation is simply a forthright challenge for more research on the matter. Chomsky, when confronted with the possibility that there is perhaps no unique discrete analysis of sounds, retorts:

> ...The real problem for the linguist is to find a theory (actually, a small part of a theory) that will come somewhere near accounting for some domain of linguistic fact; the problem for the grammarian is to develop some small fragment of a grammar that is adequate for some part of the language that concerns him. Where two equally effective fragments can be constructed, the grammarian will attempt to choose between them by enriching the domain of relevant fact or deepening linguistic theory; where two linguistic theories are equally adequate, he will attempt to adjucate between them by bringing additional facts to bear, facts which can be accounted for by one but not by the other. This is the only way in which the grammatical descriptions of particular languages or the general theory of linguistic structure can progress.[53]

It is clear, then, that one of the primary goals of a linguistic theory should be in demonstrating why one grammar is correct and all others are incorrect. Thus, at the stage of our knowledge today, the pertinent question is not, "Is language describable?", but rather, "When will the truth be discovered?"

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[52] F.W. Householder, Jr., "On Some Recent Claims in Phonological Theory", p. 444.

[53] Noam Chomsky and Morris Halle, "Some Controversial Questions in Phonological Theory", p. 462.

VII. The Battle of the Features

In the realm of scientific pursuits, it is often the case that a proposed hypothetical theory, (as well as any specific analytic procedure applied to that theory), must be bandied about among the professionals with the purposeful intent of pointing out problems hitherto unnoticed. The distinctive feature theory, which has been incorporated into generative theories and largely rejected by the structuralists, cannot solely be justified or refuted in terms of explicit empirical data pertaining to particular languages; but it must ultimately be related to universal claims about the nature of human language in general. Since the initial development of the theory, it has been the focal point of heated debates and often fruitless arguments. The main issues in current dispute as revealed in this historical sketch of the principle, have been both theoretical and practical in nature. Although the theory has been shown to be of major importance in explaining relevant phonological phenomena, answers to the remaining questions are inconclusive at present. And so, as we flee the scene of the raging battle over the technicalities of the distinctive feature principle; let us take a moment to reflect on the current status of the theoretical considerations presented in this paper as so candidly expressed in the following quote:

> ....If there are unique correct descriptions of languages, I do not believe we can hope to approximate them for any given language within our life-times, and should strive meantime to give the best descriptions we can by whatever standards we can find; Chomsky seems to believe that we already know much of the truth and should find the rest very shortly, after which linguists can go out of business.[54]

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[54] F. W. Householder, Jr., "On Some Recent Claims in Phonological Theory", in Makkai's Phonological Theory, p. 455.

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