2

DISTINCTIVE FEATURE THEORY

2.1 The Need for Distinctive Features

Although the phonological rules in Chapter 1 are all written in terms of segments, such notation is actually only an abbreviation. Rules typically apply to classes of phonetically related segments, and not to arbitrary classes of unrelated segments. Thus, the change of /s, z, t, d/ to [š, ž, č, ǰ] illustrated from American English in the preceding chapter involves something more general than four segments changing into four other segments. In particular, the four phonological segments /s, z, t, d/ have in common that they are alveolar consonants.[1] The four phonetic segments [š, ž, č, ǰ] have in common that they are alveopalatal consonants. Thus, in order to reveal that these two classes of segments are not composed of random members, the American English rule by which the former consonants are converted into the latter consonants before /y/ should, as a first approximation, be written as follows:

Alveolar → Alveopalatal / __ y
C C

[1] Actually, since they are not nasals or liquids, the consonants /s, z, t, d/ have in common that they are alveolar *obstruents* (see **2.4.1**).

If the phonological segments becoming [š, ž, č, ǰ] had been /s, k, b, r/, no general phonetic feature such as alveolar could have been stated; similarly, if /s, z, t, d/ had become [š, g, p, l], no general phonetic feature such as alveopalatal could have been stated. In fact, this is exactly what is expected. Since the two classes /s, k, b, r/ and [š, g, p, l] are composed of arbitrary segments, we should not expect to find languages utilizing these classes. However, the arbitrariness of /s, k, b, r/, as opposed to /s, z, t, d/, is revealed only when an attempt is made to *extract* the phonetic property shared by all of the segments. When a phonetic property can be extracted, a generalization is revealed. When no phonetic property can be extracted, these segments should not be expected to occur as a class in languages.

It is a significant fact about phonological systems that segments typically group themselves into phonetically definable classes. As just seen, they do so in the inputs as well as the outputs of phonological rules (see **1.4.2**). However, while the reformulation of the above rule of American English is superior to the original formulation in Chapter 1 involving individual segments, we still fail to see in this new statement of the rule why the class of alveolar consonants should become alveopalatal before the segment /y/. As stated, it would perhaps make as good sense for this change to be accomplished before the segment /p/ or /r/, etc. In order to reveal the phonetic motivation or "naturalness" of such a change before /y/, the rule must be reformulated again with /y/ restated also in terms of phonetic features:

Alveolar → Alveopalatal / __ Palatal
C C G

Now we see that alveolar consonants become alveopalatal before a palatal glide, which /y/ is. In other words, the phonetic motivation for this rule—rather than an equivalent change taking place before /p/ or /r/—is now made explicit: alveolars become *palatalized* to alveopalatals before a palatal. Thus a full understanding of this process of palatalization is possible only when phonetic features are substituted for segments.

Just as the symbols *C*, *V*, *N*, *L*, and *G* are abbreviations for consonants, vowels, nasals, liquids, and glides, symbols such as *p*, *t*, *k*, *a*, *i*, *u* are used as convenient shortcuts for the feature compositions which combine to produce these segments. The symbol *p*, for instance, stands for a consonant which is voiceless, labial, and a stop; the symbol *a* stands for a vowel which is low, central, and unrounded. While such segments will be used in the formulation of phonological rules below, it is important to recognize that the phonetic features are ultimately the factors responsible for the way phonological systems function.

2.2 Trubetzkoy's Theory of Distinctive Oppositions

The study of the phonetic properties of segments is the subject of the various branches of phonetics. As such, this study of how speech sounds are made dates back over two millennia. As phonologists, our interest in phonetic features centers around the question of how the articulatory and acoustic properties of sounds are put to work in various languages—in particular, how they function to convey meaning. We shall begin with the work of Trubetzkoy, one of the founders of the Prague School of Linguistics, which developed in the decade preceding World War II.

Trubetzkoy (1939) attempted a comprehensive taxonomy of the phonetic properties of the distinctive contrasts employed by languages. He was interested not only in how /p/ differs from /b/, but also in what the nature of the contrast was within a given phonological system. Thus, in his *Principles of Phonology*, he classified distinctive oppositions[2] on the basis of (1) their relationship to the entire system of oppositions, (2) the relationship between opposition members, and (3) the extent of their distinctive force.

2.2.1 Bilateral, Multilateral, Proportional, and Isolated Oppositions

The first dichotomy Trubetzkoy draws is between *bilateral* and *multilateral* oppositions. In bilateral oppositions, the sum of the phonetic (henceforth *distinctive*; see below) features common to both members of the opposition is common to these two members only (1939:68). Thus, in English, /p/ and /b/ stand in a distinctive opposition and have in common that they are "oral labial stops." The opposition is bilateral since there are no other consonants in English which come under the heading "oral labial stops." /m/ is not in the same class because it is nasal, and /f/, /v/, and /w/ because they are not stops. In Thai, on the other hand, one finds not only /p/ and /b/ but also /p^h/. We can still say that /p/ and /b/ stand in a bilateral opposition, but it is necessary to further specify the properties that they have in common as "oral unaspirated labial stops." However, /p^h/ and /b/ do not stand in a bilateral opposition. They have in common that they are "oral labial stops," but /p/ is also an oral labial stop. Since there is a third segment which shares the properties common to /p^h/ and /b/, these latter segments are said to be in a *multilateral* opposition.

Another example comes from English /f/ and /b/. The two consonants have in common that they are "labial obstruents" (see footnote 1). This is an example of a multilateral opposition, since /p/ and /v/ are also labial obstruents in English. In Berber, however, which has no */p/ or */v/, /f/ and /b/ stand in a bilateral opposition, since there are no other labial obstruents in the language. Thus, the same phonetic segments distinguished by the same phonetic features can stand in a multilateral opposition in one language and in a bilateral opposition in another language.

Another distinction is made concerning oppositions which, in relation to the whole system, are either *proportional* or *isolated*. Trubetzkoy states (p. 70) that "an opposition is proportional if the relation between its members is identical with the relation between the members of another opposition or several other oppositions of the same system." Otherwise the opposition is said to be an isolated one. In English, the opposition between /p/ and /b/ is proportional, because the relation between its members is identical with the relation between /t/ and /d/ and between /k/ and /g/. On the other hand, the opposition between /l/ and /r/ is isolated, since no other segments in English stand in the same relation as these two opposition members. Whether an opposition is proportional or isolated depends on the language. For example, the relation existing between /t/ and /x/ (that is, alveolar stop : velar fricative, agreeing in voice quality) is isolated in Standard German, since there is no /ɣ/ to correspond with the voiced alveolar stop /d/. In a language with /t/, /d/, /x/, and /ɣ/, the relation between /t/ and /x/ would be a proportional one, since /t/ is to /x/ as /d/ is to /ɣ/. Trubetzkoy concludes (p. 71) that "these different types of oppositions determine the inner order or structure of the phonemic inventory as a system of distinctive oppositions." Thus "proportions" can be stated, such as $p:b = t:d = k:g$, which are said to have "phonological reality" (p. 72).

2.2.2 Privative, Gradual, and Equipollent Oppositions

In classifying oppositions on the basis of the relation between the members of the oppositions, Trubetzkoy recognizes oppositions which are *privative*, *gradual*, and *equipollent* (p. 75). In privative oppositions, one member of the opposition carries a phonetic "mark" which the other member lacks. In other words, it is a question of the presence vs. the absence of a feature. In the opposition /b/ : /p/ in English, /b/ is characterized by the presence of voicing, while /p/ lacks voicing. In the opposition /m/ : /b/, /m/ is characterized by nasality, while /b/ lacks it. In Thai, /p^h/ has aspiration, while /p/ lacks it, and so on. The opposition member which is characterized by the presence of a mark is said to be "marked," while the member which is characterized by the absence of this mark is said to be "unmarked" (see **5.1.2.1**).

[2] By opposition is meant a sound difference which results in a meaning difference, as discussed in Chapter 1. Thus there is an opposition between /p/ and /b/ in English, which are said to be *phonemes*, because of such word pairs as *pan* and *ban*.

Oppositions in which the members are characterized by different degrees or gradations of the same property are said to be gradual. Thus, in a language such as Yoruba, which has the following seven-vowel system,

i		u
e		o
ɛ		ɔ
	a	

the opposition between /u/ and /o/ is a gradual one, since the vowel /ɔ/ is a third degree of the same property (vowel height). /u/ cannot be said to carry a mark, because there are three values of back rounded vowels—high, mid, and low. In Turkish, on the other hand, where the following vowel system is found.

i	ü	ɨ	u
e	ö	a	o

it is possible to regard the opposition between /u/ and /o/ as a privative one. This possibility results from the fact that there are only two vowel heights that are phonologically relevant in Turkish. The vowel /u/ can therefore be said to have (high) vowel height, whereas the vowel /o/ lacks (high) vowel height. In the binary feature system to be proposed in **2.4** below, the vowels in the first row are viewed as [+high], and the vowels in the second row are [−high].

The third possible relation between members of an opposition results when the members are considered "logically equivalent" (p. 75). In other words, it is not possible to view one as having a mark which the other lacks. Nor is it possible to view the two members as differing by the degree of some phonetic property. Such an example is the opposition in English between /p/ and /t/ or between /t/ and /k/. It is not possible, as in the case of vowel heights, to speak of a continuum from labial to velar, whereby /p/ and /t/ would differ, say, by degree of backness. Unlike vowels, where only the degree of vowel height is involved, different places of articulation in consonants are obtained by discrete changes in the two articulators. Thus, the labial consonant /p/ involves the upper and lower lips, while the consonant /t/ involves the tip of the tongue and the upper teeth. This third category of oppositions is termed equipollent.

In determining the nature of an opposition, it is always important to consider the inventory of distinctive sounds (phonemes) in the language under investigation. We have seen that the same opposition can be privative in one language but gradual in another. For this reason Trubetzkoy distinguishes between "logically" privative, gradual, or equipollent and "actually" privative, gradual, or equipollent. The /u/ : /o/ opposition discussed above is logically gradual (since we know that there are languages with /ɔ/), but

may be considered actually privative in a language such as Turkish. This opposition is, of course, actually gradual in Yoruba, which has /ɔ/. Thus, in Trubetzkoy's view, there are phonetic universals (universal relations between sounds), but languages may alter the logical (that is, phonetic) relation between two opposition members in phonological systems.

2.2.3 Constant and Neutralizable Oppositions

Trubetzkoy's (1939) final classification is made according to the extent of the distinctiveness of an opposition (p. 77). He draws a distinction between *constant* and *neutralizable* oppositions. A classic example of a neutralizable opposition comes from Standard German. While there is an opposition between the voiceless consonants /p, t, k, f, s/ and the voiced consonants /b, d, g, v, z/ in some positions of the word in German (for example, *Tier* [ti:r] 'animal' vs. *dir* [di:r] 'to you'), only the voiceless series is found at the end of a word. Although *Rat* 'advice' and *Rad* 'wheel' are written differently, both are pronounced [ra:t]. The plural forms *Räte* [rɛ:tə] 'advices' and *Rader* [rɛ:dər] 'wheels' show a contrast between /t/ and /d/, since these consonants are, with the plural suffixes *–e* and *–er*, no longer at the end of the word. The opposition between /t/ and /d/ is therefore realized phonetically only in certain positions. Where only [t] is found phonetically, the opposition is said to be *neutralized*. On the other hand, when the two members of an opposition can occur in all positions, there is no neutralization. Rather, the opposition is said to be *constant*. In Nupe, for instance, the general phonological structure is CVCV. That is, each syllable consists of a consonant followed by a vowel, with few exceptions. The opposition /t/ : /d/, as exemplified by the verbs /tá/ 'to tell' and /dá/ 'to be soft,' is a constant one, since both opposition members are found in all possible consonant positions (see **5.1.2.1**).

2.3 Jakobson's Theory of Distinctive Features

The importance of Trubetzkoy's work is that he attempted to give a *phonological* analysis of phonetic contrasts. In his framework, it is possible not only to describe the opposition between /p/ and /b/, as in English /pɪn/ and /bɪn/, as one of voicing, but also to characterize it as bilateral, proportional, privative, and neutralizable.[3] With these notions, Trubetzkoy was able to reveal how the same phonetic contrast may structure differently in different languages. Depending on the system, a given opposition may be

[3] The opposition between /p/ and /b/ is neutralizable in English because only [p] is found after word-initial /s/, e.g., *spin*, but not **sbin*.

privative in one language but gradual in another (for example, /u/ : /o/ in Yoruba and Turkish).

While Trubetzkoy's concern was to capture the phonological properties of such frequent phonetic contrasts as voicing in consonants and height in vowels, the concerns of Jakobson, another founding member of the Prague School, were somewhat different. Jakobson wanted to develop a theory of phonology which would predict only those oppositions which could be found in languages. In particular, he hypothesized that the presence of certain phonetic oppositions precludes the presence of other oppositions. For example, in works such as Jakobson, Fant and Halle (1952) and Jakobson and Halle (1956) it is maintained that languages do not have contrasts between labialized, velarized, and pharyngealized consonants, that is, /C^{w}/, /C^{ш}/, and /C̣/, respectively. Jakobson claimed that a given language will contrast only *one* of these three consonant types with a plain /C/. Thus, while there can be an opposition between /C/ and /C^{w}/, /C/ and /C^{ш}/, and /C/ and /C̣/, one cannot find an opposition between /C^{w}/ and /C^{ш}/, /C^{ш}/ and /C̣/, or /C^{w}/ and /C̣/. This mutual exclusiveness of these three kinds of consonants led Jakobson, Fant and Halle to propose that they are merely surface phonetic realizations of the same underlying feature of *flatness* (see below). They hypothesized that there are a limited number of such features, say 12 to 15, which together account for all of the oppositions found in the world's languages.

Since many more than 12 to 15 *phonetic* features are necessary to differentiate the various sounds occurring in languages, it becomes apparent that some of these phonetic features will be "conflated" into the more limited set of *phonological* or *distinctive* features. This represents, then, a major departure from earlier phonetic studies of speech sounds. In the work of other phoneticians and phonologists, there is an assumption that the same features are to be used to characterize phonological contrasts in a language and to describe the phonetic content of various speech sounds. Jakobson's position is that there are certain phonetic distinctions, such as labialization, velarization, and pharyngealization, which are not available per se as phonological features but rather are representative of the more basic phonological feature of flatness. Thus, for the first time, the possibility is entertained that the set of phonological features may not be the same as the set of phonetic features.

2.3.1 Articulatory vs. Acoustic Features

Since the earliest phonetic studies, segments have been classified according to their *articulatory* properties. In consonants, for example, one asks where a sound is made (place of articulation), how it is made (manner of articulation), and what the state of the glottis is (voiced, unvoiced, etc.). (Other factors include what airstream mechanism is involved and whether the velum is raised or lowered.) In vowels, one asks which part of the tongue is raised (front, back, central), how much it is raised (high, mid, low), and whether the lips are rounded. While this is the most common and oldest way of classifying sounds, it is now possible with technological advances to group sounds according to their *acoustic* properties. That is, phonetic features such as the one distinguishing [p] from [b] can be stated either in terms of what is involved in the production of such sounds in the vocal tract or in terms of the characteristics of the acoustic signal which results from the different articulatory gestures. In other words, segments can be similar (or dissimilar) either in the way they are made or in the way they sound, two aspects which of course are related.

While the overwhelming emphasis has been on the articulatory side of phonetics, there are distinct cases where phonological properties cannot be accounted for without considering the acoustic properties of the sounds in question. A simple case is seen in the following data from Fe?fe?-Bamileke:

[vɑp] 'to whip'
[fat] 'to eat'
[čɑk] 'to seek'

In this language, the oral stops [p], [t], and [k] can occur at the end of a word preceded by a low unrounded vowel. In such words the difference between [a] (a front vowel similar to the vowel of French *patte* 'paw') and [ɑ] (a back vowel similar to the *a* sound of *father* in certain dialects of English) is totally redundant: before [p] and [k] we find [ɑ], and before [t] we find [a]. The question is, why?

While a front vowel might be expected to be backed before a back (velar) consonant, the change of /a/ to [ɑ] before [p] is not so easily explained. It would appear that [p] and [k], which function together in this backing process, have some phonetic feature in common—and yet articulatorily they are made at opposite extremes in the oral cavity.

The reason is that [p] and [k] share an acoustic property which [t] does not share with either one. Both [p] and [k], since they are made at the peripheries of the oral cavity (one at the lips and one at the back of the mouth), produce a concentration of energy in the lower frequencies of the sound spectrum (see Fant, 1960 for further discussion). Since alveolar/dental and palatal sounds cut the oral cavity in two, they do not create a large oral cavity, but rather two smaller cavities. Consequently, they have in common a concentration of energy in the upper frequencies of the sound spectrum. This acoustic distinction is directly incorporated into the feature system proposed by Jakobson et al. Labial and velar consonants are said to share the property of *graveness* (low tonality), and alveolars and palatals share the property of *acuteness* (high tonality).

Turning to the vowels [a] and [ɑ], back vowels, like labial and velar

consonants, are made at the periphery of the oral cavity, since the tongue is raised in the back of the mouth; front vowels, like dental/alveolar and palatal consonants, are made in a non-peripheral (or medial) part of the oral cavity, since the tongue is raised in the center of the mouth. Consequently, both consonants and vowels differ in this acoustic property of graveness/acuteness, as follows:

GRAVE	ACUTE
labial C's	dental/alveolar C's
velar C's	palatal C's
back V's	front V's

Now that this acoustic property of consonants and vowels has been identified, the Fe?fe? forms given above can be accounted for in a straightforward way. Instead of writing a phonological rule in terms of segments, as follows:

$$/a/ \rightarrow [\alpha] / \_ \begin{Bmatrix} p \\ k \end{Bmatrix} \#\#$$

which states that /a/ becomes [ɑ] before word-final [p] and [k], the rule should be written in terms of phonetic features:

$$\begin{array}{lllll} \text{Acute} & \rightarrow & \text{Grave} / \_ & \text{Grave} & \#\# \\ \text{Low V} & & \text{Low V} & \text{C} & \end{array}$$

An acute low vowel becomes a grave low vowel before a grave consonant. This formulation reveals that the process in question is phonetically motivated: low vowels are changed to agree in graveness with word-final consonants. In this sense, this rule can be compared with the rule of palatalization presented at the beginning of this chapter. Both rules involve cases of *assimilation* by which segments acquire the features of surrounding segments. This assimilation can be either articulatory or acoustic in nature, depending on the feature which is being assimilated. Thus there is a need for both articulatory and acoustic features in phonology (see Hyman, 1973a).

2.3.2 Binary vs. Nonbinary Features

While one innovation of Jakobson and his co-workers was to incorporate acoustic phonetics into phonology, another innovation was to convert all phonological features into binary ones. That is, a feature can have only two values, one of which is designated as [+F] and the other as [−F]. In many cases only a binary approach is phonologically significant, as in those oppositions which Trubetzkoy termed privative. Thus, phonemes are either [+nasal] or [−nasal], though phonetically some sounds may be more heavily nasalized than others. The sound [b] is often said to be more fully voiced in French than in English. For phonological purposes, however, both are [+voice]. Presumably there will be phonetic statements which specify the *degree* of voicing or the *degree* of nasality, etc. But apparently languages will rarely, if ever, use two degrees of voicing or nasality for contrastive purposes.

In other cases, however, the binary nature of a feature may not be as clear. While Trubetzkoy's equipollent oppositions, such as Labial vs. Dental, can easily be reinterpreted as [±labial] and [±dental] (though this is not what Jakobson proposed), Trubetzkoy's gradual oppositions seem to defy binary reinterpretation. Thus, the vowels /i, e, ɛ, æ/ differ in degree of vowel height and would appear to require a scale, say from [1 vowel height] for /æ/ to [4 vowel height] for /i/. However, as will be shown in the discussion of vowel features, Jakobson reinterpreted these four vowel heights in terms of two binary features, Diffuse and Compact. In claiming that all features are binary, including features which are logically gradual from a phonetic point of view, Jakobson made an important break with all previous linguistic analyses of sounds—a break which is still being debated today, as we shall see.

2.3.3 The Distinctive Features of Jakobson and Halle

Since the proposed binary features were designed only to capture the phonological oppositions found in languages, but not necessarily to capture the different phonetic realizations of these oppositions, they are referred to as a set of *distinctive features*. Since these features are not meant to be phonetic features, but rather phonological features, they do not account for every phonetic detail of the phonological segments.

2.3.3.1 The Major Class Features Perhaps the features which best reveal the motivation of Jakobson's approach are those he set up to classify the major classes of sounds. While traditional phonetics distinguishes consonants, vowels, glides (semivowels/semiconsonants), and liquids, Jakobson et al. proposed two binary features, Consonantal and Vocalic. Like all of Jakobson's features, Consonantal and Vocalic can be defined in terms of either their acoustic or their articulatory correlates. Thus, Jakobson and Halle (1956:29) define these features as follows:[4]

> *Consonantal/non-consonantal:* acoustic—low (vs. high) total energy; articulatory—presence vs. absence of an obstruction in the vocal tract.

[4] The definitions of these features are given for reference only; for a deeper understanding of the motivation behind these features, as well as their phonetic justification, see Jakobson, Fant and Halle (1952) and Jakobson and Halle (1956).

Vocalic/non-vocalic: acoustic—presence vs. absence of a sharply defined formant structure; articulatory—primary or only excitation at the glottis together with a free passage through the vocal tract.

These two binary features define four major classes of segments, as seen below:

	TRUE CONSONANT	VOWEL	LIQUID	GLIDE
	[+cons, −voc]	[−cons, +voc]	[+cons, +voc]	[−cons, −voc]
e.g.	/p/	/a/	/l/	/y/

The class of true consonants (including stops, fricatives, affricates, and nasals) is specified as [+cons, −voc], since they are characterized by an obstruction in the vocal tract and therefore do not permit a free passage of air; the class of vowels, on the other hand, is specified as just the opposite, that is, [−cons, +voc], since there is no obstruction and consequently a free passage of air through the vocal tract. The classes of liquids (for example, /l/ and /r/ sounds) and glides (/w/ and /y/ sounds) are intermediate between these two classes, as can be seen from their feature specifications.

These specifications reveal that true consonants have nothing in common with vowels. On the other hand, vowels and liquids share the feature specification [+voc], and vowels and glides share the feature specification [−cons]. Since true consonants and vowels share neither feature specification in common, it is seen that these two classes have nothing in common except that they are comprised of segments. In other words, these binary features provide a way of revealing "natural classes" of segments:

C + L : [+cons]
C + G : [−voc]
V + L : [+voc]
V + G : [−cons]

The notion of natural class is an important one in phonology, and one which will be dealt with in greater detail in **5.1.1**. For the purposes of the present discussion, it suffices to say that feature specifications are designed to make specific claims about the similarities of classes of segments. These claims are substantiated both by phonetic studies into the articulatory and acoustic properties of sounds and by phonological studies of specific languages.

Thus, if the claim that C + L, C + G, V + L, and V + G share properties in common is correct, languages should be expected to reflect this claim. For example, phonological rules should occur where true consonants and liquids function together in the input—or in the output (see Chapter 5).

As we shall see in **2.4**, the claims made by these particular Jakobsonian features are only partially valid.

2.3.3.2 The Distinctive Features of Vowels As stated in the previous section, vowels are specified as [−cons, +voc]. In addition, the three parameters of tongue height, tongue position, and lip rounding are accounted for by means of the features Diffuse, Compact, Grave, and Flat, as seen in Table 2.1 (see Halle, 1962:389).

Table 2.1

	i	e	æ	u	o	ɔ	a
consonantal	−	−	−	−	−	−	−
vocalic	+	+	+	+	+	+	+
diffuse	+	−	−	+	−	−	−
compact	−	−	+	−	−	+	+
grave	−	−	−	+	+	+	+
flat	−	−	−	+	+	+	−
voice	+	+	+	+	+	+	+
continuant	+	+	+	+	+	+	+
strident	−	−	−	−	−	−	−
nasal	−	−	−	−	−	−	−

The features Diffuse, Compact, Grave, and Flat are defined by Jakobson and Halle (1956:29) as follows:[5]

Compact/diffuse: acoustic—higher (vs. lower) concentration of energy in a relatively narrow, central region of the spectrum, accompanied by an increase (vs. decrease) of the total amount of energy; articulatory—forward-flanged vs. backward-flanged (the difference lies in the relation between the volume of the resonance chamber in front of the narrowest stricture and behind this stricture).

Grave/acute:[6] acoustic—concentration of energy in the lower (vs. upper) frequencies of the spectrum; articulatory—peripheral vs. medial. . . .

Flat/plain:[7] acoustic—flat phonemes in contradistinction to the corresponding plain ones are characterized by a downward shift or weakening of some of their upper frequency components; articulatory—the former (narrowed slit) phonemes in contradistinction to the latter (wider slit) phonemes are produced with a decreased back or front orifice of the mouth resonator, and a concomitant velarization expanding the mouth resonator.

[5] The features Voice, Continuant, Strident, and Nasal are dealt with below.
[6] The term Acute refers to segments which are [−grave].
[7] The term Plain refers to segments which are [−flat].

From Table 2.1, the following correlations can be noted between these features and the vowels they specify:

[+diffuse] : high vowels
[−diffuse] : mid and low vowels
[+compact] : low vowels
[−compact] : high and mid vowels
[+grave] : back vowels
[−grave] : front vowels
[+flat] : rounded vowels
[−flat] : unrounded vowels

Two important aspects of this system are that no provision is made for more than two degrees of frontness/backness and that no provision is made for more than three vowel heights. The claims inherent in these proposals are that no language will ever contrast more than two degrees of frontness/backness or more than three degrees of vowel height. Since these features are designed only to capture phonological contrasts in languages, it does not matter that [ɨ] and [a] are really central vowels phonetically or that [ɛ] is a fourth vowel height intermediate between [e] and [æ]. /ɨ/ and /a/ are specified as [+back]; /ɛ/ is specified as a mid vowel, that is, as [−diffuse, −compact], and differentiated from /e/ by an additional feature, Tense, as defined below (Jakobson and Halle, 1956:30):

> *Tense/lax:*[8] acoustic—higher (vs. lower) total amount of energy in conjunction with a greater (vs. smaller) spread of energy in the spectrum and in time; articulatory—greater (vs. smaller) deformation of the vocal tract away from its rest position.

The vowel /e/ is [+tense], while the vowel /ɛ/ is [−tense]. Similarly, the vowels /i/ and /u/ are [+tense], while the corresponding lax vowels /ɪ/ and /ʊ/ are [−tense]. Turning to degrees of frontness/backness, if a language has the two phonemes /u/ (a back rounded vowel) and /ɨ/ (a central unrounded vowel), these can be differentiated on the basis of the specification for the feature Flat: /u/ is [+grave, +flat], and /ɨ/ is [+grave, −flat]. On the other hand, if the same language were to contrast /ɯ/ (a back unrounded vowel) and /ɨ/ (a central unrounded vowel), a problem would arise, since both of these vowels would have to be specified as back unrounded, that is, as [+grave, −flat]. While no language has been shown to have such a contrast, the difference between /ɯ/ and /ɨ/ could conceivably be characterized by specifying the former as [+tense] and the latter as [−tense]. In such a way, Jakobson's claim that languages do not contrast three degrees of frontness/backness can be maintained (but see **2.5.3**).

[8] The term Lax refers to segments which are [−tense].

The four remaining features of the vowel chart, namely Voice, Continuant, Strident, and Nasal, are defined as follows (Jakobson and Halle, 1956:30, 31):

> *Voiced/voiceless:* acoustic—presence vs. absence of periodic low frequency excitation; articulatory—periodic vibrations of the vocal cords vs. lack of such vibrations.
>
> *Discontinuous/continuant:*[9] acoustic—silence (at least in frequency range above vocal cord vibration) followed and/or preceded by spread of energy over a wide frequency region . . . vs. absence of abrupt transition between sound and such a silence; articulatory—rapid turning on and off of source either through a rapid closure and/or opening of the vocal tract that distinguishes plosives from constrictives [that is, stops and affricates from fricatives].
>
> *Strident/mellow:*[10] acoustic—higher intensity noise vs. lower intensity noise; articulatory—rough-edged vs. smooth-edged. . . .
>
> *Nasal/oral (nasalized/non-nasalized):* acoustic—spreading the available energy over wider (vs. narrower) frequency regions by a reduction in the intensity of certain (primarily the first) formants and introduction of additional (nasal) formant; articulatory—mouth resonator supplemented by the nose cavity vs. the exclusion of the nasal resonator.

All of the vowels discussed so far are specified [+voice, +continuant, −strident, −nasal]. While languages have been known to have voiceless as well as nasalized vowels, vowels are universally specified [+continuant] and [−strident]. That is, all vowels are characterized by a continuous air flow, while no vowels are characterized by the kind of high-intensity noise described by the specification [+strident]. Thus, the contrasts between [+continuant] and [−continuant] and [+strident] and [−strident] are limited to consonants.

2.3.3.3 The Distinctive Features of Consonants By consonant is meant, in the Jakobsonian framework, any segment which is *not* specified [−cons, +voc]. That is, any segment which is either [+cons] or [−voc] qualifies as a consonant. One of the great advantages of Jakobson's feature system is that it makes it possible to characterize both consonants and vowels in terms of the same features. Whereas phoneticians speak of vowels as being either front, central, or back but of consonants as being labial, dental, etc., these different placements of the two articulators required to make vowels and consonants are related in Jakobson's system by means of the features Diffuse and Grave. Table 2.2 (see Halle, 1964:396) shows how the same distinctive features already illustrated for vowels capture the

[9] Discontinuous segments are [−continuant]; continuant segments are [+continuant]; see below.

[10] The term Mellow refers to segments which are [−strident].

Table 2.2 Distinctive Feature Representation of English Consonants

	p	b	f	v	m	t	d	θ	ð	s	z	n	č	ǰ	š	ž	k	g	l	r	w	y	h
cons	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	−	−
voc	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
diff	+	+	+	+	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−	−	−	−
grave	+	+	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	+	−	−	+	−	−
flat	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	−
voice	−	+	−	+	+	−	+	−	+	−	+	+	−	+	−	+	−	+	+	+	+	+	−
cont	−	−	+	+	−	−	−	+	+	+	+	−	−	−	+	+	−	−	+	+	+	+	+
strid	−	−	+	+	−	−	−	−	−	+	+	−	+	+	+	+	−	−	−	−	−	−	−
nasal	−	−	−	−	+	−	−	−	−	−	−	+	−	−	−	−	−	−	−	−	−	−	−
comp	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−

contrasts of English consonants.[11] As stated earlier, the features Consonantal and Vocalic distinguish between *true consonants*, which are [+cons, −voc]; *liquids*, which are [+cons, +voc]; and *glides*, which are [−cons, −voc]. In addition, the following correlations between the remaining features and the consonants they specify can be extracted from this chart:

[+diffuse]	:	labial and dental/alveolar consonants
[−diffuse]	:	palatal and velar/back consonants
[+grave]	:	labial and velar/back consonants
[−grave]	:	dental/alveolar and palatal consonants
[+voice]	:	voiced consonants
[−voice]	:	voiceless consonants
[+continuant]	:	fricatives, liquids, glides
[−continuant]	:	stops and affricates
[+strident]	:	noisy fricatives (labiodental, alveolar, alveopalatal), affricates
[−strident]	:	less noisy fricatives (interdental, as well as palatal and velar; see below), stops, liquids, glides
[+nasal]	:	nasal consonants
[−nasal]	:	oral consonants

In addition, aspirated consonants, as well as the glide /h/, are specified as [+tense].[12]

2.3.3.3.1 Primary Articulations This feature analysis is possible only as a result of Jakobson's focus on underlying sound contrasts rather than on surface phonetic contrasts. As an example, consider the consonant chart included in Appendix 1. In this arrangement of consonants, it is necessary to distinguish at least *ten* places of articulation: bilabial, labiodental, interdental, dental/alveolar, alveopalatal, palatal, velar, uvular, pharyngeal, and glottal. It is quite clear, however, that no language will ever *contrast* ten places of articulation. Rather, if one takes a close look at this consonant chart, a number of gaps are observed. Some of these gaps represent impossible feature combinations; for example, voiced glottal stops do not exist. Other gaps represent infrequent feature combinations such as palatal and velar affricates ([c^{c}, $ɟ^{ɟ}$] and [k^{x}, $g^{ɣ}$]), which are much less frequent than labiodental, alveolar, and alveopalatal affricates ([p^{f}, b^{v}], [t^{s}, d^{z}], and [č, ǰ] = [$t^{š}$, $d^{ž}$]).

Notice that only the fricatives [θ] and [ð] are represented in the interdental position (the affricates [$t^{θ}$] and [$d^{ð}$] are also possible, as we shall see below). Thus, only in fricatives is there a potential contrast between interdental and dental/alveolar consonants, that is, /θ/ and /ð/ vs. /s/ and /z/.

[11] Just as the features Continuant and Strident are not used for vowels, the feature Compact is not used for consonants.

[12] Other secondary articulations involve the features Sharp and Checked; see **2.3.3.3.2.**

If one could show that there is an additional feature distinguishing these two pairs of consonants, then it would no longer be necessary to recognize an interdental position as a phonologically relevant distinction. Jakobson et al. (1952, 1956) claim that such a feature does exist, namely Strident, and that /θ/ and /ð/ differ from /s/ and /z/ in that the former are [−strident], whereas the latter are [+strident]. Thus this contrast, which is usually viewed as a difference in place of articulation, can be reinterpreted as a difference in noise components. In fact, this same contrast between [+strident] and [−strident] can be used to differentiate the labial fricatives [φ, β], which are [−strident], and the labiodental fricatives [f, v], which are [+strident]. Finally, the alveopalatals [š, ž] differ from the palatal fricatives [ç, j] in that they are [+strident], whereas the latter are [−strident].

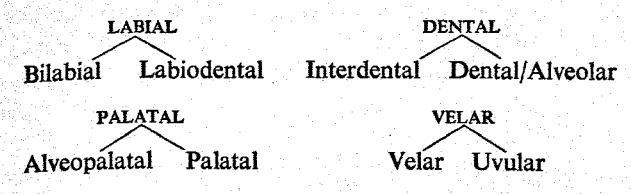
In order to eliminate the labiodental and alveopalatal positions, however, it is necessary to account for the difference between [p, b] and [p^f, b^v] on the one hand and [c, ɟ] and [č, ǰ] on the other, that is, the difference between stops and affricates. Since the affricates [p^f, b^v, t^s, d^z, č, ǰ] are characterized by considerable noise (stridency), Jakobson et al. attribute the difference between stops and affricates to this feature: affricates are [+strident], whereas stops are [−strident]. We therefore have the following feature specifications:

	φ	f	θ	s	š	ç	p	p^f	t	t^s	č	c
strid	−	+	−	+	+	−	−	+	−	+	+	−
cont	+	+	+	+	+	+	−	−	−	−	−	−

Thus, the features Strident and Continuant define the oppositions stop/fricative, stop/affricate, and affricate/fricative. By use of the feature Strident, six places of articulation (bilabial, labiodental, interdental, dental/alveolar, alveopalatal, palatal) are reduced to three. We can refer to these three places of articulation as labial, dental, and palatal, bearing in mind that each of these stands for two more precise phonetic places of articulation.

Jakobson, Fant and Halle (1952:24) further propose that the uvular fricative [X] differs from the velar fricative [x] in that it is [+strident], whereas the latter is [−strident]. While this works for the fricative oppositions in these two positions, it is not possible to view the difference between the velar stop [k] and the uvular stop [q] as one of stridency. Harms (1968: 32) uses the feature Flat (see below) to distinguish /k/ and /q/ in Quechua: /k/ is [−flat] and /q/ is [+flat]. This is only possible, however, if there is no opposition between /k^w/ and /q/, since /k^w/, being a rounded consonant, is [+flat]. While the Jakobsonian features are not fully adequate to this purpose, it will be shown in **2.4.2.1** that velars and uvulars can be classified under one heading which will be called velar. Thus there are four general

positions, each of which subdivides into two more specific phonetic places of articulation distinguished by other features:



These four places of articulation are distinguished by means of the two distinctive features Grave and Diffuse:

	LABIAL	DENTAL	PALATAL	VELAR
Grave	+	−	−	+
Diffuse	+	+	−	−

2.3.3.3.2 Secondary Articulations Distinctions in consonants with secondary articulations (labialization, palatalization, etc.) are captured by means of the features Flat (defined earlier), Sharp, and Checked, the latter two being defined as follows (Jakobson and Halle, 1956:31):

> *Sharp/plain:* acoustic—sharp phonemes in contradistinction to the corresponding plain ones are characterized by an upward shift of some of their upper frequency components; articulatory—the sharp (widened slit) vs. plain (narrower slit) phonemes exhibit a dilated pharyngeal pass, that is, a widened back orifice of the mouth resonator; a concomitant palatalization restricts and compartments the mouth cavity.
>
> *Checked/unchecked:* acoustic—higher rate of discharge of energy within a reduced interval of time vs. lower rate of discharge within a longer interval; articulatory—glottalized vs. non-glottalized.

These features define the following sets of consonants with secondary articulations (only the *plus* specifications are of interest here):

	[+flat]	:	labialized, velarized, pharyngealized, and retroflex consonants
	[+sharp]	:	palatalized consonants
	[+checked]	:	glottalized consonants
cf.	[+tense]	:	aspirated and geminate/long consonants

By treating labialized, velarized, pharyngealized, and retroflex consonants all as phonetic manifestations of the feature specification [+flat], the claim is made that no language will ever contrast,say, /t^w/ and /ṭ/, or /ṭ/ and /t^w/. This feature system therefore makes a claim—or prediction—about languages which is not made in feature systems not relating these secondary articulations as realizations of the same underlying property. In this sense, Flat is what

has come to be known as a "cover feature," since it can stand for any one of four possible phonological contrasts, depending on the language (see **2.4.2.3**).

2.3.3.4 Summary Jakobson, Fant and Halle's system proposes to account for all of the possible phonological contrasts of languages by means of the following thirteen features (excluding features of tone and stress):

Vocalic	Voice	Checked
Consonantal	Nasal	Grave
Compact	Continuant	Flat
Diffuse	Strident	Sharp
Tense		

These features represent innovations in three areas: (1) the features capture phonological contrasts rather than describe phonetic segments, (2) the features are all binary in nature, and (3) the features are defined primarily in acoustic terms.

2.4 The Distinctive Features of Chomsky and Halle

The distinctive features presented in Chapter VII of *The Sound Pattern of English* (*SPE*), although based to a great extent on the work of Jakobson, Fant and Halle (1952) and Jakobson and Halle (1956), reveal a number of modifications. These modifications are to be found both in the specific set of distinctive features used to capture contrasts and in the conceptualization of these features.

While Jakobson's emphasis was on capturing all the possible phonological contrasts of languages by means of his features, Chomsky and Halle (1968) explicitly distinguish two functions of their features. On the one hand, the distinctive features are designed, like Jakobson's features, to capture the phonological contrasts of languages. On the other hand, they are designed to describe the *phonetic* content of segments derived by phonological rules, as well as underlying segments. This difference, with Chomsky and Halle looking as well at the noncontrastive feature composition of derived segments, will become clear as the modifications they proposed in the set of distinctive features are pointed out.

2.4.1 The Major Class Features

As pointed out in **2.3.3.1**, the Jakobsonian features Consonantal and Vocalic define four major classes of segments: True Consonants, Vowels, Liquids, and Glides. In addition, these features reveal certain similarities between the major classes: true consonants and liquids are [+cons], true consonants and glides are [−voc], vowels and liquids are [+voc], and vowels and glides are [−cons]. These feature specifications therefore predict that segments will group together in just this way, for example, that true consonants and liquids will be subject to certain phonological rules that vowels and glides are not subject to.

There are, however, serious problems with these features, as pointed out by Chomsky and Halle (1968). While the binary features Consonantal and Vocalic provide a means of capturing relations between segment classes in groups of two, there is no straightforward way to group three classes together as opposed to the fourth. In fact, the most natural grouping of these four major classes may be between true consonants, liquids, and glides on the one hand and vowels on the other. That is, phonological properties must often be stated in terms of vowels and nonvowels, as when one gives the general word structure of a language as CVCV (consonant-vowel-consonant-vowel). In such formulae the C stands for either a true consonant, a liquid, or a glide. These consonants have in common that they are usually not syllabic.[13] Vowels, on the other hand, are always syllabic. If one attempts to state a CVCV constraint on word structure in a language, it is necessary to use a disjunction of the following sort (where the braces indicate that *either* one of the specified features *or* the other is to apply):

$$\#\# \begin{Bmatrix}[+\text{cons}]\\[-\text{voc}]\end{Bmatrix} \begin{bmatrix}-\text{cons}\\+\text{voc}\end{bmatrix} \begin{Bmatrix}[+\text{cons}]\\[-\text{voc}]\end{Bmatrix} \begin{bmatrix}-\text{cons}\\+\text{voc}\end{bmatrix} \ldots \#\#$$

Since the class of nonvowels is defined as those segments which are either [+cons] or [−voc], it is necessary to use a disjunction to express the above CVCV word structure constraint. However, in so doing, the generalization which is missed is that every other segment is *syllabic*. Each CV sequence defines a syllable in this language. It therefore cannot be the case that both C and V are syllabic. Rather, if a new feature Syllabic is substituted for the old feature Vocalic, this word structure constraint can be stated much more satisfactorily as follows:

$$\#\# \quad [-\text{syll}] \quad [+\text{syll}] \quad [-\text{syll}] \quad [+\text{syll}] \ldots \#\#$$

After providing evidence that languages commonly group segments into vowels and nonvowels, Chomsky and Halle (1968:354) propose, following Milner and Bailey, that the feature Syllabic replace the feature Vocalic. [+syllabic] segments are those constituting a syllabic peak, that is, vowels, syllabic liquids, and syllabic nasals (see Table 2.3); all remaining segments are said to be [−syllabic].

[13] A segment will be viewed as syllabic if it constitutes the *nucleus* or *peak* of a syllable (see **6.1.1.1**). Liquids can, of course, be syllabic, as can nasal consonants, as we shall see. Glides, on the other hand, when they "turn" syllabic, become vowels.

While this new feature allows the grouping of true consonants, (nonsyllabic) liquids, and glides, as opposed to vowels, there is no feature which allows the grouping of vowels, liquids, and glides, as opposed to true consonants. If such a grouping were to be attempted using the features Consonantal and Vocalic, another disjunction would be required, namely:

$$\begin{Bmatrix}[-\text{cons}]\\[+\text{voc}]\end{Bmatrix}$$

Vowels, liquids, and glides have in common that their normal state of the glottis is [+voice]. Voiceless vowels, liquids, and glides are attested in languages but are relatively rare. On the other hand, nasal consonants, which, like oral consonants, are specified [+cons, −voc], also have [+voice] as their normal state of the glottis. Voiceless nasals do exist, but again they are relatively rare. Thus it appears that there is a need for a feature which will group vowels, liquids, glides, and nasals together. In order to group these segments together, Chomsky and Halle (1968:302) propose the feature Sonorant: vowels, liquids, glides, and nasals are [+sonorant], defined by a relatively free air passage either through the mouth or through the nose; non–nasal true consonants, which are called *obstruents* (that is, stops, affricates, and fricatives), are [−sonorant]. As we shall observe in later chapters, such a distinction is often utilized by languages in phonological rules. Thus the feature Vocalic is abandoned, and the two new features Syllabic and Sonorant, along with the Jakobsonian features Consonantal and Nasal, define the following major classes of segments:

Table 2.3

	C	V	L	G	N	L̩	N̩
cons	+	−	+	−	+	+	+
syll	−	+	−	−	−	+	+
son	−	+	+	+	+	+	+
nas	−	−	−	−	+	−	+

In Table 2.3, C stands for the class of obstruents, and L̩ and N̩ for syllabic liquids and nasals, respectively. Two things should be noted about this table. First, it can now be seen that glides and vowels differ in precisely the same way as nonsyllabic and syllabic liquids and nasals, that is, G:V = L:L̩ = N : N̩. Second, according to these feature specifications, liquids and nasals differ only in nasality: liquids are [−nasal], while nasals are [+nasal]. This can potentially create a problem, since the above four features do not differentiate nasalized liquids (for example, [l̃], [r̃]) from true nasals (for example, [n]). Here we have the possibility of using the feature Continuant, carried over from Jakobson, whereby liquids are [+cont] and nasals [−cont]. It should, however, be noted that although Chomsky and Halle (1968:303) characterize voiceless vowels (and presumably voiceless liquids, glides, and nasals) as [+sonorant], they are probably best seen as [−sonorant], that is, as obstruents in the case of L̥, G̥, and N̥. This includes /h/, which Chomsky and Halle consider to be a voiceless glide and [+sonorant].

2.4.2 Primary Placement Features for Vowels and Consonants

Chomsky and Halle (1968) retain the features Consonantal (p. 302), Tense (p. 324), Voice (p. 326), Continuant (p. 317), Nasal (p. 316), and Strident (p. 329) from the earlier feature system. In all other cases new features are substituted. The approximate correlations between the two systems, which we shall now discuss in turn, are given below:

CHOMSKY AND HALLE	JAKOBSON ET AL.	
	vowels	*consonants*
[+high]	[+diff]	[−diff]
[+low]	[+comp]	[+flat]
[+back]	[+grave]	[+grave, −diff]
[+anterior]	——	[+diff]
[+coronal]	——	[−grave]
[+round]	[+flat]	[+flat]

2.4.2.1 The Features High, Back, and Low The features High, Back, and Low characterize the body of the tongue. They are defined by Chomsky and Halle (1968) as follows:

> High sounds are produced by raising the body of the tongue above the level it occupies in the neutral position; nonhigh sounds are produced without such a raising of the tongue body. (p. 304)
>
> Back sounds are produced by retracting the body of the tongue from the neutral position; nonback sounds are produced without such a retraction from the neutral position. (p. 395)
>
> Low sounds are produced by lowering the body of the tongue below the level that it occupies in the neutral position; nonlow sounds are produced without such a lowering of the body of the tongue. (p. 305)

The neutral position of the body of the tongue is "assumed to be raised and fronted, approximating the configuration found on the vowel [e] [read [ɛ]] in English *bed*" (p. 304). These features are used for both vowels and consonants.

Since in the case of the features High and Low, no segment can be [+high, +low] (for this would imply a sound which is simultaneously both raised and lowered from the neutral position), these features define three possibilities: [+high, −low], [−high, −low] and [−high, +low]. Since [+high] automatically implies [−low] and [+low] implies [−high], we can refer to these three classes as [+high], [−high, −low], and [+low]. Segments which are [+high] include all high vowels; the glides /y/ and /w/; and palatal, palatalized, velar, and velarized consonants. Thus, the segments [i, u, y, w, č, t^y, k, t^w] are all [+high]. Segments which are [−high, −low] include mid vowels and uvulars, for example, [e, o, q, R]. Finally, segments which are [+low] include low vowels, pharyngeals and pharyngealized consonants, and glottal (laryngeal) consonants, for example, [æ, a, ḥ, ṭ, h, ʔ]. Thus, the features Diffuse and Compact (the latter of which applied only to vowels in Jakobson's system) are replaced by the features High and Low.

One interesting observation in this change is that precisely the opposite claim is made concerning the relatedness of consonants and vowels. In Jakobson's feature system, labial and dental consonants, along with high vowels, are [+diff], while palatal and velar consonants, along with nonhigh vowels, are [−diff]. In Chomsky and Halle's feature system, palatal and velar consonants, along with high vowels, are [+high], while labial and dental consonants, along with nonhigh vowels, are [−high]:

JAKOBSON ET AL.		CHOMSKY AND HALLE	
[+diffuse]	[−diffuse]	[+high]	[−high]
labials	palatals	palatals	labials
dentals	velars	velars	dentals
high V's	nonhigh V's	high V's	nonhigh V's

Thus there is a fundamental difference in the claim made about the shared properties of consonants and vowels. The only way to resolve this difference is by consulting the world's languages to see how consonants and vowels pattern.

McCawley (1967) cites Maxakali, in which vowels are inserted before syllable-final stops, as follows: [ə] before [p], [a] before [t], [i] before [č], and [i̯] before [k]. There appears to be in this example a case of tongue body height assimilation[14]. The segments [p, t, o, a] are all [−high], while the segments [č, k, i, i̯] are all [+high]. The feature High aptly captures this height agreement, while the feature Diffuse makes the opposite—and wrong—prediction that high vowels will go with [p] and [t] and nonhigh vowels with [č] and [k]. With the feature High, it is possible to state that the inserted

[14] Although this conclusion is well-founded, McCawley's report of the Maxakali data is considerably simplified; see Gudschinsky, Popovich and Popovich (1970:82–84).

vowel will be [+high] before a syllable-final [+high] consonant and [−high] before a syllable-final [−high] consonant.

Further evidence is provided by Maran (1971:32ff). In the history of Burmese, the proto syllable-final sequence *ak became [ek] (and later [et]). This change from *a to [e] in the environment of a following velar consonant is argued by Maran to be an agreement in tongue body height. The feature Diffuse would predict that the proto sequences *ap and *at should become, respectively, [ep] and [et], rather than *ak becoming [ek]. However, the vowel *a stays [a] before labials and dentals (although *ap does change to [at]).

The feature Back characterizes velar(ized), uvular, and pharyngeal(ized) consonants as well as back vowels. Segments which are [+back] are characterized by the retraction of the body of the tongue. Front vowels, as well as any consonants produced in front of the velar region (unless they are velarized or pharyngealized), are automatically [−back]. Glottal and glottalized consonants, including [h], are considered to be [−back], since they do not involve the retraction of the tongue body (except, of course, consonants such as the ejective [k'], which is [+back] because it is a *velar* which is glottalized). The following distinctive feature matrices indicate how these features apply to vowels and consonants (where the feature Round distinguishes rounded vowels from unrounded vowels):

	i	e	æ	u	o	ɔ	a
high	+	−	−	+	−	−	−
low	−	−	+	−	−	+	+
back	−	−	−	+	+	+	+
round	−	−	−	+	+	+	−

	p	t	č	k	q	ḥ	ʔ	t^y	t^w	ṭ	t'
high	−	−	+	+	−	−	−	+	+	−	−
low	−	−	−	−	−	+	+	−	−	+	+
back	−	−	−	+	+	+	−	−	+	+	−

2.4.2.2 The Features Anterior and Coronal This second matrix fails to show the difference between [p] and [t], [č] and [t^y], [k] and [t^w], [ḥ] and [ṭ], and [ʔ] and [t']. In the case of [p] and [t], the features High, Low, and Back fail to show the difference between labials and dentals. In all of the other cases, the features fail to show the difference between primary place of articulation (palatal, velar, pharyngeal, glottal) and secondary place of articulation (palatalized, velarized, pharyngealized, glottalized).[15] Thus

[15] If uvularized consonants exist, there is a potential problem distinguishing the uvular stop [q] from a uvularized [t].

other features are needed to distinguish between primary and secondary articulations.

For this purpose, Chomsky and Halle (1968) introduce the features Anterior and Coronal. These are defined as follows:

> Anterior sounds are produced with an obstruction that is located in front of the palato-alveolar [that is, alveopalatal] region of the mouth; non-anterior sounds are produced without such an obstruction. The palato-alveolar region is that where the ordinary English [š] is produced. (p. 304)
>
> Coronal sounds are produced with the blade of the tongue raised from its neutral position; noncoronal sounds are produced with the blade of the tongue in the neutral position. (p. 304)

Thus labial and dental consonants are [+ant], while all other consonants are [−ant]. Dentals, alveolars, and alveopalatals are [+cor], while all other consonants are [−cor] (including "true palatals," for example, [ç], [y]). While the feature Anterior does not apply to vowels, retroflex vowels (for example, [ə˞] in American English) are [+cor]. These feature specifications are summarized below:

	p	t	č	c	k	q
ant	+	+	−	−	−	−
cor	−	+	+	−	−	−

It should be clear that these features are designed in part to replace the Jakobsonian features Grave and Diffuse. We have already seen the weaknesses of the feature Diffuse. On the other hand, the importance of the feature Grave has already been demonstrated (see Hyman, 1973a). By and large, what Chomsky and Halle attempted to do was to replace Jakobson's acoustically oriented features with articulatorily oriented features. Thus, the feature Grave is discarded with almost no discussion (p. 306). Consonants which are now [+ant] are those which in the earlier system were [+diff]. The feature Coronal, while closely paralleling the old feature Grave (but with opposite value), has no exact equivalent in Chomsky and Halle's framework. [+cor] consonants include dentals, alveolars, retroflex consonants, and alveopalatals. While all of these are [−grave], the [−grave] true palatals (for example, [c, j, y]) are [−cor], according to Chomsky and Halle.[16] With this exception only, a [+grave] segment will be [−cor] and a [−grave] segment will be [+cor] in the Chomsky and Halle system.

2.4.2.3 Secondary Articulations In addition to changing the features from being essentially acoustically motivated to being articulatory in nature, a more basic modification was introduced. While Jakobson's aim had been

[16] J. Hoard and C. Sloat have suggested, in personal communications, that true palatals should also be viewed as [+cor], though we shall not further investigate this possibility here.

to provide only those distinctive features that were necessary to characterize phonemic contrasts in the world's languages, Chomsky and Halle enriched the set of features so as to permit finer phonetic statements. In other words, in addition to capturing underlying contrasts, the features assumed a second function, which was to specify the phonetic content of segments derived by phonological rules (see McCawley, 1967:522–523). Starting with Halle (1959), phonological rules which convert underlying (systematic) phonemic representations to surface (systematic) phonetic representations are stated in terms of binary features. Thus, it now becomes necessary to refer to binary feature specifications which are not distinctive in a given language.

The standard example centers around the Jakobsonian feature Flat. Recall that [+flat] segments include labialized, velarized, and pharyngealized consonants as well as rounded vowels. Jakobson postulated that no language would ever have a contrast between labialized, velarized, and pharyngealized consonants, and therefore, with this "complementary distribution" in the world's languages, the three consonant types were said to be surface manifestations of a broader phonological category of flat consonants. In each language a statement would be required about whether [+flat] referred to [C^{w}], [C^{ɰ}], or [C̭].

McCawley (1967:524–525) showed, however, that such an approach leads to complications in formulating phonological rules. He cites the case of Arabic, which has pharyngealized consonants which are [+flat] and the three-vowel system /i, a, u/, of which the last is [+flat]. Already we see that [+flat] refers to two different phonetic properties. In addition, vowels which are adjacent to pharyngealized consonants are also pharyngealized, as in the following rule.

$$V \rightarrow \underset{\begin{Bmatrix} — \text{ Ç} \\ \text{Ç } — \end{Bmatrix}}{\text{V̭}} \quad \begin{matrix} \text{(a)} \\ \text{(b)} \end{matrix}$$

In other words, a vowel becomes pharyngealized before (a) or after (b), a pharyngealized consonant. When one rewrites this rule in terms of features, the following results:

$$[+\text{syll}] \rightarrow [+\text{flat}] \,/\, \left\{ \begin{matrix} — \begin{bmatrix} +\text{flat} \\ -\text{syll} \end{bmatrix} \\ \begin{bmatrix} +\text{flat} \\ -\text{syll} \end{bmatrix} — \end{matrix} \right\}$$

What this now means is that [+flat], in addition to standing for pharyngealization in [−syll] segments in Arabic (that is, consonants), also stands for (1) rounding in [u], (2) pharyngealization in [i̭] and [a̭], and (3) rounding *and* pharyngealization in [ṷ]. Since the phonology of Arabic will have to provide such "mapping" statements of the [+flat] specification onto these segments, these statements will be quite complex. McCawley (1967) therefore

suggests that more specific features relating to lip-rounding and pharyngealization be used.[17]

Chomsky and Halle (1968) introduce the feature Round to cover rounded vowels and labialized consonants:

> Rounded sounds are produced with a narrowing of the lip orifice; nonrounded sounds are produced without such a narrowing. (p. 309)

Pharyngealized consonants are taken to be [+back, +low], revealing the retracting and lowering of the body of the tongue in making pharyngealized sounds. This leaves the problem of marking pharyngealization in vowels. If we were to consider the Arabic pharyngealized vowels [i̪] and [u̪] as [+back, +low], it would not be possible to distinguish [i̪] from [a] nor [u̪] from a hypothetical [ɔ]. In addition, one could not distinguish [a] from [a̪], since [a] is already [+back, +low]. It seems to be necessary, then, to introduce another binary feature relating to the position of the tongue root.

Chomsky and Halle (1968) propose a feature Covered (pp. 314–315), identical to Stewart's (1967, 1971) feature Advanced Tongue Root (ATR). Numerous West African languages (for example, Akan, Igbo) show a vowel harmony (see **6.3.1**) which divides vowels into two series, one of which is specified [+advanced tongue root] and one of which is specified [−advanced tongue root]. The latter corresponds, it seems, to pharyngealized vowels. In Igbo, the [+ATR] vowels include /i, e, u, o/, while the [−ATR] vowels include /i̪, a, u̪, o̪/. Since pharyngealized consonants are [−ATR], the rule of pharyngealization of vowels in Arabic can be rewritten as follows:

$$[+\text{syll}] \rightarrow [-\text{ATR}] \,/\, \left\{ \begin{matrix} \_\_ \begin{bmatrix} -\text{ATR} \\ -\text{syll} \end{bmatrix} \\ \begin{bmatrix} -\text{ATR} \\ -\text{syll} \end{bmatrix} \_\_ \end{matrix} \right\}$$

In this proposal, the assimilation of the pharyngealization of the consonant onto a neighboring vowel is revealed in a straightforward way.

One further modification Chomsky and Halle (1968) make is to discard the feature Sharp, which was used for palatalized (but not palatal) consonants. The feature Sharp was one of the few which did not have an application to both consonants and vowels (compare Compact, which was used only for vowels). The problem inherent in the feature Sharp is revealed when a rule such as

$$\begin{bmatrix} \text{p} \\ \text{t} \\ \text{k} \end{bmatrix} \rightarrow \begin{bmatrix} \text{p}^{\text{y}} \\ \text{t}^{\text{y}} \\ \text{k}^{\text{y}} \end{bmatrix} / \_\_ \text{ i}$$

is formalized in terms of features:

$$[-\text{syll}] \rightarrow [+\text{sharp}] / \_\_ \begin{bmatrix} +\text{syll} \\ +\text{high} \\ -\text{back} \end{bmatrix}$$

While this is clearly a case of consonants assimilating to the high front (palatal) position of the vowel [i], the feature specification [+sharp] disguises the similarity between palatalized and high front vowels.[18] In order to remedy this situation, Chomsky and Halle (1968) recognize palatals and palatalized consonants as [+high, −back]. Now the above rule can be rewritten as follows:

$$[-\text{syll}] \rightarrow \begin{bmatrix} +\text{high} \\ -\text{back} \end{bmatrix} / \_\_ \begin{bmatrix} +\text{syll} \\ +\text{high} \\ -\text{back} \end{bmatrix}$$

Notice that the labial and dental consonants [p] and [t], which are [−high, −back], must change one feature and become [+high]. The velar consonant [k], which is already [+high], must change one feature specification and become [−back]. A uvular consonant such as [q], which is [−high, +back], would presumably have to change two features to become [+high, −back] if palatalized.

2.4.2.4 Additional Features Chomsky and Halle (1968) introduce a number of other features, many of which are meant to be only tentative. For example, features are mentioned which are needed to distinguish the clicks of the Khoisan languages of South Africa and of Xhosa and Zulu. Also, features are needed for implosives, nasal release, prenasalization, etc. Even the most cursory glance at the phonetic material presented by Ladefoged (1971) will convince any phonologist that much more work is required on phonological and phonetic features.

[17] The status of the feature Flat is not clear as of the writing of this book. If it is a phonetically valid feature, then languages should be expected to have flatness assimilation rules such as the following:

$$\text{ɯ} \rightarrow \text{u} \,/\, \text{Ç} \_\_ \text{Ç}$$

That is, a back unrounded vowel is rounded between pharyngealized consonants. In features this would be written:

$$\begin{bmatrix} +\text{syll} \\ -\text{flat} \end{bmatrix} \rightarrow [+\text{flat}] \,/\, [+\text{flat}] \underset{\text{C}}{\_\_} [+\text{flat}]_{\text{C}}$$

Some evidence for Flat is presented in Hyman (1972b: 120ff).

[18] It also fails to reveal the relationship between palatals, which are [−sharp], and palatalized consonants, which are [+sharp]. Of course, palatalized palatals would be [+sharp].

One last important feature which we shall now look at is Delayed Release,[19] which Chomsky and Halle (1968) define as follows:

> There are basically two ways in which a closure in the vocal tract may be released, either instantaneously as in the plosives [that is, stops] or with a delay as in the affricates. During the delayed release, turbulence is generated in the vocal tract so that the release phase of affricates is acoustically quite similar to the cognate fricative. The instantaneous release is normally accompanied by much less or no turbulence. (p. 318)

Jakobson had originally planned on the feature Strident to distinguish affricates from stops, for example, [p^f] from [p]. However, for this to be possible, it would mean that no language would ever contrast affricates such as [p^φ] and [p^f] or [t^θ] and [t^s]. Since the fricatives [f] and [s] are [+strident] (see **2.3.3.3.1**), it follows that affricates released with a similar sound component should be [+strident] as well. Similarly, since [φ] and [θ] are [−strident], the corresponding affricates [p^φ] and [t^θ] should be [−strident]. However, recall that Jakobson differentiated stops such as [t] and affricates such as [t^θ] on the basis of this feature Strident, with the former being minus and the latter plus.

While the inconsistent treatment of [θ] as [−strident] but [t^θ] as [+strident] presented a problem in itself, the final blow to this approach to affricates came when McCawley (1967:523), basing himself on Li (1946:398), pointed out that Chipewyan contrasts /t/, /t^θ/, and /t^s/ as well as the fricatives /θ/ and /s/. While /t^s/ can differ from /t/ in stridency, there is no way to distinguish /t^s/ and /t^θ/ in such a case. Therefore, the feature Delayed Release is necessary to distinguish in general between affricates and stops, with Strident accounting for the difference between /t^θ/ and /t^s/:

	t	t^θ	t^s	θ	s
cont	−	−	−	+	+
strid	−	−	+	−	+
del rel	−	+	+	+	+

The feature Delayed Release contrasts only in sounds produced with a complete closure in the vocal tract, that is, stops vs. affricates.

2.5 Further Remarks and Revisions

While *The Sound Pattern of English* represents one of the most comprehensive treatments of phonological distinctive features accomplished to date, various phonologists and phoneticians have suggested further modifications since the appearance of this book in 1968. Halle himself has changed his position on some of the issues concerning glottal mechanisms (see **6.2.2.5**). The purpose of this section is to point out a few of the remaining problems inherent in the *SPE* feature system.

[19] Other linguists have used the opposite feature, Abrupt Release, though we shall follow Chomsky and Halle in this regard.

2.5.1 The Feature Labial

Although Chomsky and Halle (1968) solve the problem of relating palatals and palatalized consonants to high front vowels, their feature system fails to relate labial and labialized (rounded) segments. It fails first to relate labial consonants such as [p, b, m], which are [+ant, −cor] and [−round], to labialized consonants such as [t^w] and [k^w], which are [+round]. It fails also to show the relationship between labials and rounded vowels, since the former are [−round] and the latter [+round].

That there is a need for a feature Labial covering all of the above segments is seen from the following facts from Igbo reduplication (Hyman, 1973a).[20] In Igbo, verb stems, which are of the form CV, reduplicate (that is, become double) with a high vowel in the reduplicated (prefixed) syllable. Thus, the verb /lé/ 'look' reduplicates as [òlílé] 'looking' and the verb /lá/ 'return' reduplicates as [ọ̀lịlá] 'returning.' From these examples it is seen that the expected reduplicated vowel is [i] when the stem vowel is [e] and [ị] when it is [a] (see the discussion of advanced tongue root in **2.4.2.3**). However, when these stem vowels occur with a labial stem consonant, the reduplicated vowel is, in many dialects, [u] or [ụ], for example:

VERB STEM		DIALECT A	DIALECT B
/bè/	'cut'	[òbìbè]	[òbùbè]
/bà/	'enter'	[ọ̀bịbà]	[ọ̀bụbà]

Dialect A has the older forms, while dialect B has changed [i] and [ị] to [u] and [ụ] under the influence of the labial consonant. Assuming that the rule of dialect B is to be written so as to change unrounded high vowels to rounded high vowels between labial consonants when followed in turn by a nonhigh vowel, we obtain the following using Chomsky and Halle's (1968) features:

$$\begin{bmatrix}+\text{syll}\\+\text{high}\end{bmatrix} \rightarrow [+\text{round}] \,/\, \begin{bmatrix}-\text{syll}\\+\text{ant}\\-\text{cor}\end{bmatrix} \_\_ \begin{bmatrix}-\text{syll}\\+\text{ant}\\-\text{cor}\end{bmatrix} \begin{bmatrix}+\text{syll}\\-\text{high}\end{bmatrix}$$

Although the change of [i] to [u] between labial consonants is an assimilation to the labial position, the features Round, Anterior, and Coronal do not

[20] Other discussions of the need for a feature Labial include Wang (1968), Zimmer (1969), Anderson (1971), Vennemann and Ladefoged (1971), and Campbell (1974).

permit us to expose this assimilation. If, on the other hand, we were to use the feature Labial, the rule could be rewritten in a more explanatory way:

$$\begin{bmatrix}+\text{syll}\\+\text{high}\end{bmatrix} \rightarrow [+\text{labial}] \,/\, \begin{bmatrix}-\text{syll}\\+\text{labial}\end{bmatrix} \_\_ \begin{bmatrix}-\text{syll}\\+\text{labial}\end{bmatrix} \begin{bmatrix}+\text{syll}\\-\text{high}\end{bmatrix}$$

The feature specification [+labial] functions here as a "cover feature" for labial and labialized consonants as well as rounded vowels (see Vennemann and Ladefoged, 1971:18). In fact, the Igbo consonants which condition this assimilation include /p, b, m, f, w, k^w, g^w, $ŋ^w$, $\widehat{kp}$, $\widehat{gb}$/, that is, bilabials, labiodentals, labialized velars, and labiovelars—briefly, any consonant having to do with the lips.

2.5.2 The Treatment of Labiovelars

The labiovelar consonants /$\widehat{kp}$, $\widehat{gb}$, $\widehat{ŋm}$/ present a problem for Chomsky and Halle's (1968) feature system. It is argued (p. 311) that since Nupe has a surface contrast between [$\widehat{kp}$] and [$\widehat{kp}^w$], these labiovelars should be considered as velarized labials rather than as labialized velars. That is, their feature specifications are as in (a), not as in (b):

(a) $\begin{bmatrix}+\text{ant}\\-\text{cor}\\+\text{back}\\+\text{high}\end{bmatrix}$ (b) $\begin{bmatrix}-\text{ant}\\-\text{cor}\\+\text{back}\\+\text{high}\\+\text{round}\end{bmatrix}$

If [$\widehat{kp}$] were treated as in (b), that is, as a velar consonant with extreme rounding, then there would be no way to distinguish [$\widehat{kp}$] and [$\widehat{kp}^w$]. In addition, there would be no way to distinguish [$\widehat{kp}$] and [k^w], both of which exist in Igbo. The problem inherent in this approach is that there is no way to view /$\widehat{kp}$/ as equally labial and velar. One of the two features must be chosen as primary, the other as secondary.

Chomsky and Halle (1968) argue that since [$\widehat{kp}^w$] exists, [$\widehat{kp}$] could not already be considered [+round], that is, a labialized velar. A problem arises, however, when a palatized labiovelar is taken into consideration. Examples of a plain vs. labialized vs. palatalized labiovelar are given below, from Nupe:

[$\widehat{kp}$ā] 'to feed'
[$\widehat{kp}^w$à] 'to be plentiful, cheap'
[ē$\widehat{gb}^y$ǎ] 'bow string'

Chomsky and Halle state (1968:307) that an "inadequacy of the former framework [that is, Jakobson's] is that it provided no explanation for the fact that palatalization, velarization, and pharyngealization are mutually exclusive." Palatalization, which is represented by the features [+high, −back], and velarization, which is represented by the features [+high, +back], are automatically mutually exclusive in the *SPE* framework, since a segment cannot be simultaneously [−back] and [+back].

However, if [$\widehat{kp}$] and [$\widehat{gb}$] are velarized labials, as Chomsky and Halle (1968) claim, then [$\widehat{kp}^y$] and [$\widehat{gb}^y$] should be phonetic impossibilities. If, on the other hand, we consider [$\widehat{kp}^y$] and [$\widehat{gb}^y$] to be [−back], as palatalization in their framework would require, then [$\widehat{kp}^y$] and [p^y] merge together, as seen in the following distinctive feature matrices:

[p]	[p^w]	[p^y]	[$\widehat{kp}$]
+ant	+ant	+ant	+ant
−cor	−cor	−cor	−cor
−back	−back	−back	+back
−high	−high	+high	+high
−round	+round	−round	−round

[$\widehat{kp}^w$]	[$\widehat{kp}^y$]	[k^w]	[k^y]
+ant	+ant	−ant	−ant
−cor	−cor	−cor	−cor
+back	−back	+back	−back
+high	+high	+high	+high
+round	−round	+round	−round

If, however, [$\widehat{kp}^y$] is considered to be [+back], then it would not be possible to distinguish it from plain [$\widehat{kp}$]. The conclusion which must be drawn is that features are needed to distinguish primary and secondary places of articulation, as well as double places of articulation for coarticulated consonants such as the labiovelars under consideration. It may be necessary, in fact, to return to such traditional features as Labial, Palatal, Velar, etc. (see Wang, 1968; Vennemann and Ladefoged, 1971).

2.5.3 Binarity

Finally, it would not be possible to critically evaluate Jakobson's and Chomsky and Halle's systems without stating a few reservations one might have concerning binary features. The notion that all phonological features are binary has been questioned by a number of phonologists in various ways.[21] One area which is frequently cited is vowel height.

According to Jakobson, three vowel heights only are utilized phonemically by any language. These are distinguished in his system as [+diff, −comp] (high vowels), [−diff, −comp] (mid vowels), and [−diff, +comp] (low vowels). Since no vowel can be [+diff, +comp], only three vowel heights are possible.

[21] See, for instance, Martinet (1965), Wilson (1966), Contreras (1969), and, for an early defense of binarity, Halle (1957).

In Chomsky and Halle's framework, three vowel heights are recognized, which carry the feature specifications [+high, −low] (high vowels), [−high, −low] (mid vowels), and [−high, +low] (low vowels). Again, there is no fourth vowel height, because no vowel can be [+high, +low].

This raises the problem of what to do about languages with four phonetic vowel heights, for example, Danish (Martinet, 1937) or Swedish (Fant, 1967). In languages with the vowels [i, e, ɛ, æ], it has become customary to view both [e] and [ɛ] as [−high, −low]. The vowel [e] is generally viewed to be [+tense], while the vowel [ɛ] is considered [−tense]. In some cases, this may in fact be internally motivated by the phonological properties of a language. If, for instance, /i, e, u, o/ are pronounced [ɪ, ɛ, ʊ, ɔ] in closed syllables in a language, a rule such as the following can be written (where $ represents a syllable boundary):

$$[+\text{syll}] \rightarrow [-\text{tense}] \,/\, \_\_ \,[-\text{syll}]\,\$$$

Just as [+tense] /i/ becomes [−tense] [ɪ] in closed syllables, so does [+tense] /e/ become [−tense] [ɛ]. Thus, the proportion $i{:}\imath = e{:}\varepsilon$ appears to be justified.

If on the other hand, a language were to have a four-way phonemic contrast between /i/, /e/, /ɛ/, and /æ/ in CV (that is, open) syllables, it would appear necessary to recognize four contrasting vowel heights. Recognizing this possibility, Wang (1968:701) suggests replacing Chomsky and Halle's features High and Low with the new features High and Mid, which define *four* vowel heights in the following way:

CHOMSKY AND HALLE

/i/	/e/	/ɛ/	/æ/
[+high, −low]	[−high, −low, +tense]	[−high, −low, −tense]	[−high, +low]

WANG

/i/	/e/	/ɛ/	/æ/
[+high, −mid]	[+high, +mid]	[−high, +mid]	[−high, −mid]

But if one has to redefine the features in such a way (and there is even a slight hint [Wang, 1968:700n] that a third feature may occasionally be needed to distinguish a fifth vowel height), one might raise the question again: why binary features? Why not simply view the four vowels *i–e–ɛ–æ* as what Trubetzkoy called a gradual opposition?

Jakobson, Fant and Halle state (1952:3): "Any minimal distinction carried by the message confronts the listener with a two-choice situation." That is, the speaker has to decide between two opposites, presence of a feature in the speech signal versus its absence. Thus, the binary principle is a way of conceptualizing the task of the listener, who must decide what he hears.[22] Fant (1967:361) states that it is possible to view Swedish vowels as having four distinct values of the same feature (height), although he argues for a binary approach "in order to allow a consistent use of the binary principle within the whole system." Thus it seems to be an important argument that since many features (for example, Nasal, Voice) are binary, it is advantageous to view all features as such (though Fant labels this approach "a matter of coding convenience only"). Viewed slightly differently, it is easier to compare and evaluate like features than unlike ones. Thus, Halle (1964: 396) counts the number of distinctive features necessary to define natural classes. In Chapter 4 we shall see the importance of feature counting in the so-called "simplicity metric." It should be clear that we can count much more easily if everything is stated in the same terms (but see Contreras, 1969).

2.5.4 Conclusion

Needless to say, there is much that remains to be resolved in distinctive feature theory. Recent attacks on distinctive features have been made by Foley (1970) and Vennemann (1972a), who argue for gradual phonological features representing the relative strength of various consonants and vowels (for example, [p] is "stronger" than [t], which is "stronger" than [k], etc.). On another front, Ladefoged (1971) has proposed that the feature Voice, often cited as one of the clearest binary features, be replaced with a continuum characterizing the degree of Glottal Stricture. He proposes a scale based on the states of the glottis, ranging from voiceless to glottal stop, including the intermediate states breathy voice, murmur, lax voice, voice, tense voice, creaky voice, creak. Finally, Halle (1972:180ff) has proposed replacing the feature Voice with the two features Stiff Vocal Cords and Slack Vocal Cords (see **6.2.2.5**). Unfortunately the implications of nonbinary features have not been revealed as yet, since few if any complex phonological descriptions have attempted to apply, for example, Ladefoged's (1971) multivalued features in phonological rules.

In the remaining chapters of this book, phonological processes will be presented wherever possible with notational abbreviations, for example, *C* instead of [−syll], *V* instead of [+syll, −cons], *N* instead of [−syll, +nas]. Where necessary, however, reference will be made to features, for example, Voice, Grave, Palatal, Nasal. It will be generally assumed that the inventory

[22] Recall that the binary features which were first developed were defined primarily in their acoustic aspects, with their articulatory definitions only secondary in importance.

of phonological features is identical to the inventory of phonetic features, and that languages implement these universal phonetic features in various linguistic ways. In other words, phonetic features can be "phonologized" by individual languages. Of course, it may be that a phonetic feature is used phonologically by one language but not by another. In stating phonological rules, features will be chosen which seem to best explain the motivation of the processes in question.

3

PHONOLOGICAL ANALYSIS

3.0 Different Views of the Phoneme

In Chapter 1 the difference between phonetics and phonology was discussed. It was shown that in some cases phonological representations are not identical to phonetic transcriptions. In addition, the notion of distinctiveness was discussed in Chapters 1 and 2. It was claimed, for instance, that two languages can have exactly the same inventory of phonetic sounds (or phones), but significantly different phonological systems. That is, the same sounds can be organized in different ways. Just how much emphasis is to be given to these "different ways" is a matter of much debate, as we shall see.

In this chapter we shall examine the nature of phonological analysis. Since phonologists disagree in their basic assumptions about the nature of phonology, we shall see that the specific analysis of the phonetic data of a language greatly depends on the phonological *theory* underlying the analyst's work, a fact which must be constantly kept in mind. All phonologists agree that it is necessary to recognize both phonetic units (phones) and phonological units (phonemes). But there are many differences beyond this basic agreement. In 1.3 the *phoneme* was defined as a minimal unit of sound capable of distinguishing words of different meanings. Both /p/ and /b/ are phonemes in