A SURVEY OF PHONOLOGICAL FEATURES

by

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This review is intended to provide a convenient but detailed summary of the current status of various segmental features. It covers all the features given in The Sound Pattern of English (Chomsky & Halle 1968, henceforth SPE), and several features proposed since then. In a sense it is an update of Kenstowicz & Kisseberth (1979)'s discussion (henceforth K&K), though with more emphasis on phonetics. K&K do an excellent job of supplementing SPE with more and better arguments for many of the natural classes given by the SPE features, and these arguments are generally cited, not repeated, in this paper. K&K also give a good discussion of the overall what and why of features, which is not attempted here (though see also Keating (1988). This paper, therefore, does not entirely replace K&K's treatment of features. Other discussions of the SPE features from earlier well-known texts are also referred to, but are not entirely repeated, here. Therefore the reader may also want to consult Anderson (1974), Hyman (1975), Sommerstein (1977), Halle & Clements (1983), or Anderson (1985) either for a general introduction to features, or in regard to specific citations throughout this paper. In particular, Hyman (1975) and Anderson (1985) can be recommended for a summary of the acoustics-based feature system of Jakobson, Fant & Halle (1963), which SPE replaced. However, this paper is intended to be useful to the student who has not already read these (or other) references. Finally, this survey is concerned only with the features themselves, and so discusses new ideas about the structure and geometry of feature representations only as they affect the inventory of segmental features.

I. Place of articulation for consonants

With SPE there was a shift from acoustic to articulatory features, and specifically to a focus on the active articulator -- its state, or configuration, rather than its location in traditional place of articulation descriptions. The SPE features for place of articulation were quite innovative; they have also been subject to various proposals for revision.

A. Labials

1. [anterior]. This feature was proposed in SPE to divide places of articulation into alveolar-and-fronter vs. palatoalveolar-and-backer. K&K expressed reservations about this feature in that, in grouping together labials, dentals, and alveolars, it seems to refer to no natural classes in rules. Others have noted, in addition, that unlike most of the features representing place of articulation differences, [anterior] does not refer to a single active articulator; it is only used for representing lexical distinctions.[1] These reservations applies equally to two other features, [strident] and [distributed], which are discussed below under coronal consonants. For example, use of

[distributed] to distinguish within labial and coronal places of articulation gives as unlikely natural classes in English non-distributed alveolars and labiodentals as against distributed dentals and palatoalveolars. Such groupings were the result of a tendency to use a given feature to make as many distinctions as possible. More recent proposals focus on the natural classes predicted by features, and on limiting place of articulation features to single articulators. Thus Steriade, in unpublished work, proposed that [anterior], [strident], and [distributed] be limited to distinguishing among coronals, and this proposal is adopted by Sagey (1986) and much subsequent work.

2. [labial]. This feature represents an innovation since SPE, and has been proposed in two different senses. Anderson (1974) proposes it primarily to refer to labial places of articulation, that is, to replace [-anterior, -coronal] as part of the representation for labials (bilabials, labiodentals, labial-velars, and other double articulations). He also uses it to refer to some types of rounding, but not to rounding in general. However, the more common intention with a feature [labial] has been a "cover feature" that would relate labial consonants and [+round] segments (rounded vowels and glides, and labialized consonants). Vennemann & Ladefoged (1971) first proposed the idea of a cover feature (a feature not used to represent lexical distinctions but needed for natural classes and rule-writing) for cases such as [w] becoming [v], for [m] and [v] becoming [u], for [ɣ] becoming [v] between rounded vowels, and for front vowels becoming rounded before labial or rounded consonants. Hyman (1975) argues for such a cover feature on the basis of Igbo reduplication, in which non-labial stem consonants reduplicate with a high front unrounded vowel, while labial stem consonants reduplicate with a high back rounded vowel. "Labial" consonants here include bilabials, labiodentals, labialized velars, and labiovelars. Although K&K think that assimilation-based arguments for [labial] are generally suspect, such a feature to relate all segment types involving the lips seems to have been rather widely accepted, e.g. Halle (1983).

3. Bilabials vs. labiodentals. These are the two places of articulation included within labials. They must have distinct representations because a few languages contrast these kinds of consonants (for example, Ewe has voiced and voiceless fricatives of both types -- see Ladefoged 1968, 1971, or Ladefoged & Maddieson 1986). Other languages with at least one contrasting pair of fricatives listed

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[1] We should note that [+anterior] as in SPE may have an acoustic correlate: a diffuse spectrum (Stevens & Blumstein 1978), though whether this property draws a dividing line precisely where [+anterior] does is doubtful.

in UPSID (the UCLA Phonological Segment Inventory Database, Maddieson 1984) are Iai, Kanuri, and Tarascan, the latter two having more marginal contrasts[2]. In SPE, one feature used to provide this distinction was [strident], with labiodentals noisier (i.e. [+strident]) than bilabials ([-strident]). Another possibility also given in SPE is [distributed], since bilabial constrictions are arguably slightly more distributed than labiodental constrictions. (A distributed articulation is one in which there is a relatively broad constriction in the direction of airflow.) This feature is used instead of [strident] by Stahlke (1971) in his account of the Kpando dialect of Ewe. However, use of either of these features goes against the move to limit such features to single articulators, in this case coronals. With this move, labials and labiodentals are less straightforwardly distinguished.

The resulting treatment of the bilabial vs. labiodental fricatives basically consists of relying on other, non-place, features for the place distinction. When two or more feature differences accompany a segment contrast, it is not always clear which feature should be treated as contrastive, and which redundant (predictable) for that contrast. Thus Sagey (1986) suggests the manner feature [continuant] to distinguish bilabials from labiodentals, treating the place difference as redundant. This works fine for English and many other languages (at least above the level of phonetic detail). Labiodental stops are not found in languages, and from Maddieson (1984) we learn that bilabial stops most often contrast with labiodental fricatives; thus the contrast in stop vs. fricative ([continuant]) can often replace the place of articulation contrast. In several other cases in UPSID a voiced bilabial fricative contrasts with a voiceless labiodental one, so the contrast can be represented as one of voicing. But neither of these will work when consonants at the two places have the same manner and voicing, as in Ewe and the other languages cited above. It is clear from Ladefoged (1968)'s description of Ewe that the distinction is not due to some other manner feature, such as [sonorant] or [tense]. Furthermore, according to Stahlke (1971), there is no internal phonological evidence from Ewe (such as participation of one of these places of articulation in a natural class with other segments) to indicate what feature is involved in the contrast. Some new feature seems to be needed just to characterize this rare contrast, a curious situation because no natural classes or patterns are at issue.

B. Coronals

Coronal sounds are articulated with the front or blade (including

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[2]For example, in the Yerwa or Maiduguri dialect of Kanuri, the relation is allophonic rather than contrastive (Hutchison 1981).

the tip) of the tongue, and in SPE include dental, alveolar, retroflex, and palatoalveolar places of articulation. SPE used the features [anterior, strident] to distinguish among the English coronals (i.e. the dental, alveolar, and palatoalveolar fricatives), and the feature [distributed] to make additional distinctions. (See section IA1 above for discussion of limiting these features to coronals.) Several issues have arisen in relation to the coronals.

1. [coronal], [grave], and palatals. For consonants, SPE gave up the Jakobson, Fant & Halle acoustic feature [grave] in favor of the not-quite-equivalent articulatory feature [coronal]: most sounds that were [+grave] are [-coronal]. The difference is that while palatals were [-grave] for Jakobson, Fant & Halle, they were said to be [-coronal] in SPE. This change in the natural classes elicited a furor of complaints, either that palatals pattern with dental and alveolars (which are [+coronal]), or that velars alternate with labials (e.g. Hyman 1973, Vago 1976, Odden 1978, Becker 1978). Clements (1976) and later Halle & Stevens (1979) proposed to redefine [+coronal] to include palatals. The only potential distinction then between old [grave] and new [coronal] concerns the representation of uvular and pharyngeal places. These are certainly [-coronal], but were unspecified for [grave] in the Jakobson, Fant, & Halle system (as discussed in Jakobson 1957). Nonetheless, on all of the definitions of gravity given in Jakobson, Fant & Halle (1963), uvulars and pharyngeals are plausibly [+grave]. On this interpretation, the new definition of [coronal] is exactly equivalent to [grave].

2. Distinctions among coronals. SPE, with its focus on active articulators, rejected features taken from the traditional place of articulation continuum along the roof of the mouth. Instead, three features are in effect used to distinguish among coronal places: [anterior], [distributed], [strident]. The last feature is useful only for fricatives, so we will first consider other coronal distinctions.

a. Non-fricative coronals. [anterior] divides the coronals at the alveolar ridge: alveolars and dentals are [+anterior], while the various post-alveolars are [-anterior]. Lahiri & Blumstein (1984) claim that for non-fricatives, there is no contrast between palatal and palatoalveolar. On their account, this leaves the following distinctions to be made among four categories of non-fricatives:

[+anterior] -- dental must be distinguished from alveolar
[-anterior] -- retroflex must be distinguished from palatal or palatoalveolar

Certain Dravidian languages and most Australian languages use all four categories contrastively for oral and nasal stops, and for laterals: dental, alveolar, retroflex, and palatoalveolar or palatal. The alveolars and retroflexes often pattern together in opposition to the dentals and palatals, giving evidence that a further binary feature is needed. The SPE feature for these distinctions is [distributed]. Strictly speaking, this is a manner feature rather than a place of articulation feature, but the manner of the active articulator is taken as the basic dimension. For coronals, this feature is treated as the equivalent of the traditional distinction between apical (alveolar and retroflex, [-distributed]) and laminal (dental and palatal or palato-alveolar, [+distributed]).

Challenges to this four-category system are presented by some of the data on place of articulation given by Ladefoged & Maddieson (1986). Some of their cases seem to involve other features as well, such as apical dental vs. apical alveolar clicks, and palatoalveolar vs. palatal stops, where in both cases affrication may occur. If these contrasts involve frication, then they can be treated under the system of fricative features, discussed below, which allow more contrasts to be represented. Other of Ladefoged & Maddieson's cases are presented tentatively on the basis of a single description in the literature, such as apical retroflexes vs. sublaminal retroflexes, and apical dental vs. apical alveolar laterals. Finally, a contrast in Malayalam between palatoalveolar and palatal nasals is cited from Mohanan & Mohanan (1984), exactly what Lahiri & Blumstein (1984) say does not occur. So depending on how these cases hold up, the feature system described above may not suffice for coronal non-fricatives.

Even if it turns out that the palatoalveolar - palatal distinction is not used for minimal contrasts, it is still desirable to characterize the difference for the systematic phonetic level of representation. In Keating (in preparation) I present cross-language evidence gleaned from the UCLA X-ray database (Dart 1987) which suggests that palatals are articulatorily more complex than palatoalveolars. I propose that palatals are simultaneously coronal and [+high, -back], while palatoalveolars are coronal but unspecified for the tongue body features. This claim needs additional testing, however.

b. Fricative coronals and [strident]. Fricatives, like non-fricatives, contrast in [anterior] and [distributed]. As it happens, Australian languages typically lack fricatives altogether, and so do not offer series parallel to their stops and laterals, but many other languages do provide relevant contrasts. For example, Catford (in progress) describes four categories of coronal fricatives in Ubykh that appear to be distinguished by these two features.

Fricatives seem to occur at more places of articulation than do the four stop categories; for example, we find both palatoalveolar and palatal places within a language. Since both are [-anterior, +distributed], some third feature is needed to distinguish these contrasting categories. In SPE, the feature [strident] was used for this (and other) contrasts, refering to greater noisiness resulting from various articulatory considerations. The earlier use of this feature by Jakobson, Fant, & Halle referred specifically to an articulation in which an airstream is directed to impinge on an obstacle, creating extra turbulence. This is essentially the same definition as in Halle & Stevens (1979; see also Shadle 1985); and although they called this feature [grooved], in line with its articulatory definition, the name [strident] seems likely to persist (see Stevens 1983, Stevens et al. 1986), though [sibilant] may also be used with this meaning. Alveolar, palatoalveolar, and retroflex fricatives are all strident. This feature thus separates palatal from palatoalveolar fricatives with minus vs. plus values of [strident]. Also, in SPE and most treatments of English, [strident], not [distributed], is used for the dental vs. alveolar fricative contrast. Furthermore, anterior distributed (dental) coronals can also contrast in stridency, ie. [θ] can have a strident counterpart, which Halle & Stevens identify with the "tongue tip down" [s]. It could also be identified with a dental sibilant [s̪]. The following chart summarizes these coronal fricative distinctions. Additional features would be needed if all differences between fricatives across languages were to be described (e.g. Ladefoged & Maddieson 1986).

	θ	s	s̪	ʃ	ʂ	ç
anterior	+	+	+	-	-	-
distributed	+	-	+	+	-	+
strident	-	+	+	+	+	-

Besides giving the needed place of articulation distinctions, the feature [strident] gives needed fricative natural classes, for example, the class of fricatives referred to by the English plural (etc.) rule. However, [strident] cannot make these place distinctions for other manners of consonants. That is why the possible occurrence of such contrasts in nasals, discussed in the preceding section, is problematic for the system.

One advantage of using manner features for fine place distinctions is that there is no need to specify where, for example, "dental" ends and "alveolar" begins in the mouth. The only distinction that must be made is the line between alveolars and palatoalveolars or retroflexes, that is, the boundary between [+anterior] and [-anterior].

C. Tongue body features for place

1. Vowel features for primary places. Chomsky & Halle proposed that all articulations involving the tongue body be described by the features [high,low,back]. Such articulations include not only vowels and vowel-like secondary articulations, but also consonant primary places of articulation from palatal back to pharyngeal. The features work as follows.

	palatals palatalization [i]	velars velarization [u]	uvulars uvularization [o]	pharyngeals pharyngealization [ɑ]
high	+	+	–	–
low	–	–	–	+
back	–	+	+	+

Thus palatals, palatalization, and high front vowels are said to share similar tongue body articulations, while velars, velarization, and high back vowels are said to share a different set of similar tongue body articulations. One motivation is the patterning of velars with back vowels, and palatals with front vowels: rules of velar fronting in front vowel contexts can be stated as assimilations with these features. K&K (p. 250) offer arguments for the parallel treatment of uvulars and pharyngeals. Evidence that uvulars are more like mid vowels comes from rules in Greenlandic Eskimo, Quechua, and other languages that lower high vowels to mid in a uvular context. Evidence that pharyngeals are more like low vowels comes from Semitic rules giving /ɑ/ in pharyngeal contexts.

The whole area of back consonant distinctions seems unclear. Since SPE, various proposals have been made to split off the pharyngeals, using for them features like [ATR] or [Constricted Pharynx] instead of [+back,+low]. These features overlap in involving movement of the tongue root in the lower pharynx. If features are really meant to correspond to articulators, then this duplication should be unnecessary. Most recently, Steriade (1987) adopts this proposal as part of giving up use of the SPE tongue-body features for consonants. More work on languages containing the relevant segment types is needed to determine just what are the independently required features.

A problem with the SPE way of distinguishing velars vs. uvulars is that phonetically it would seem that velars and uvulars are really on a diagonal, not a vertical, line, with uvulars being both lower and backer than velars. Phonologically, languages appear to choose one direction as the nominal one. The example used by K&K shows that Eskimo treats uvulars as being lower than velars, as the SPE features predict. However, in Kirghiz (Hebert & Poppe 1963), uvulars are said to alternate with velars as a function of vowel backness, not vowel height. Thus in Kirghiz uvulars seem to be treated as being backer, not lower, than velars: Eskimo and Kirghiz reify the phonetic diagonal line differently[3]. Another puzzling case is that of !Xóõ (Traill 1985). X-rays show that !Xóõ uvulars differ from velars phonetically not in height but in backness, yet phonological rules in the language treat both as [+back], along with [+back] vowels.

Another problem involves characterizing pharyngeal and laryngeal consonants. K&K express some reservations about whether an Arabic rule lowering /i/ to /ɑ/ in a pharyngeal environment supports the use of [low] for pharyngeal consonants, since laryngeal consonants are also involved in the rule. SPE describes laryngeal consonants as [+low] to handle such patterning, but clearly this is not a low tongue body articulation.

Finally, it is important to note that in SPE, [high] replaced the Jakobson, Fant & Halle feature [diffuse] so as to correctly group together certain consonants and vowels: Hyman (1975) gives a good review of this point, plus others concerning the differences between the two feature systems.

2. Secondary articulations. The same tongue body features that are used for vowels and primary consonant articulations are also used for secondary articulations in which vowel qualities are superimposed on consonants. Thus a palatalized labial not only has all of the features associated with its labial articulation, but also the features associated with palatalization: the tongue body is [+high,-low,-back]. This is a very direct representation of the idea that secondary articulations involve the simultaneous addition of vowel articulations to other, primary, consonant articulations.

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[3] This assumes that the description of Kirghiz is phonetically accurate; if uvulars really alternate with <u>palatals</u> then of course there is no problem for the SPE features. Also, it should be noted that even if the facts are as given, it is still possible to represent the consonant alternation with SPE features, if the features [high] and [back] are unspecified. However, such a derivation will not express the apparent phonetic generalization.

a. Primary vs. secondary. In this system, secondary articulations are represented with the same features as primary consonant articulations involving the tongue body. This means that it is not possible to represent secondary articulations on consonants whose primary articulations are made with the tongue body. Now whether this is desirable must be a phonetic issue, since many languages are considered to have secondary articulations at such places of articulation phonologically, corresponding to secondary articulations at other places of articulation. For example, some Slavic languages have "palatalized velars" along with palatalized labials and coronals; Maddieson (1984) gives several other languages with such segments. However, under the SPE hypothesis, there can be no phonetic difference between a palatalized velar and a palatal: when the specification for palatalization ([-back, +high, -low]) is applied to primary velars ([+back, +high, -low]), a primary palatal results. If a language has sounds which pattern within the phonology as palatalized velars, they should be phonetic palatals. Chomsky & Halle simply assert that this is so, without citing any evidence.

In Keating (in preparation) I consider this claim in some detail. Use of the UCLA X-ray database (Dart 1987) shows that indeed palatalized velars have occlusions that are entirely fronted relative to plain velars. However, palatalized velars do not look like palatals; palatals, but not palatalized velars, involve a coronal articulation with very broad contact in the post-alveolar region. Palatalized velars look like velars that have been fronted along the palate, without contact being broader; indeed, they look like velars in front vowel contexts in languages without palatalization contrasts. However, since palatals are recognized as coronals, the feature system can easily accomodate a distinction between palatals and palatalized velars; the latter are [-coronal].

Palatalized velars are not the only secondary articulation relevant to the SPE claim. Maddieson (1984) lists other cases such as pharyngealized velars in Shilha. Colarusso (1975) and Catford (1977) describe other supposedly impossible sounds, namely palatalized uvular stops and fricatives and pharyngealized uvular fricatives in Ubykh, Abkhaz, and other languages of the NW Causcasus. Ubykh has many back consonants: in addition to palatalized and labialized velar stops and fricatives, it contrasts palatalized, plain, pharyngealized, labialized, and pharyngealized-labialized uvular stops and fricatives. Chomsky & Halle (p. 305) choose to interpret these segments as having primary articulations: the palatalized velars are given as palatals, the palatalized uvulars as velars, and the pharyngealized uvulars as pharyngeals. This results in a proposed straightforward inventory of plain palatals, and plain vs. labialized velars, uvulars, and pharyngeals. It is certainly interesting that the inventory has precisely the gaps allowing such a reanalysis, but Colarusso makes it clear that Ubykh and Circassian languages do indeed lack sounds that occur in other Caucasian languages.

Furthermore, the inventory of the Bzyb dialect of Abkhaz does not allow such easy reinterpretation: here there are what Catford and Colarusso describe as pharyngealized uvular fricatives contrasting with both plain uvulars and plain pharyngeals. Catford (1983) provides two sample X-rays from Bgažba (1964) of these pharyngealized uvulars, though not of plain uvulars or pharyngeals. Colarusso (1977) reproduces more of Bgažba's X-rays, including the plain and pharyngealized uvulars. These novel segment types involve very broad constrictions in both the uvular region and the upper pharynx that are unlike the constrictions of primary back consonants.

Catford clearly considers the SPE treatment of secondary articulations to be incorrect. He, like Anderson (1974), describes palatalized velars, palatalized uvulars, and pharyngealized uvulars as having constrictions that are more extensive -- more distributed in the SPE terminology -- than plain velars or uvulars (and presumably palatals). Although this is not true of plain vs. palatalized velars, there is no feature problem with this distinction, as discussed above. Colarusso discusses various options for the other segment types of Bzyb, including [distributed] and [ATR] (see below), deciding in favor of the latter. Clearly, these unusual segment types should be incorporated into any account of feature representations of secondary articulations.

b. Other considerations. An additional problem with the SPE system is that some restrictions on secondary articulations are not captured by this system. Pharyngealization and uvularization are at best rare[4]; languages prefer secondary articulations involving [+high] articulations. Furthermore, not only are secondary articulations involving [+back] rare overall, but no language contrasts any two of them: languages have velarization or pharyngealization[5]. This gap is particularly odd since in vowel systems languages prefer height to backness contrasts. The SPE system for describing secondary articulations, by treating them all as equivalent to vowel contrasts, does not predict such a difference.

It is also interesting that in Maddieson (1984) no retroflex, palatal, palatoalveolar, or labial-velar stops have any secondary

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[4]What is described as pharyngealization in Arabic varies phonetically across dialects from velarization to uvularization to true pharyngealization, with Tunisian clearly having uvularization (Ghazeli 1977), and Syrian, Jordanian, and related dialects supposedly more likely to have true pharyngealization.

articulations. (However, labialized palatoalveolar and labialized palatal <u>fricatives</u> and <u>affricates</u> occur.) Presumably this is in part because these categories of plosives, and secondary articulations, are all rare, making their combination statistically unlikely.

Thus there are some problems with representing secondary articulations by vowel features. A different point that is often raised in this regard seems less problematic, however. At a phonetic level of description, it is clear that vowels and back consonants can all be somewhat pharyngealized in the context of contrastively pharyngealized segments (e.g. Ghazeli 1977, Catford 1977). This fact is sometimes taken to show that vowel features cannot be used for both kinds of segments (e.g. Hyman 1975:50), since this would require back vowels to be further backed by assimilation. However, such contextual effects show only that underlying vowel quality and the assimilation cannot both use a single binary vowel feature value. This suggests at least two (not incompatible) solutions to the problem: underspecification of underlying vowel quality, and phonetic (i.e. non-binary) feature values in assimilation.

c. Redundant vowel features. An issue related to secondary articulations is the assignment of redundant tongue body features to coronal consonants. When no secondary articulation occurs with a consonant, it may have certain expected or redundant values for tongue body features. For labials, it is impossible to say what the tongue is doing except on the basis of the surrounding context. But for coronals, certain articulations may be expected for ease in positioning the tongue blade. In SPE (pp. 306-7) it was assumed that the anterior consonants and the coronals, in the absence of language-particular phonological values, were all [-back] redundantly. Furthermore, the palatoalveolars were also [+high]. This combination of [-back] and [+high] for palatoalveolars means that they should be (non-distinctively) palatalized in, for example, English. This is not accurate phonetically, though it would be possible to write language-specific phonetic implementation rules which would produce non-palatalized English consonants, as a matter of phonetic detail. Nonetheless, it seems preferable not to specify tongue body positions so completely in these cases.

More recently Stevens, Keyser, & Kawasaki (1986) have proposed that the tongue body feature [back] can redundantly characterize dentals and alveolars, and that this redundant value is capable of playing a phonological role in a language. The value for [back] agrees with the

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[5] A possible exception suggested by Ian Maddieson is certain Ethiopian languages not listed in UPSID that may contrast labial-velarization with pharyngealization. However, the velarization might then be redundant.

usual value for [distributed], namely, dentals [+back] and alveolars [-back]. Stevens et al. argue for redundant values of [back] in part because in some Australian languages such as Lardil, vowels alternate in backness after stem-final consonants that differ in distributedness. Thus in their analysis, not only must the features have these redundant values, but those values must be available within the phonology, as in the SPE theory. Stevens et al. also claim to find support for these redundant values of [back] in second formant frequency variation in English: F2 onset is lower after dentals than after alveolars, indicating a difference in tongue backness. However, more vowels, with different second formants of their own, would have to be examined to confirm such a result.

3. A single set of features. We have reviewed the use of vowel features for primary consonant places of articulation, contrastive secondary articulations, and redundant tongue body control. Should one set of tongue body features really do all these jobs? SPE (pp. 305-8) justified this approach with the following reasons: first, secondary articulations on consonants are clearly related to vowels, both in terms of articulation and in terms of assimilation processes; second, these secondary articulations are mutually exclusive with each other and with primary palatal and dorsal places; third, these primary places may correspond phonologically to secondary articulations at other places in a language (for example, palatals may pattern in a language as palatalized velars, parallel to palatalized labials, etc.). The first reason is the least controversial, since it is simply the traditional view of secondary articulations. It also accounts for part of the second reason, the fact that consonants cannot have more than one secondary articulation at a time, since vowels cannot occur simultaneously. As for the rest of the second reason, we have already seen that dorsal and palatal consonants can also have phonetically distinct secondary articulations. The third reason is a version of the second.

The intuition underlying the SPE position is that a single articulator, the tongue body, is responsible both for vowels and for certain primary consonant places of articulation, namely palatal and dorsal, and that it can only do one thing at a time. As a consequence of using the same articulator, the primary articulations for these places are strongly affected by the vowel context. Such contextual effects appear to be stronger for these places than for other places, and this difference is evidence for the articulatory relation between palatal and dorsal places, and vowels[6]. However, this whole question remains quite open.

D. Labial-velars

Traditionally-based feature systems such as Ladefoged (1971) usually treat labial-velars (and by implication, labial-palatals and labial-alveolars) as additional values for a continuous or multi-valued "place of articulation" feature. There is thus no direct representation of the fact that, for example, labial-velars combine labial and velar articulations. (More precisely, for Ladefoged labial-velars would have the value "labial-velar" for the multi-valued [place of articulation] feature, and additionally would have the cover feature representation [+labial]; the labial connection would thus be represented, but not the velar connection.) In the SPE system labial-velars are related more directly to the labial and velar places, but only because they have to be either labialized velars or velarized labials. This ambiguity was taken to be a virtue, and defended as such by Anderson (1976, 1981). However, Ohala (1979, Ohala and Lorentz 1977) has argued persuasively that such ambiguity should not be a variable across languages, but rather available within each language: labial-velars are both labials and velars. They most often behave like velars for nasal assimilation (where the back cavity is more important), but as labials for assimilation of fricatives or spirantization (where the front cavity is more important).

Halle (1983) proposed to represent labial-velars as [+labial, +high, +back], that is, simultaneous independent articulations. He argued that the SPE system distinguishes labial, coronal, and tongue body articulations as independent mechanisms, and thus allows double articulations that combine these (indeed, triple articulations). He contrasts this with traditional place of articulation theory, which would appear to make any arbitrary combination formally possible. This kind of representation for double articulations is pursued further in Sagey (1986) and Ladefoged & Maddieson (1986).

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[6] For all places of articulation, vowel context affects the tongue body position (cf. figures in Perkell 1969). If anything, these tongue body effects are stronger for labials and coronals than for dorsals. Thus the statements above explicitly refer to the primary articulation (the area of constriction) of a place of articulation. The effects of tongue body position are much more noticeable acoustically in dorsal consonants, even if they are articulatorily more limited, because consonant noise, as in frication and stop bursts, is determined mainly by the cavity in front of the constriction. For labials and alveolars (etc.), the tongue body position does not affect this front cavity. For palatals and velars, etc., it does.

II. Vowel features

A. Height and backness

The SPE features for vowels distinguish three primary heights and back vs. front. Other distinctions that might be described along these primary dimensions are instead ascribed in SPE to other features: [tense] and [covered] replacing more height distinctions, and [round] replacing more backness distinctions. The need to distinguish at least four (phonetic) heights and possibly three degrees of backness in lexical representations, is brought up again and again in discussions of vowel features (e.g. Wang 1968, Lindau 1978). In SPE, if a language has more than two vowels within one of the six combinations of binary height and backness features, then those two vowels will have to be distinguished by some non-height feature. The phonological claims, then, are that first, such vowel pairs are more closely related than other pairs, and second, whatever feature is used to distinguish within such vowel pairs will also describe a natural class cutting across vowel heights. For example, the two pairs of mid vowels in a symmetrical seven-vowel system, as in Yoruba, would have to be distinguished by some feature besides [high,low,back]. This new feature defines new natural classes within the language. Such vowel pairs sharing a phonological height are often reflexes of earlier harmony sets (as in Yoruba), or length distinctions (as in Germanic), and so in fact generally do pattern together. The crucial point is that the mere fact that a language has a particular inventory of vowel heights is not in itself evidence against the phonological use of binary height features. Rather, such evidence would have to consist of, e.g. a language with four heights in which no two patterned together as a pair, so that no additional feature could be motivated, or a language in which phonological rules referred to an apparent continuum of height values. While vowel chain shift rules can be expressed with SPE features, they may miss obvious generalizations. For an inconclusive debate over a possible case of this sort, see Lindau (1978) and Yip (1980). For further discussion on this issue, and on vowel features more generally, see K&K, and Hyman (1988).

B. [tense] and [ATR]

After SPE, various proposals surfaced to collapse [tense] (as in English and German) with [covered] or [Advanced Tongue Root] (as in West African vowel harmony systems), including Halle & Stevens (1969), Perkell (1971), and Ladefoged (1971); K&K adopt this idea. But Lindau (1978, 1979) argues that phonetically distinct dimensions are involved: in terms of the vocal tract shape, the "tense" distinction is one of tongue height, while the "ATR" distinction is one of total pharynx size, which Lindau renames [expanded/constricted pharynx] to clarify that multiple articulators are involved. According to Lindau, in Agwagwune, a Lower Cross River language of southeastern Nigeria, not only is there ATR harmony, but also there is reduction (laxing) of every vowel in closed syllables. That is, at least for phonetic descriptions, [ATR] must be kept distinct from [tense]. Lindau also suggests the name [peripheral] for [tense] since [tense] is so unclear in meaning; this is fine as long as [peripheral] is understood to include a duration difference, as well as the tongue position difference. More recently, however, the trend has been to use [ATR] (rather than [tense]) for both dimensions, presumably in part because [ATR] is more clearly associated with a particular articulator than is [tense].

Also after SPE, there was a short-lived move to replace the tongue-body feature [low] with the features [ATR] and [Constricted Pharynx] (Perkell 1971); these features are used to give an extra vowel height by, for example, Mascaro (1976). Colarusso (1975) also uses these features.

C. [round]

The need for a feature [round] remains uncontroversial, but there is more than one kind of rounding that needs to be represented. Lip action that narrows the area of lip opening can be protrusive or not. Such a phonetic distinction is motivated in Linker (1982)'s cross-language study of vowel rounding. Lindau (1978) adds a feature [compressed] to distinguish the contrastive "inrounding" and "outrounding" of the Swedish high front vowels. Such an additional feature is not needed once a feature [labial] is recognized, though. If [labial], as a kind of cover feature, refers to any involvement of the lips, and [round] is limited to actual protrusion, then non-protrusive rounding can be represented as [+labial] but [-round]. It should be noted that this proposal is somewhat different from one in Anderson (1974) using the same two features.

D. Tongue blade

For some vowels, the tongue blade is also involved as a secondary articulator: for example, retroflexed or "r-colored" vowels in English. Features normally associated with consonants, such as those for retroflexion, can be used for vowels along with the more usual tongue body features.

In a different vein, however, Clements (1976) proposes that the high front vowel [i] in its primary articulation involves the tongue blade as well as the body, and is thus redundantly [+coronal]. He uses this feature value to account for patterns of assimilation of consonants to this vowel. Given that languages do differ in the phonetic details of otherwise similar vowels (Disner 1983), it would be interesting to see if there is any correlation between the kind of [i] vowel in a given language, for example whether the blade is involved, and the occurrence of consonant-vowel assimilations.

III. Manner features

A. Major class features

The original major class features in SPE were vocalic, consonantal, and sonorant. However, in Ch. 8 (p. 354) of SPE, [vocalic] was replaced by [syllabic]. Subsequently, [syllabic] was eliminated as a feature, and is now encoded in syllable structure. Thus [consonantal] and [sonorant] are left as the only major class features. The feature [consonantal] distinguishes vowels and the glides [h,?,y,w] from all other consonants. The feature [sonorant] distinguishes vowels and sonorant consonants from obstruent consonants. K&K express some doubts about whether the class of glides should include the non-traditional [ḥ] and [?], but they also give examples justifying all these divisions. The SPE major class features together divide segments into classes of varying sonority. However, some phonologists have proposed using directly a single sonority hierarchy or continuum, as a constraint on syllable structure as well as in certain rules (Hankamer & Aissen 1974, Kiparsky 1979, Steriade 1982, Selkirk 1984). Most recently, Clements (1987) reviews this line of work and suggests that binary features are still to be preferred as the basis for generalizations about relative sonority. He uses as major class features [syllabic] (actually not a segmental feature, but instead part of CV structure), [vocoid] (simply the opposite of SPE [consonantal]), [approximant] (which groups together liquids and glides), and [sonorant]. His choice of these features comes not only from their role in defining sonority distinctions, but also from evidence about the natural classes predicted by each of these features.

B. Consonant articulations

Very few changes have occurred with features describing consonant manner of articulation, with the major exception of laryngeal features, which are discussed separately below. Those manner features which are primarily used to distinguish places of articulation, including [strident], were discussed above in (Ib). The definitions and use of such features as [nasal], [lateral], and [continuant] are much as in SPE; any of the earlier texts can be consulted for summaries and discussions of these features. However, Halle & Clements (1983) and other recent work use [-continuant] to mean oral contact rather than complete oral blockage, such that [l] is [-continuant] along with stops.

However, two manner features from SPE, [delayed primary release] and [delayed secondary release], no longer are in general use. The job of these release features, representing the complex nature of affricates and affricated clicks, is now done by contour segment representations in CV phonology. CV theory allows more than one segment matrix to be sequenced within a single segment, eliminating the need for features of timing relations. Later features in the spirit of SPE that are no longer needed for this same reason include [prenasalized] and [preaspirated]. Further implications of such enriched phonological structures are discussed below in (IV).

C. Laryngeal and related features

As Sommerstein (1977) notes, the SPE proposal for voicing (the features [voice], [tense], [heightened subglottal pressure], and [glottal constriction]) was never widely accepted. The feature [glottal constriction] played a marginal, optional role for voicing; the feature [tense] described supralaryngeal adjustments for consonants that would suppress voicing, [heightened subglottal pressure] indicated extra energy for aspiration, and [voice] indicated a particular vocal cord configuration suitable for voicing, not vocal cord vibration per se. Perhaps their most important innovation in this respect was the decision to represent the glottal configuration but not the results of the configuration -- i.e. not whether vocal cord vibration actually occurs. The various features interacted in somewhat complicated ways in determining vibration, aspiration, etc., and were therefore perhaps too hard to learn to use, rather than theoretically unacceptable; there was also little evidence presented in their support.

Among phonologists, the most successful replacements have been the Halle & Stevens (1971) features. (The original paper has not been published, but see e.g. Anderson 1974, 1978, Stevens & Perkell 1977 for descriptions.) Halle & Stevens (henceforth H&S) use four binary features to describe two dimensions of laryngeal control; one is the stiffness-slackness of the vocal cords, the other their spread-constricted positioning. These features, like the SPE features, describe the state and position of the vocal cords at the moment of release in a segment, rather than any resulting activity such as vocal cord vibration or aspiration. They were meant to describe all aspects of laryngeal distinctions, including airstream mechanisms, phonation types, and fundamental frequency, as well as voicing and aspiration. The features attempted to relate all of these dimensions by representing them with shared features. Sagey (1986) is a recent case in which the features are used in all of these ways. However, since the original proposal, many criticisms of these features have been made (several of which are contained in chapters of the Fromkin (1978) tone volume), both in terms of their physical phonetic accuracy, and their phonological usefulness. Some of these will be repeated here.

1. Voicing. First consider the Halle & Stevens features simply as a way of representing voicing distinctions. They do not offer a straightforward characterization in terms of whether or not the vocal cords are vibrating, even though they require a fairly precise physical description of the glottal state. Although Hayes (1984) suggests that some facts from Russian require this type of glottal representation, this move has not been generally endorsed. Such authors as Anderson (1974), Clements (1985), and even Stevens et al. (1986) include a separate [voice] feature, a cover feature to refer either to something like the presence or absence of vocal cord vibration, or to more abstract phonological categories.

Among phoneticians, the H&S features have not been widely adopted. Most importantly, claims made by H&S about vocal cord control for voicing have not been supported by experimental evidence. The H&S feature system assumes that voiced obstruents have slackened vocal cords to allow vibration, while voiceless obstruents have stiffened vocal cords to suppress it. However, Chen (1970) and Hirose and his colleages (cited by Hombert et al. 1979) have provided evidence from laryngeal EMG that there is no difference in vocal cord stiffness for voiced vs. voiceless consonants. Another reason for lack of phonetician support, however, may be that most phoneticians had already adopted the "Voice Onset Time" framework of Lisker & Abramson (1964). Thus Lisker & Abramson (1971), Ladefoged (1971), and Keating (1984) all use some version of VOT rather than static glottal configuration features for phonetic voicing variation (though Keating also uses [voice] as a binary phonological feature). In general, however, Lisker & Abramson's work has had no impact on phonologists. One factor may be that Lisker & Abramson made no attempt to provide an explicit feature system or form of representation; another is their use of a relative timing dimension. In favoring features that describe static configurations over relative timing, Chomsky & Halle reanalyzed Lisker & Abramson's results, provoking an angry reply (Lisker & Abramson 1971). Nonetheless, H&S retain this one aspect of the SPE voicing features: a description of the glottal state at a moment of time, rather than a description of sequencing of events.

It should be noted that H&S's claims are based on vocal cord modeling rather than observation of speakers. While it is certainly true that, for example, stiffening the vocal cords will prevent voicing, it does not follow that that is how people usually do make voiceless consonants. In the case of voiceless consonants, a glottal spreading gesture is more typically used. The H&S glottal spreading feature, which by definition refers only to the moment of release, necessarily entails aspiration as well as voicelessness. This is because an open glottis at the time of release results in aspiration. Yet voiceless unaspirated consonants can also be produced with a glottal spreading gesture: the gesture is simply completed within time of the consonant constriction, so that the glottis is closed by the release. The H&S features cannot distinguish different glottal gesture timing possibilities. They must use the vocal cord stiffness feature to indicate voicelessness without aspiration, but this is done at the expense of descriptive accuracy. (For an account of voicelessness and aspiration which uses only a glottal spreading gesture with different relative timings, see Browman & Goldstein 1986. This limited treatment, however, encounters its own empirical difficulties.)

The other H&S features [±spread glottis], [±constricted glottis] provide three degrees of glottal constriction (spread, neutral, constricted), as opposed to the many degrees used by Ladefoged or Catford. These two features have been widely adopted for the description of aspiration and glottalization, since there is a convenient feature value for each of these characteristics: [+spread glottis] for aspiration and [h], and [+constricted glottis] for glottal stops and glottalization. There is no doubt that the glottis is spread at consonant release for aspiration and constricted for glottalization, and thus these feature values, taken apart from the system as a whole, are phonetically quite accurate. It is probably fair to say that many people use these two particular feature values as names for these characteristics without necessarily endorsing the whole system of four features. The features for vocal cord stiffness are, after all, the more problematic ones.

2. Co-occurrences with tone. The features have most often been criticized for their claims about the relations between tone and other dimensions. The four features are used to describe a variety of laryngeal dimensions so as to predict when values along these dimensions will be correlated, such as tonal correlations with voicing. The appeal of the features lies in such correlations, which indeed are often observed in languages. We will consider each in turn, leaving the question of airstream mechanisms until the end.

a. Tones and voicing. The basic idea is that stiff vocal cords raise f0 on a sonorant while slack vocal cords lower it; thus Low tone is represented by the combination [-stiff, +slack], Mid tone by [-stiff, -slack], and High tone by [+stiff, -slack]. Since slack vocal cords also facilitate voicing in obstruents, such voicing is associated with Low tone or lowered f0 in an adjacent sonorant. Since stiff vocal cords also suppress voicing, voicelessness is associated with High tone or raised f0 in an adjacent sonorant. Since the vocal cords for voiced sonorants have neutral tension, they are associated with Mid tone, or no special pitch perturbation effects. Such correlations are indeed observed in languages, but not as uniformly as the hypothesis requires. One problem with this system is that in fact sonorants often affect f0, and tones, just as obstruents do. This is especially obvious when the sonorants come in voiced/voiceless pairs (Maddieson 1984). Another point is made by Traill et al. (ms) with respect to the "depressor" consonants of Zulu. Here, where non-tonal effects of consonants on vowel f0 have been phonologized, they are not correlated with phonetic voicing. Other problems along these lines are discussed by Anderson (1978:161-167) and Hombert (1978).

b. Tones and other consonant dimensions. A further set of correlations with tone arises because vocal cord stiffness is also involved in describing phonation types and airstream mechanisms. Slack vocal cords not only imply Low tone and obstruent voicing; they also are used for breathy voice. Neutral vocal cords not only imply Mid tone and sonorant voicing; they also are used for implosives and two kinds of voiceless obstruents. Stiff vocal cords not only imply High tone and voicelessness; they also are used for ejectives and voiceless glottalized obstruents. In qualitative phonetic terms, f0 differences of these kinds often are observed with these consonant types (though see Painter 1978's data for some counterexamples). One counterexample, even to these qualitative predictions, given by Hombert (1978) is that ejectives, unlike other glottalized consonants, are neutral with respect to tone. Other difficulties arise because the feature system does not confine itself to general qualitative predictions about "higher" and "lower" f0. Because it represents three different pitch levels, it makes much stronger, more specific claims that can run into empirical difficulty. For example, both plain voiced and breathy voiced consonants are predicted to lower tones and f0; they do, but in fact breathy voicing lowers f0 more than plain voicing.

A further objection in the literature is that these glottal correlations are singled out for featural representation while other articulatory effects on f0 have no representation in the H&S system. The H&S features do not represent, for example, the effects of vowel height, vertical larynx movement, or aerodynamics on f0, yet there are no other formal mechanisms for f0 variation. For discussion and/or examples, see Hombert (1978), Anderson (1978), Bird (1971), Painter (1978).

c. Tones and phonation type. Vowels themselves may vary in phonation type, and in the H&S system this should preclude orthogonal tone specifications. The H&S features predict the following correlations of phonation and tone: first, a plain vowel may have any of the three tones; second, breathy and creaky vowels, (as well as voiced consonants) go with Low tone; third, (plain) glides (and, vacuously, voiceless vowels) go with Mid tone; finally, glottalized vowels go with High tone. However, in languages, various phonation types may occur with many different tones; for some examples of a single phonation type contrasting in tone, see Anderson (1978), Ladefoged (1983) and Maddieson & Ladefoged (1985).

This class of co-occurrences is important, because here it is the same segment (the vowel) that carries both the tone and the phonation type. In the cases above, where the vowel has the tone and the consonant has the voicing or other dimension, it is possible at least to represent mis-matched co-occurrences; the claim would be only that such mismatches should be marked. Here, however, contradictory values of the H&S features need to appear on a single segment.

3. Airstream mechanism features. Airstream mechanisms refer to the source and direction of airflow for speech sounds. While most speech sounds involve a pulmonic egressive mechanism, others are also possible, most notably glottalic egressive (ejective), glottalic ingressive (implosive), and velaric ingressive (click). For descriptions of these mechanisms, see Ladefoged (1971, 1982). SPE proposed several tentative features for airstream mechanisms, which are discussed by Ladefoged (1971). The SPE features are basically just the traditional descriptive terms: [ejection], [implosion], [velaric suction], [velaric pressure]. Though Ladefoged has his own proposals on this topic, certainly the SPE features will do the job.

However, the H&S laryngeal features also distinguish categories of consonants produced with different airstream mechanisms. For example, glottalic mechanisms are characterized as [+constricted glottis], with ejectives (as well as voiceless glottalized consonants) having [+stiff vocal cords] and implosives having [-stiff, -slack vocal cords]. Therefore H&S suggested, but did not insist, that just the laryngeal features would suffice. These features do not directly encode the airstream mechanisms, but in representing laryngeal configurations, do succeed in capturing the minimal contrasts involved. This step is argued for by Sagey (1986), who uses only the H&S laryngeal features. Two issues arise in connection with this move. One is the success of predictions about the interaction of airstream mechanisms with other laryngeal dimensions; this was discussed in the preceding section (2b). The other is the role of redundant information in the feature system: the argument here is that airstream mechanism per se is a redundant detail that can be filled in by language-specific phonetic rules. Yet it is not the case that the H&S features in general aim to eliminate redundancy; glottal articulatory distinctions, not phonological ones, are the basis of the system. While no airstream difference is noted between glottalized and ejective voiceless consonants (which form a single category here), voiced laryngealized consonants are distinguished from implosives, though they never contrast in languages. More strikingly, voicelessness in vowels is distinguished from voicelessness in approximants. The H&S features are clearly designed to represent phonetic detail, not to eliminate it. This makes the appeal to redundancy in the single case of airstream mechanisms a weak argument.

In sum, there are enough problems with the H&S feature system that it should be used only with extreme caution and only after considering the difficulties discussed here and in the literature. To be sure, most of the difficulties center on the use of the vocal cord stiffness features, especially in connection with tone; the glottal stricture features are less problematic.

IV. Prosodic features

The most profound changes in features since SPE involve the prosodic features. Post-SPE developments in phonological theory have added multi-level structure to phonological representations, and as a result certain segmental features are no longer needed. Thus the total number of features is reduced under the new theories. The features [stress] and [syllabic] are now encoded in structure. These features share the property of being relational rather than intrinsic to segments. Thus [stress] is no longer a feature assigned to individual segments (typically, with vowels receiving [+stress]), but is now a relational property of syllables in strong-weak relations encoded in metrical structure (e.g. Hayes 1981). Similarly, as mentioned above, [syllabic] is now encoded in hierarchical tree structure built over segments (e.g. Kiparsky 1979, Clements & Keyser 1983). For both features, the exact nature of the structure posited differs across particular proposals, but the general effect of the research on features seems agreed upon. This change means that it is no longer necessary to define phonetic correlates of a feature [syllabic].

As part of CV phonology (McCarthy 1979, 1981; Halle & Vergnaud 1980; Clements & Keyser 1983, Steriade 1982, and many subsequent works), features encoding timing relations, including [length], are also recast as structure. This change also affects timing features discussed earlier in (IIIb), such as [delayed primary release], [prenasalized], [preaspirated], and other similar features. After SPE, various phonologists proposed complex segment representations to deal with sequences of feature values within a single segment (e.g. Campbell 1974, Anderson 1976, Williamson 1977). In CV theory these features are replaced by sequences of skeletal positions and sequences of featural melodies (matrices). The two sequences are linked together, sometimes in two-to-one fashion. Gemination is represented not by a feature [length] on a segment, but as a single melody linked to two skeletal positions; "contour" segments such as unit affricates and prenasalized stops are represented as two melodies linked to a single skeletal position. With [length] eliminated as a feature, it is not available for other possible uses, e.g. distinguishing taps from trills. However, Anderson (1974) proposed that, even if gemination is represented by structure rather than a feature, a phonetic feature [n long] should be retained for non-contrastive differences of durational detail.

V. Conclusion

On the basis of this review, we can identify some recent trends affecting feature inventories. An important development is that some features have been replaced with structure. The eliminated features represented relative properties of segments that are now encoded in metrical or CV structure. The role of features is now more limited to inherent phonetic properties of segments. The development of feature geometry extends this trend further: representing natural classes is now done by hierarchical structure as well as by the features themselves.

Another trend since SPE has been to eliminate predictable phonetic detail from feature representations. This has resulted in the elimination of a few features. However, eliminating redundancy is done at a price: it becomes more difficult to relate phonological representations to phonetic ones. Doing so requires that phonetic features be added into full phonetic representations, a move that under the SPE system was claimed to be unnecessary. However, a current contrary trend is the interpretation of feature organization in terms of articulation, that is, feature organization may be based on articulatory organization. Such a phonetic basis for feature representations is in the spirit of SPE, but does not itself contribute to deriving explicitly phonetic surface forms.

Despite these and other changes in feature inventories, many features have remained fairly stable over the years. Some features are used by nearly everyone working within a generative framework; relatively few features are embroiled in controversy. It is quite possible to choose a reasonable set of features to work with; in problem areas one can retreat to more traditional features. In this spirit I offer a concensus set of features. While it does not address every question or need, it avoids the worst empirical and theoretical difficulties, and in most respects represents current practice.

Concensus set of segmental features:

consonantal, sonorant, nasal
labial, round
coronal, anterior, strident, distributed
lateral, continuant
high, low, back, tense, ATR
voiced
spread glottis (aspirated), constricted glottis (glottalized)
implosive, ejective, click
tonal features
labiodental
trill

For use of these features to describe consonants and vowels, see feature charts such as those in Halle & Clements (1983:33). For discussion and examples, see the text of this paper.

VI. Addendum: Summary of SPE Features

Here is a convenient summary of the complete set of features proposed in SPE, in terms of their current status. As additional reference points, for each feature it is noted whether it appears in Stevens et al. (1986) and/or Sagey (1986), where these two sources are taken to reflect the recent views of Stevens and Halle, respectively. (The features in Sagey (1986) are much the same as those in Halle & Clements (1983)). The definitions of features are discussed in the text above.

[vocalic] - even in SPE, replaced by [syllabic]
[consonantal] - no changes; see K&K;
    in Stevens et al, Sagey
[syllabic] - replaced by CV syllable structure; see Clements & Keyser
[sonorant] - as binary feature, no changes; some prefer sonority
    hierarchy; see K&K;
    in Stevens et al., Sagey
[nasal] - no changes;
    in Stevens et al., Sagey

[lateral] - no changes;
    in Stevens et al, Sagey
[continuant] - no changes;
    in Stevens et al., Sagey
[strident] - redefined in Halle & Stevens 1979;
    in Stevens et al., Sagey

[coronal] - redefined in Halle & Stevens 1979, also Lahiri & Blumstein
    1984;
    in Stevens et al., Sagey
[anterior] - K&K found suspicious; possibly limited to coronals;
    in Stevens et al., Sagey
[distributed] - doing more work in Halle & Stevens 1979; possibly
    limited to coronals;
    in Stevens et al., Sagey

[delayed (primary) release] - replaced by CV structure

[high] - as binary feature, no changes; some prefer continuous scale;
    some discussion of use for primary consonant places;
    in Stevens et al., Sagey
[low] - as for [high];
    in Stevens et al., Sagey
[back] - as for [high]; in Stevens et al., Sagey
[round] - supplemented with cover feature [labial];

in Stevens et al., Sagey
[tense] - rarely used for obstruent distinctions, usually limited to vowel distinctions; not same as [covered] per Lindau 1979; in Stevens et al.
[voice] - mainly used as cover feature for actual voicing, not glottal state for spontaneous voicing; in Stevens et al.

[covered] - usually called [ATR]; more accurately, [expanded] (Lindau)

[glottal constriction] - replaced by Halle & Stevens 1971 [constr gl]

[delayed secondary release] - rarely discussed; argued by Sagey to never be contrastive
[velaric suction] - as for [delayed secondary release]
[implosion] - replaced by Halle & Stevens 1971 features
[velaric pressure] - as for [delayed secondary release]
[ejection] - replaced by Halle & Stevens 1971 features
[heightened subglottal pressure] - for aspiration, replaced by Halle & Stevens [spread glottis]; not used for stress as stress is no longer segmental; for trill vs tap, replaced by [rate] for Ladefoged (1971)

[stress] - replaced by metrical structure
[length] - replaced by CV structure; however, in Stevens et al.

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INDEX OF FEATURES

This is an alphabetic listing of the features discussed in this article. They are listed by section number. It includes actual feature names (in brackets []) and more traditional place terms. SPE means that it is an SPE feature and is mentioned in VI. Addendum.