PHONOLOGICAL FEATURES: PROBLEMS AND PROPOSALS

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Inadequacies in the *Sound pattern of English* feature system, in the realm of unattained natural classes and unaccommodated contrasts, are shown; and alternative solutions to these problems are considered. One involves added features; the other involves the notational innovation of the 'complex symbol'.

The purposes of this paper are: (1) to demonstrate certain inadequacies in the feature system proposed by Chomsky & Halle's *Sound pattern of English* (1968; henceforth *SPE*), and (2) to indicate some possible resolutions of these inadequacies. The minimum requirements for adequacy in a feature system are that it provide for the 'natural' (i.e. intersecting or cross-classifying) classes which function in the phonological processes of natural language, and that it provide for the phonological contrasts of each language. I will attempt to show that the *SPE* system fails to meet both these requirements.

1. UNATTAINED NATURAL CLASSES. Concerning the requirement of providing adequately for natural classes, Chomsky & Halle (335) say:

... it is almost always taken for granted that phonological segments can be grouped into sets that differ as to their 'naturalness' ... These judgements of 'naturalness' are supported empirically by the observation that it is the 'natural' classes that are relevant to the formulation of phonological processes in the most varied languages, though there is no logical necessity for this to be the case. In view of this, if a theory of language failed to provide a mechanism for making distinctions between more or less natural classes of segments, this failure would be sufficient reason for rejecting the theory as being incapable of attaining the level of explanatory adequacy.

The following natural classes unattainable in the *SPE* feature system will show that it is to be 'rejected' as being 'incapable of attaining the level of explanatory adequacy'.

(1) Labial attraction rules:

    a. Finnish $\emptyset > v$ / #____*oo* (Hakulinen 1961:31).

    b. Finnish $k \rightarrow v$ / $\left\{\begin{matrix} u\_\_\_\_u \\ \ddot{u}\_\_\_\_\ddot{u} \end{matrix}\right\}$ C $\left\{\begin{matrix} C \\ \# \end{matrix}\right\}$ (Wiik 1967).

    c. Turkish morpheme-structure condition: a + labial C + high V $\Rightarrow$ a + labial C + u (Lees 1961:291–2, 285–6; Zimmer, 1969:311).

    d. Tulu $\ddot{i} \rightarrow u$ $\left\{\begin{matrix} \begin{bmatrix} V \\ +\text{round} \end{bmatrix} C_1^2 \\ \begin{bmatrix} C \\ \text{labial} \end{bmatrix} \end{matrix}\right\}$ ____ (Bright 1972:41–3).

    e. Nupe $\emptyset \rightarrow \left\{\begin{matrix} i \text{ / C\_\_\_\_C} \\ a \text{ / C\_\_\_\_}h \\ u \text{ / C\_\_\_\_ labial C} \end{matrix}\right\}$ (Hyman 1970:23).

    f. Cakchiquel $\vartheta \rightarrow o$ / ____ labial C (Campbell 1971).

    g. Cakchiquel $i > u$ / ____ labial C + V (Campbell 1971).

    h. Eastern Finnish dialects $e \rightarrow o$ / ____ v (Skousen 1972).

    i. Latin $i \rightarrow (u)$ / ____ labial C (e.g. *optimus, optumus; pontifex, pontufex; surripuit, surrupuit*).

Nothing in the feature system of *SPE* shows that these 'labial attraction rules' are at all natural. There is no reason why [+anterior, −coronal] consonants (labials) should cause vowels to become [+round], as in 1c–g, or why consonants should become labials in the environment of round vowels, as in 1a–b.

(2) Round vowel (or glide) and labial consonant interchange rules:

a. Finnish $\left\{\begin{matrix} u \\ \ddot{u} \end{matrix}\right\} \rightarrow v$ / V___V (Wiik).

b. Aztec men used *w* and women *v* in corresponding forms (Newman 1967).

c. *w* > *v* (historically) in Latin, Sanskrit, German, Finnish, Latvian, and Scandinavian languages; and in dialects of Cakchiquel, Aztec, Tzeltal, and Tzotzil.

d. Mono *m* → *w* / V___ (Voegelin et al. 1962:45, 84).

e. Spanish *b* > *u* / ___C (e.g. *absencia* > *ausencia* 'absence')

f Cakchiquel (of Comalapa and Tecpan) *w* → *f* / ___# (Campbell 1971).

g. Tzutujil (of San Juan la Laguna) and Cakchiquel (of Santa Catarina Palopó) *w* → *p* / ___# (Campbell 1971).

h. Papago *w* → *p* in reduplicated forms (Voegelin et al., 41, 47; Proto-Uto-Aztecan **p* > *w* in Papago and Pima.)

i. Swahili *w* → *b* / nasal___ (Polomé 1967:69–70).

j. Rumanian *b* > *u* / ___ liquid (Nandris 1963:111–12).

Again *SPE* provides no explanation for these rules. *SPE* gives us no reason to suspect these to be natural rules and sound changes, because its feature system does not define any intrinsic or inherent relationship between [+round] vowels (or glides) and [+anterior, −coronal] consonants (labials).

(3) Labial C and labialized C interchange rules:

a. PIE **k^w* > Greek *p* before non-front vowels; cf. Lat. *sequor*, Gk. *hépomai* 'follow'

b. Gulf Nahua dialects *k^w* > *b* (Hasler 1958).

c. Proto-Siouan-Iroquoian **p* > Seneca *k^w* (Chafe 1964).

d. Latin $\begin{bmatrix} k^w \\ g^w \end{bmatrix}$ > Rumanian $\begin{bmatrix} p \\ b \end{bmatrix}$ (Nandris, 110).

e. Proto-Uto-Aztecan **k^w* > Tepiman **b* (Voegelin et al., 29, 48).

f. Proto-Mixe-Zoquean **k^w* > Mixe and Tapachultec *p* (Longacre 1967:137).

g. Proto-Muskogean **k^w* > Choctaw, Koasati, Hitchiti *b* (Haas 1947).

h. PIE **k^w* > *p* in some Italic languages (and some Celtic); cf. Lat. *quid*, Oscan *pid* 'what?'

i. Cora $\begin{bmatrix} m \\ p \end{bmatrix} \rightarrow \begin{bmatrix} m^w \\ p^w \end{bmatrix}$ / ___*a* (Voegelin et al., 56–7).

j. PIE **k^w* > Proto-Germanic **p* in some cases (Bennett 1969).

In *SPE*'s feature system, labialized consonants and labial consonants have nothing in common. Labials are [+anterior, −coronal]; labialized consonants are [+round], with point-of-articulation features specified.

(4) Labials plus velars or post-velars (uvulars) as a natural class:

a. Rumanian $\begin{bmatrix} k \\ g \\ \eta \end{bmatrix} > \begin{bmatrix} p \\ b \\ m \end{bmatrix} /$____dental   (e.g. *opt* < *octo* 'eight'; *limn* < *liŋnum* 'wood') (Nandris, 108–9, 152, 155).

b. Margi labials and velars occur with moderate rounding, dentals and alveolars with extreme rounding (*SPE*, 310).

c. English $x > f$ (e.g. *enough, tough, rough*).

d. Cakchiquel, Quiché, and Tzutujil $\begin{bmatrix} p' \\ q' \end{bmatrix} \rightarrow \begin{bmatrix} p^\Omega \\ q^\Omega \end{bmatrix} /$ ____V (McWhorter 1969).[1]

e. Cuzco Quechua p alternates with q in certain (possessive) morphemes; historically $p > q /$____$\left\{ \begin{matrix} C \\ \# \end{matrix} \right\}$ (Parker 1969).

f. Proto-Algonkian *$p > k$ in Atsina (Haas 1969:30).

g. Proto-Algonkian *$p > k$ in Yurok (Haas 1969:68).

h. English $\gamma > w$ (e.g. *bugan > bow, lagu > law*) (Lass 1971).

i. Proto-Uto-Aztecan *$w >$ Papago g (Voegelin et al., 41, 49).

j. Rumanian dialects $\begin{bmatrix} p \\ b \end{bmatrix} \rightarrow \begin{bmatrix} k^y \\ g^y \end{bmatrix} /$ ____i (e.g. *lup* 'wolf', *luk^{y}i* 'wolves')

(Nandris, 108, 112, 148; pointed out to me by Malcolm McClure).

Many more examples of this sort could be given, but these suffice to demonstrate the need for natural classes involving labials with velars, and labials with uvulars. In Jakobson's feature system, such natural classes could be shown quite easily by the feature of 'gravity', which defined the class of segments at the periphery of the oral cavity. Labials and uvulars were grave, while dentals (or alveolars) and velars were non-grave in a language which had uvulars. If there were no contrasting uvular segments, then labials and velars were grave. This seems an exactly correct way to define the natural classes illustrated above. However, *SPE* provides no such neat natural class:

LABIALS	UVULARS	'NATURAL CLASS'
$\begin{bmatrix} +\text{anterior} \\ -\text{coronal} \\ -\text{low} \\ -\text{back} \\ -\text{high} \end{bmatrix}$	$\begin{bmatrix} -\text{anterior} \\ -\text{coronal} \\ -\text{low} \\ +\text{back} \\ -\text{high} \end{bmatrix}$	$\begin{bmatrix} \alpha\,\text{anterior} \\ -\text{coronal} \\ -\text{low} \\ -\alpha\,\text{back} \\ -\text{high} \end{bmatrix}$

The feature [−high] is needed to exclude velars, [−coronal] to exclude dentals, and [−low] to exclude pharyngeals. Of course, Jakobson's 'gravity' feature, or something like it, will not work in the *SPE* system, where features are assumed to have 'intrinsic phonetic content' and therefore cannot tolerate such shifts in definition to accommodate language-specific facts.

(5) Velars and *h*:

a. Finnish $k \rightarrow h /$ ____t (Wiik).

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[1] Actually these are phonetically [b$^\Omega$] and [q$^\Omega$]: the first is a voiced imploded labial stop, and the latter a voiceless imploded uvular stop; however, they function as members of the series of the voiceless glottalized stops.

b. Asanti $\begin{bmatrix} k \\ g \\ h \end{bmatrix} \rightarrow \begin{bmatrix} t\varphi \\ d\textit{ʒ} \\ \varphi \end{bmatrix} / \underline{\quad} \left\{ \begin{matrix} i \\ e \end{matrix} \right\}$ (Fromkin 1970:26).

c. Hebrew has several rules sensitive to the environment before $h \ x \ ʔ \ ʕ$ (Rosen 1962:3; pointed out to me by Allan Harris).

d. Navajo h and x alternate freely before a in pre-final syllables; h^w and x^w alternate similarly before o (Hoijer 1945:15–16).

e. Japanese $h \rightarrow \left\{ \begin{matrix} \varphi / \underline{\quad} i \\ \varphi / \underline{\quad} i \end{matrix} \right\}$ (Bloch 1950:100).

f. Quiché $h > x / \underline{\quad} a$ (Campbell 1971).

g. Proto-Mayan $*\eta >$ Kekchi and Huastec h (Campbell 1971).

h. Tzutujil $h > x / \underline{\quad} CV$ (Campbell 1971).

i. Proto-Mayan $*k >$ Pokomam h in verb suffixes (Campbell 1971).

j. Spanish x is dialectally pronounced [h] (Navarro 1948:143).

These rules show that velars and h need to be members of some natural class, but in the *SPE* system they share no common features. Velars are [+high, +back], while h is [+low] and minus everything else (cf. *SPE*, 307). The only possible way of bringing these together in *SPE* is [α high, α back, −α low], but this is not very 'natural'.

2. UNATTAINED CONTRASTS. I will discuss below several contrasts for which the *SPE* feature system does not provide. However, before these are presented, it is important to consider constraints on lexical representations (underlying forms). Chomsky & Halle (298) say that the only constraint needed is for lexical representations to be chosen in such a way as to maximize the 'value' of the lexicon and grammar. Similarly, Postal 1968 invokes his 'naturalness condition' on lexical representations; and both *SPE* and Postal clearly reject totally abstract features (i.e. features without intrinsic content). It is assumed that lexical representations should be the same as surface phonetic representations (ignoring scales for the moment) except when there is strong reason for them not to be. Thus lexical representations differ from surface representations in that redundant information (not present in underlying structure) is supplied to the surface by rules (or conditions); and lexical representations show a constant form for any given lexical item, though a single lexical item may have several variant forms on the surface ('allomorphs'). In brief, lexical representations are abstract, and differ from their corresponding surface forms only when there is good reason—when the grammar is simplified by such a difference.

Chomsky & Halle also say that only binary classificatory features may appear in the lexicon. If this were the whole story, it would be easy to demonstrate several contrasts which cannot be attained in the *SPE* system by strictly binary features. A problem may arise, however, from the fact that features also have a phonetic function characterized in terms of physical scales (297). For this reason it is necessary to consider the relationship of features in their classificatory (binary) function to features in their phonetic (scalar) function.

The reason for the binary requirement on classificatory features is clear. If there were no such requirement, it would be possible to have, e.g., only one feature (say

[+ phonation]) with a fixed range of coefficient scalar values for each important point or manner of articulation.[2] For this reason, totally abstract features cannot be allowed; rather, features with 'intrinsic phonetic content' in both the phonetic and classificatory functions are needed.

In the *SPE* scheme, it could be possible to set up unattained underlying contrasts as segments which do not have the same phonetic content as their corresponding surface forms, but in which the right surface forms could be produced by the use of scalar values. Thus, confronted with some underlying contrast which *SPE* does not handle, one might merely set up a distinction by giving the underlying contrasting segments different feature specifications, though these might not be accurate from the viewpoint of intrinsic phonetic content. Then, by using scales, one might attain the correct surface phonetics.

Let us illustrate the discussion with some examples of unattained contrasts. *SPE* gives no way of specifying a palatalized velar, or of distinguishing velars from palatalized velars, or palatals from palatalized palatals. Velars are [+ high], and palatalization is shown by [+ high]: thus velar stop k and a palatalized velar stop k^y, e.g. in various Yuman languages (Wares 1968), have the same feature specifications. It might be argued, in this special case, that palatalization of velars is not shown by [+ high], but rather that both are [+ high], while the k is [+ back] and k^y is [− back]. But if this were so, k^y could not be distinguished from c (a plain palatal stop), since both are [+ high] and [− back]. In terms of binary classificatory features, it will always be impossible to specify one member of the set [k k^y c] (not to mention [c^y]). But since languages rarely contrast all three of these segments, it is possible to set up an underlying k/k^y contrast distinguished by plus or minus 'back'; i.e., the palatalized velar is attributed the feature specifications of a plain palatal stop. Then, through the employment of scales, the correct surface distinctions can be obtained.

This device may conveniently capture the distinction, but k^y and c are not the same in terms of backness, highness, or 'palatalizedness'; so it is an illegitimate use of binary features to ascribe to k^y the underlying phonetic content of c. Moreover, there is absolutely no way in *SPE* to show c being palatalized to c^y, as in Moksha

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[2] Peter Ladefoged has often pointed out that features may be non-binary and still not rely on scalar values as classificatory devices. Ladefoged 1971 proposed non-binary features for vowel heights and for the front/central/back opposition; cf. also Contreras 1969. I am unprepared to evaluate these claims. I agree with Ladefoged and Contreras that the present feature system does not account for the phenomena which they point out; but I am not convinced that non-binary features are the solution. If a language shows a shift of low vowels to mid, and mid to high, then the *SPE* system will not easily accommodate the feeling that this is a unitary process. This observation does not, however, necessarily require non-binary features for a solution. One might just as well write a clause into the proposed evaluation metric (if one believes in such things) to indicate that processes such as vowel shifting are natural, and not to be penalized for requiring extra features or rules. This is in agreement with one of Chomsky & Halle's stated goals for linguistic theory, that of defining the evaluation metric. Either way, redefining the evaluation metric or admitting non-binary features, seems to me a weakening of constraints on phonological theory, and thus undesirable per se. If one does not believe in evaluation metrics, then I can see no possible argument either for binary or non-binary features. Without some principles of interpretation, the notation 1, 2, or 3 for vowel heights tells no more than plus/minus high or low as far as shifting heights are concerned (see McCawley, MS, for a convincing demonstration).

Mordvin (Hammarberg 1971:434).[3] Many Baltic and Slavic languages distinguish alveo-palatals from palatalized alveo-palatals (e.g. *š/šʸ* or *č/čʸ*); and should any of these prove to be underlying contrasts, then *SPE* would have no empty feature (such as 'backness' in the case of *k/kʸ*) which could be employed to distinguish the two as categorically (binarily) distinct.[4]

I conclude, with Chomsky & Halle and with Postal, that there must be good reason for setting up underlying segments with different specifications from the corresponding surface forms (i.e., for violating the naturalness condition). However, the fact that *SPE* cannot attain some needed contrasts is not reason enough. This ploy of using unreal underlying segments and converting them into real phonetic segments by scales is to be condemned—since, in every language which has some unachieved contrast, it would require that a rule be added to the grammar in order to get from the somewhat abstract, phonetically unreal (but binary) underlying form to the phonetically real (scalar) surface form. This is complicating, and meta-theoretically redundant. Therefore, even if I should not be able to demonstrate conclusively that *SPE* fails to attain certain contrasts (given the possible 'scalar' values), I can at least show that it can achieve them only in ad-hoc, awkward, and 'unrevealing' ways. Thus Chomsky's argument against phrase-structure grammars (1957:34) holds against the *SPE* feature system. My point is stronger than this, however: I believe that *SPE* simply fails to account for certain contrasts, and that not even scalar abstractness (if it were legitimate) can save it from failure.

With the above in mind, let us consider some other contrasts which *SPE* does not 'reveal' well, such as that involving central vs. back vowels. Since vowels are either plus or minus 'back', *SPE* makes no classificatory distinction between central and back vowels (e.g. high central unrounded *i* vs. high back unrounded *ɯ*, or mid central unrounded *ə* vs. mid back unrounded *ɤ*). But Feʔfeʔ and Ngwe (African languages) contrast central and back unrounded vowels (Ladefoged 1964:35). Somali contrasts central rounded *ø ʉ* with back rounded *o u* in underlying structure (Armstrong 1964:3). *SPE* cannot handle these contrasts, since it would consider both central and back vowels categorically as back vowels.[5]

Another example is given by *SPE* (311), which provides no means of distinguishing labiovelars from labials which are velarized. It is said that labials with extreme velarization ([+ant, −cor, +back, +high]) and velars with extreme rounding

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[3] Chomsky & Halle (307) claim that 'subsidiary articulations [palatalization, velarization, and pharyngealization] are not found with consonants that are formed with the body of the tongue, i.e. consonants that are non-coronal and non-anterior'. This claim, however, is clearly false. The fronting of *k* to *c* (a plain palatal stop), which *SPE* would see as an instance of palatalization, is rather only a change in point of articulation, a case of attaining 'palatalness', but not of becoming 'palatalized'. 'Palatalization' is the real secondary manner of articulation, and can co-occur with true palatals, as in Mordvin. See DeArmond 1966 for more examples and details.

[4] I find the arguments in Schane 1971 unconvincing; but if they are accepted, then perhaps the feature system is obligated not only to provide for all the underlying contrasts, but also for all contrasts on an autonomous phonemic level. If this happens, then there are many more contrasts which *SPE* cannot handle.

[5] Some Swedish and Norwegian dialects contrast *u* (back rounded), *ʉ* (central rounded), and *ü* (front rounded). This contrast is also not attained in *SPE*, since it recognizes no distinction between central and back vowels (cf. Wang 1968:700).

([−ant, −cor, +back, +high, +round]) are the same articulatory gesture. This is disturbing, in view of the claim that these features have intrinsic phonetic content.

Thus far I have tried to show serious problems in the *SPE* feature system. I have attempted to demonstrate that the *SPE* system fails to provide for important natural classes and contrasts. In what follows, I will attempt to explain why the system fails and discuss possible resolutions of the inadequacies.

Ultimately some features will have to be changed or redefined, and perhaps some new ones added, if we are to resolve all the problems raised above. It is probable, however, that a single approach will not provide a solution to the various problems. I will now concentrate on a potential solution to problems involving segments with multiple articulatory gestures, suggesting a re-interpretation of the nature of these segments. I will attempt to give a solution which will eliminate the complexities involved in these segments, as well as the need for many new or redefined features. Since my re-interpretation has such an effect, the investigation of problems relating to segments with multiple articulatory gestures should precede the investigation of unitary segments and their problems. In this way, the re-interpretation of complex segments will facilitate solutions to problems in the treatment of unitary segments. I will return to this discussion below.

3. A DILEMMA. The inadequacies of the *SPE* system are in large part caused by the failure to realize that the feature which defines a natural class for round vowels and labialized consonants must also handle pure labials; and that the feature which defines a natural class for non-low front vowels (*i e*) and palatalized consonants must also handle palatals (including alveo-palatals).[6] Furthermore, while vowels need only one kind of labiality or palatalness, some consonants need two: both *p* and *p^w* (or *b* and *b^w*) are contrastive segments in some languages (e.g. Margi—cf. Hoffman 1963), and round vowels must share some feature inherently with both.[7] Similarly, *š* and *š^y* contrast in Livonian (cf. Posti 1942), as well as *c* and *c^y* in Mordvin, and both segments of the contrastive pairs must share some feature inherently with *i e*.

One possible remedy would be simply to add new features, e.g. a feature of 'labiality' shared by round vowels and labial consonants. Then vowels could become [+labial] in the environment of labial consonants, as in the rules of set 1 above. Consonants could become [+round] (i.e. labialized) in the environment of [+round] vowels, as in the rules of many languages (e.g. Nootka). Similarly, a feature of 'palatalness' might be suggested, shared by *i* and *e* with palatalized consonants. Then [+palatal] vowels could make consonants [+palatal] (i.e. palatalized), while [−back] vowels could cause some consonants to become [−back] (i.e. palatals). Thus *i* and *e* could interact both with palatal consonants

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[6] Actually, the *SPE* approach does not handle either 'palatalness' or 'palatalization' very well. It must say that both [+high] *i* and [−high] *e* cause consonants to become [+high], i.e. palatalized. But there is no natural explanation why [−high] *e* should palatalize consonants to [+high] (cf. Fromkin, 35–6).

[7] Wang (701) assumes that 'there are no contrasts between plain labial consonants and labialized labial consonants at the morphophonemic level of representation.' This, however, is clearly false; thus Margi contrasts [b^w ɓ^w m^w p^w f^w v^w] with their plain counterparts (Hoffman, 27–8).

and palatalized consonants, and there would be a way of specifying palatalized palatals and palatalized velars.

Though this addition of features would seem to solve many problems, there is something ad-hoc about requiring two features such as labiality and roundness to represent the simple 'lip-roundedness' of vowels. On the other hand, there is surely something wrong with the *SPE* account which provides no account of this dual interaction.

There is a dilemma here. Some might suppose that there is nothing wrong with the addition of new features such as 'labiality', which have a low functional yield in the sense that they are seldom needed in the world's languages, and serve to distinguish a very few, highly marked segments in the languages where they are needed. However, the addition of new features automatically increases the number of cross-classifying, intersecting 'natural' classes and possible contrasts within a feature system. For this reason it is highly undesirable to add new features, even though motivated by need, since this may create excessive power, making many impossible (unnatural) classes and contrasts available. Is there, then, any alternative?

4. THE COMPLEX SYMBOL. I will suggest an alternative to the addition of new features, as well as some motivation for the alternative. Let us begin with affricates, which have been a thorny problem for most phonological theories. In the IPA and European tradition, such segments are usually written as complex *ts*, *tʃ* etc. In the American tradition, they have been treated as unit segments—*c̣*, *č* etc. Jakobson et al. 1951 seemed to be following the American tradition in using the features *strident* and *continuant* to account for affricates and fricatives. But this was inadequate, since it did not provide for non-strident affricates, as in Chipewyan (cf. *SPE* 329):

t	d	t'
¢	dz	¢'
tθ	dδ	tθ'

Postal proposed ABRUPT ONSET (interrupted or [−continuant]) and ABRUPT OFFSET to account for the non-strident affricates. Chomsky & Halle proposed the feature DELAYED RELEASE to serve this function. (One wonders why they did not simply say plus/minus AFFRICATION for this feature, since it is contingent upon the segment's already being [−continuant].) These proposals still follow the American tradition of unitary interpretation. The tactic employed is quite transparent: a non-attained contrast was noted in the Jakobsonian feature system, and it was remedied by the addition of a new feature. But is it possible that the non-attained contrast can be handled without the creation of a new feature, with low functional load and frequency of occurrence in the sense mentioned above? (Presumably languages like Chipewyan, which contrast non-strident affricates, are quite rare.)

Suppose affricates were treated, following the IPA tradition, as complex units or complex symbols.[8] Suppose they were written with more than one column of

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[8] I have taken the notion of the complex symbol in phonology from Hoard 1967. I have, however, generalized its use to segments which he may not have intended (he restricted it more or less to affricates).

features, but were interpreted as a single unit. Then the affricate č (or tš) might be:

$$\begin{bmatrix} -\text{anterior} & +\text{strident} \\ +\text{coronal} & +\text{continuant} \\ -\text{continuant} & \end{bmatrix}$$

while tθ might be:

$$\begin{bmatrix} +\text{anterior} & -\text{strident} \\ +\text{coronal} & +\text{continuant} \\ -\text{continuant} & \end{bmatrix}$$

There are, no doubt, more elegant ways of formalizing the notion of the complex symbol; for one thing, continuancy is redundant in the second column (I have left out other redundant features such as those referring to point of articulation, which are predictable in homorganic affricates). The point is that, if such a notation were introduced into the theory of phonology, we could rid ourselves of the 'offset features' which are occasionally needed to attain certain contrasts. Of course there must be strong constraints on what features could co-occur in a complex symbol; but these could be stated as universal redundancy or marking constraints.[9]

One advantage of the complex symbol is the possibility of explaining labialized labials and palatalized palatals with unit segments in a complex symbol, e.g.:

$$p^w: \begin{bmatrix} +\text{ant} & +\text{round} \\ -\text{cor} & \\ -\text{cont} & \end{bmatrix} \qquad š^y: \begin{bmatrix} -\text{ant} & \\ +\text{cor} & +\text{high} \\ +\text{cont} & \end{bmatrix}$$

This would eliminate the need for vowels to be ascribed more than one type of labiality or palatalness just so they could interact with both primary points of consonantal articulation (labials and palatals) and secondary manners of articulation (labialized and palatalized consonants). There would be little need to add features here, since vowels could interact with appropriate features in either column of the complex symbol.[10]
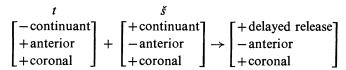
An argument in favor of the complex symbol is that segments where it is used are articulatorily complex, in that they involve separate but related articulatory gestures—occurring not quite simultaneously in time, but in close juxtaposition. Thus the labiality of *p* is inherent and simultaneous with its other distinctive features; while the labialization of p^w is not inherent or simultaneous, but must actually await the release of the stop before it can be realized. The same is true of palatalization, which Ladefoged (1971:38) describes as a 'high front vowel-like articulation which occurs very slightly after the consonant'. Thus consonants with certain secondary manners of articulation are, for the most part, parallel to affricates, and are perhaps best described by a complex symbol. This argument for

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[9] The fact that additional marking conventions would be required is not a legitimate argument against the complex symbol. While some different ones might be needed, a large number of the old ones would be eliminated. Complex segments would automatically be marked segments, and many marking conventions could be eliminated by reading features in the right-hand portion of the complex symbol as marked with respect to their occurrence in the left-hand portion.

[10] I should emphasize that the complex symbol interpretation of such sounds in no way implies that they are not really unit segments, since it can be shown from the rules and structure of many languages that they must be units. This is, of course, what led American linguists to the unit interpretation in the first place.

the complex symbol is one of phonetic realism; the complex symbol builds in the aspects of real time and multiple articulatory gestures which are involved in the production of these segments, which the *SPE* system neglects.[11]

Another point in favor of the complex symbol is its usefulness in describing 'amalgamation' rules in language—by which I mean rules in which unit segments are produced by a convergence of underlying separate segments. An example is found in Skagit (from Hoard): $x^w ig^w ə\check{c}Pələd$ 'I am not going to eat', from underlying $x^w i$ 'not', $g^w ə$ 'subjective relative pronoun', d 'my', s 'nominalizer', $Pəl$ 'eat', $əd$ 'transitive'. The $\check{c}$ produced from $d + s$ is not different phonetically (or in autonomous phonemics) from underlying $\check{c}$. We might look to Polish for another example, where *trzy* 'three' is underlyingly [t] [š] [ɨ], while *czy* 'whether' is [tš] [ɨ]. In cultivated speech these are well distinguished, but in rapid speech there is often an amalgamation, so that the forms become homophonous (cf. Hoard for details). One could give more examples of such amalgamation rules; the point, however, is not that they are common, but that they demonstrate the relationship of the non-complex segments to the complex ones. In such cases there is no real change in feature composition, for both the articulatory gestures of t and $\check{s}$ are still present in the affricate, and the only real change is in their unitary status. This relationship is not well revealed in a rule which says that

$$
\overset{t}{\begin{bmatrix} -\text{continuant} \\ +\text{anterior} \\ +\text{coronal} \end{bmatrix}} + \overset{\check{s}}{\begin{bmatrix} +\text{continuant} \\ -\text{anterior} \\ +\text{coronal} \end{bmatrix}} \rightarrow \begin{bmatrix} +\text{delayed release} \\ -\text{anterior} \\ +\text{coronal} \end{bmatrix}
$$

[11] This discussion may raise a question about the labialness of, e.g., the k of Eng. *coat*, or the palatalness of the k of Eng. *key*. It is reasonable to allow the phonetic distinctness of these to be captured by scales. All such 'intrinsic' or 'co-articulated' allophones (Ladefoged 1970, 1971) are of virtually no importance to phonology, since they are not language-specific. They do not constitute evidence against the notion of the complex symbol because they do not involve separate, non-simultaneous articulatory gestures (cf. Fromkin, 37).

Another question which should be anticipated is: how complex can a complex symbol be? I.e., how many columns might be needed? Since single segments are usually not extremely complex in their natural occurrence (i.e., they do not normally involve many articulatory gestures), complex symbols should not need many columns; and I believe that normally only two columns will be involved. Occasionally three may be required to represent affricates with certain secondary manners of articulation, e.g. ts^w.

Jakobson et al. (35) believe that some segments may be simultaneously labialized and palatalized; if true, this would raise the possibility of very complex segments. Listed as examples are Kashmiri and Dungan Chinese. The Kashmiri forms listed are: /kar^w/, /kar/, /kaṛ/, and /kaṛ^w/, all forms of the verb 'to do'. These are actually phonetically [kor^w], [kɑr], [kar^y], [kür^w] respectively, and come from the morphophonemic *kar + w*, *kar*, *kar + y*, *kar + u* respectively (Hoard, 31). Thus Kashmiri seems not to have simultaneous labialization and palatalization, either phonetically or in underlying structures. The Dungan Chinese case (as discussed by Hoard) seems to be on the authority of Trubetzkoy (1969 : 132), but it is apparently not a real case either. Trubetzkoy's analysis (1939) is unusual in recognizing no independent glides: his root structure is C + V + Sonorant (*n* or *r*), while the usual analysis of related Chinese dialects is C + Semivowel + V + Sonorant. Thus Trubetzkoy's claim for simultaneous labialization and palatalization is unwarranted on structural grounds. In all other cases of alleged simultaneous palatalization and labialization (cf. *SPE*, 310), a front rounded glide [w̃] seems to occur as a single articulatory gesture, constituting a secondary manner of consonantal articulation. Thus, it would seem that complex symbols would normally not need many columns (probably not more than three).

Another argument for the complex symbol comes from rules for simplification of complex segments. E.g., Pochutla Aztec has a rule (Boas 1917):

$$\begin{bmatrix} \wp \\ \check{c} \end{bmatrix} \rightarrow \begin{bmatrix} s \\ \check{s} \end{bmatrix} / \underline{\quad} C$$

A rule in terms of *SPE* features,

$$\begin{bmatrix} +\text{coronal} \\ +\text{delayed release} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{continuant} \\ (-\text{delayed release}) \end{bmatrix}$$

does not reveal that the only change is the loss of one articulatory gesture, the first column of a complex symbol. Again, Nootka has a rule of simplification (Sapir & Swadesh 1939):

$$\begin{bmatrix} k^w \\ q^w \end{bmatrix} \rightarrow \begin{bmatrix} k \\ q \end{bmatrix} / \underline{\quad} \begin{Bmatrix} C \\ \# \end{Bmatrix}$$

This seems to be a response to the difficulty of producing the multiple articulatory gestures in contexts before consonants, and such a rule would seem to be reflected best in the complex symbol approach. Nootka has another rule in which $\hbar^w$ becomes w intervocalically. The complex symbol approach would say that the first articulatory gesture was lost in this environment, whereas *SPE* features would require something like:

$$\begin{bmatrix} -\text{ant} \\ -\text{cor} \\ -\text{high} \\ +\text{low} \\ +\text{back} \\ +\text{round} \\ -\text{cons} \\ -\text{voc} \end{bmatrix} \rightarrow [+\text{high}]$$

Here the phonetic difference between labialized pharyngeal $\hbar^w$ and w is surely more than the height of its articulation, since w is one of the articulatory gestures present before simplification.

A final point in favor of the complex symbol comes from gemination and consonant-gradation rules. In many languages, such rules do not geminate entire affricates (e.g. *tštš*), but rather geminate only one column of the complex symbol. E.g., in Vote (Ariste 1968:12) the affricates which correspond to geminate stops are *tts* and *ttš*. It is hard to see how an *SPE* rule would account for the fact that gemination affects not the entire segment, but only the first column, the first articulatory gesture. Similarly, languages with palatalization do not really geminate palatalized consonants, e.g. $d^y d^y$, but rather geminate only the first gesture, e.g. dd^y (an example is Lappish, according to a personal communication from Robert Harms). This is reflected naturally in the complex-symbol approach.

Though the complex symbol would eliminate many difficulties (e.g. the need for vowels to interact both with primary points and secondary manners of articulation), it certainly cannot solve all the problems raised above. E.g., the need for natural classes relating labials to velars and to uvulars, or relating h to velars, can be solved only by revising the features themselves. Indeed, the features of 'labiality'

and 'palatalness' may be needed anyway, because (leaving questions of complex segments aside for the moment) true labials defined as [+anterior, −coronal] still share nothing with round vowels. Thus, while the complex symbol has real value in overcoming the difficulties of representing complex segments with multiple articulatory gestures, the feature system still needs to be overhauled in order to account for natural classes like those discussed above. Since it is undesirable to add features, we may hope that this overhaul can be accomplished through a re-alignment of features rather than by increasing their number (e.g. perhaps through a redefinition of 'coronal' or 'grave'). The combined result of the complex symbol and of feature revision should effect a reduction in the over-all number of features.

5. CONCLUSION. I have discussed what I consider to be inadequacies in the *SPE* feature system, and I have considered three alternative solutions. One, which I reject as unworthy of further attention, is the greater use of scalar values, even on an underlying, classificatory level. The second is the addition of a few new, well-motivated features; this has the disadvantage of greatly increasing the power of any feature system to accommodate classes and contrasts, even beyond those needed. The third alternative is a revision of the interpretation of 'segment' in such a way as to allow single segments with multiple articulatory gestures to be defined in complex symbols.

The proposal to add the notion 'complex symbol' to the metatheory parallels Harris' (and Chomsky's) argument for the inclusion of transformations in the theory. Harris (1957:155) says 'it [transformation] replaces a large part of the complexities of constituent analysis and sentence structure, at the cost of adding a level to grammatical analysis.' The same is true of the complex symbol; it replaces a large part of the complexity of the feature system, at the cost of adding a bit of notational machinery to the theory. Future research might well aim at formalizing constraints on complex symbols, just as on transformations.

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