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[BACK] and [ROUND]

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1. INTRODUCTION

The phonetic parameters relating to the position of the tongue in the horizontal dimension and to the shape of the lips are traditional for classifying vowels into four series—front unrounded, back rounded, front rounded, and back (or central) unrounded. For Trubetzkoy frontness or backness and rounding or unrounding are intimately related as *localization* or *timbre* features, which are jointly opposed to his *aperture* or *saturation* features used for characterizing vowel height. Jakobson's *grave/acute* and *flat/plain* specify the four series of vowels and along with *sharp/plain* constitute a set of *tonality* features. For Chomsky and Halle it is the *cavity* features [back] and [round] which jointly specify these four series.

We shall examine the relationship between frontness/backness and rounding/unrounding and shall show that (a) tongue position (*frontness*) is primary for vowels such as *i, e, æ*, whereas lip shape (*rounding*) is primary for vowels such as *u, o, ɔ*, and (b) where these two parameters form a hierarchy, tongue position takes precedence over lip shape.

Consider the common vowel pattern *i, e, a, o, u*—what Trubetzkoy (1957) called a five-vowel triangular system. For the nonlow vowels Trubetzkoy allowed the particular language system to decide which of his localization features was the primary one. Three situations are possible:

- (a) Tongue position is primary and lip shape is redundant. In Japanese, plain and palatalized consonants contrast before *u, o, a* but are neutralized before *i, e*. Because of this neutralization there is a class of front vowels opposed to a class of back ones, and lip shape becomes subordinate.
- (b) Lip shape is primary and tongue position is redundant. In Russian, vowels have fronted variants between palatalized consonants and backed variants after plain (phonetically velarized) consonants. Since what is constant for Russian vowels is the shape of the lips, this is primary and tongue position is subordinate.

- (c) Neither feature has precedence over the other. In Spanish, there are no neutralizations involving the vowels nor are there allophones characterized by different degrees of backness or rounding: *i*, *e* are always realized as front unrounded, and *u*, *o* as back rounded. Hence, neither localization feature can be extracted as primary. Rather, both features combine to form two maximally opposed series—what Trubetzkoy impressionistically called *light* and *dark*, an equipollent opposition. For triangular vowel systems (where there is one low vowel), Trubetzkoy considered the equipollent cases to be the most frequent.¹

For Trubetzkoy there is no "inherent" hierarchy between his localization features. The relative importance of each feature is language-specific, and depending on the system either feature can be the primary one.

At first it appears that Jakobson allows the same three situations as Trubetzkoy:

In vowel patterns with only one tonality feature the following three cases are found: (a) the opposition grave vs. acute alone [e.g., Wichita, Slovak, Japanese]; (b) rarely, the opposition flat vs. plain alone [e.g., Russian]; (c) quite frequently a fusion of the two oppositions [e.g., Spanish, Italian] (Jakobson, Fant, and Halle, (1965, p. 33)).

But, further on, one gets the impression that flat/plain is viewed as subordinate to grave/acute:

The opposition flat vs. plain as a *secondary tonality feature* [emphasis mine] of vowels supplements the optimal grave vs. acute opposition by an attenuated grave and/or acute: for instance /u/ and /i/ by /i/ and/or /y/ (p. 36).

This "inherent" hierarchy is corroborated by the redundancy-free matrices given in the appendix to Jakobson, Fant, and Halle, where grave/acute is the nonredundant specification for the English vowels (p. 44) and, surprisingly, even for the Russian vowels (p. 45). For Jakobson, then, flat/plain as a tonality feature seems to be "universally" subordinate to grave/acute.

What may have been implicit in Jakobson becomes explicit within generative phonology. Where an inventory of segments is given, one frequently finds "distinctive" matrices such as in (1) (where redundant specifications appear in parentheses):²

(1)		i	e	a	o	u
	high	+	-	-	-	+
	low	(-)	-	+	-	(-)
	back	-	-	(+)	+	+
	round	(-)	(-)	(-)	(+)	(+)

In this matrix the nonlow vowels are *nonredundantly* specified for the feature [back].³ Values for [round] can be predicted for these vowels through a morpheme structure rule such as (2):

$$(2) \begin{bmatrix} -\text{low} \\ \alpha\text{back} \end{bmatrix} \rightarrow [\alpha\text{round}]$$

¹ Had Trubetzkoy allowed morphological criteria, equipollent systems might have been less common. For example, in Spanish *i*, *e*, *a* function as thematic vowels in the verb conjugation.

² In pre-1968 generative studies, the features [grave] and [flat] are used for specifying vowels instead of [back] and [round]. For the sake of consistency, when discussing generative phonology we shall use only [back] and [round]. However, anything said about these features applies *mutatis mutandis* to [grave] and [flat].

³ One notable exception to the setting up of [back] as the nonredundant feature is found in Halle's (1959) treatment of the Russian vowels. Following Trubetzkoy and Jakobson, Halle considers [round] (his "low tonality") to be the nonredundant specification.

However, the choice of [back] as the nonredundant feature is totally arbitrary since a matrix of equal complexity will result if the nonlow vowels are *nonredundantly* specified for [round]. Then the values for [back] become redundant and we have the morpheme structure rule (3):

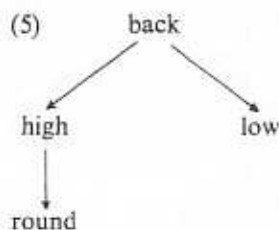
$$(3) \begin{bmatrix} -\text{low} \\ \alpha\text{round} \end{bmatrix} \rightarrow [\alpha\text{back}]$$

From a purely formal point of view, there is no reason for selecting either partially specified matrix over the other.

With the advent of "markedness," the role of partially specified matrices and morpheme structure rules has taken on less importance. But the relative ranking of [back] and [round] remains unchanged. As shown in (4), within Chomsky and Halle's (1968) system of markedness, [back] is the primary feature for the vowels *i, e, u, o* as each of these vowels must be specified for it; values for [round] are redundant in that these four vowels are all unmarked for it:

(4)	i	e	æ	u	o	ɔ	ũ	õ	æ	i	ʌ	ɑ
high	U	M	U	U	M	U	U	M	U	U	M	U
low	U	U	M	U	U	M	U	U	M	U	U	U
back	-	-	M	+	+	U	-	-	M	+	+	U
round	U	U	U	U	U	M	M	M	M	M	M	U

Furthermore, to insure the selection of the optimal five-vowel pattern, Chomsky and Halle propose as conditions on vowel systems that "no vowel segment can be marked for the feature 'round' unless some vowel segment in the system is marked for the feature 'high'" and "the availability for marking of the features 'high' and 'low' depends on the prior marking of the feature 'back', resulting in the hierarchical structure shown in [5]:" (p. 410):



With regard to the features [back] and [round] in Chomsky and Halle's system, the former is both the "primary feature" for distinguishing certain vowels and the "higher feature" on the hierarchy. However, "primary feature" and "higher feature" are not necessarily coextensive notions. The concept of "primary feature" applies to the intrinsic content of segments. We shall show that for certain vowels [back] is the primary or distinguishing feature while for other vowels [round] is primary. On the other hand, the notion of "higher feature" is extrinsic to segments. It characterizes properties of phonological systems—for example, the availability of features for marking or the conditions under which feature specifications can be modified.

2. [BACK] AND [ROUND] AS PRIMARY FEATURES

Assimilation often reveals which feature is primary. Palatalization and labialization are processes where consonants acquire vowel-like features. In Nupe (Hyman (1970)), which has an underlying seven-vowel system, consonants are palatalized before *i, e, æ*

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and they are labialized before *u*, *o*, *ɔ*. What is significant about these assimilations is that the palatalized consonant acquires the *tongue position* characteristic of *front* vowels while the labialized consonant acquires the *lip shape* characteristic of *rounded* vowels. Before *a* neither assimilation occurs: *a* has neither the tongue position of front vowels nor the lip shape of rounded ones.⁴

In Menomini (Bloomfield (1964)), "nonsyllabics are often strongly palatalized or labiovelarized by the preceding vowel, initial nonsyllabics by the following vowel: *mip* 'early in the morning' (both consonants palatalized), *mwāk* 'loon' (both consonants labiovelarized)" (p. 107). The vowel *a* is phonetically rounded: "*a* [ranges] from French *pâte* to English *saw*".

In Nupe and Menomini the palatalized and labialized consonants are frequently allophonic variants of the plain ones. Where these consonant articulations have become contrastive a different situation presents itself. The Russian palatalized consonants historically had their origin as palatalizations due to a following front vowel or glide. Subsequently palatalization became contrastive. As Trubetzkoy pointed out, to insure maximal differentiation between contrasting palatalized and plain consonants, the latter often become velarized. In this way the palatalized and plain consonants are phonetically opposed as high tonality versus low tonality. Once front tongue position becomes a contrastive consonant feature, at the surface level it loses its distinguishing force as a vowel feature. In such systems lip shape then becomes the constant phonetic trait for identifying the vowels and the tongue position of the vowel is free to assimilate to that of the consonant. This assimilation is merely another way of insuring the optimal contrast between palatalized and plain consonants: the vowel allophones provide further information concerning the tonality of the adjacent consonants. It is this phonetic aspect of the Russian vowels which led Trubetzkoy, Jakobson, and Halle to consider lip shape as the primary feature. We would claim, rather, that this constant lip shape of vowels is simply a superficial aspect of systems containing contrastive palatalized consonants. At a deeper level, front tongue position *still* has to be the primary feature for characterizing Russian *i*, *e*. Synchronically, there are morphophonemic processes where underlying plain consonants become palatalized when followed by these vowels. (See Lightner (1965b)).

Umlauting can be viewed as assimilation between vowels. In Germanic, back vowels were influenced by a following *i*: in the case of the nonlow vowels, *u* became *ü* (not *i*), and *o* became *ö* (not *λ*). Icelandic is particularly interesting since, in addition to *i*-umlaut, there is also *u*-umlaut due to a following *u*: *i* becomes *ü* (not *i*), and *e* becomes *ö* (not *λ*). For both kinds of umlaut, the vowel which undergoes umlaut assimilates the *primary feature of the conditioning vowel* without losing its own primary feature. Thus, when *u*, *o* become *ü*, *ö* by *i*-umlaut, they acquire the tongue position of *i* while retaining their original lip shape, and when *i*, *e* become *ü*, *ö* by *u*-umlaut they acquire the lip shape of *u* and keep their original tongue position. Since *a* is "negative" in the sense that it has neither the tongue position characteristic of front vowels nor the lip shape characteristic of rounded vowels, it can partake equally of *i*-umlaut and *u*-umlaut, yielding *æ* and *ɔ*, respectively.

⁴ Hyman (1970) has claimed that the labialized consonants of Nupe are also velarized—that is, they have the tongue position as well as the lip shape of back rounded vowels. This coarticulation is to be expected whenever the consonant articulation anticipates that of the following vowel. In fact, it would not surprise us if in languages with autonomous labialized consonants, these consonants were also velarized. Such coarticulation would have the further advantage of accentuating the tonality difference between the labialized and the plain consonants. In any case, whether or not labialization is accompanied by velarization, there is no question that lip shape is the important distinguishing trait for these consonants.

The French front rounded vowels did not arise from umlauting, but they still had their origin in back rounded vowels. For example, Latin \bar{u} spontaneously shifted to \bar{i} everywhere. Why \bar{u} and not i ? If rounding is the primary feature for back rounded vowels, then in a change from u to \bar{u} the primary feature is preserved while the subordinate feature, tongue position, is affected. Synchronically, within French, one can still demonstrate that the front rounded vowels belong structurally with rounded and not with front vowels (Schane (1968)).

Neutralization provides further evidence that front tongue position is primary for i, e , and lip rounding for u, o . We already noted that in Japanese plain and palatalized consonants contrast before u, o, a , but are neutralized before i, e . Conversely, Trubetzkoy observes that in Artshi, spoken in the East Caucasus, plain and labialized consonants contrast before i, e, a , but are neutralized before u, o . Classical Latin had contrasts between k and k^w . In the development of several of the Romance languages the loss of this contrast before u, o preceded its loss before other vowels.

Trubetzkoy noted that languages with "mixed" series of vowels—front rounded and/or back unrounded—also have the "basic" series—front unrounded and back rounded. He further observed that of the two mixed series front rounded is the more common. This observation has a natural explanation within a system where tongue position is primary for front vowels and lip shape is primary for rounded vowels. Within such a framework the unmarked situation for front vowels is to be unrounded (i, e, ε), and the unmarked situation for rounded vowels is to be back (u, o, \circ). A marked front vowel would be rounded ($\bar{i}, \bar{e}, \bar{\varepsilon}$); a marked rounded vowel would be front ($\bar{u}, \bar{o}, \bar{\varepsilon}$). Consequently, marking either "basic" series produces front rounded vowels. Further on we shall consider the status of back unrounded vowels.

Let us return to the matrix of the standard five-vowel system as shown in (6) (where redundant values appear in parentheses):

(6)	i	e	a	o	u
high	+	-	(-)	-	+
low	(-)	(-)	+	(-)	(-)
back	-	-	(+)	(+)	(+)
round	(-)	(-)	(-)	+	+

The redundancies in (7) hold:

- (7) (a) (i) [+high] → [-low]
 (ii) [+low] → [-high]
- (b) (i) [-back] → [-round]
 (ii) [+round] → [+back]
- (c) (i) [+low] → $\left[\begin{array}{l} +\text{back} \\ -\text{round} \end{array} \right]$
 (ii) $\left\{ \begin{array}{l} [-\text{back}] \\ [+round] \end{array} \right\} \rightarrow [-\text{low}]$

Each (i)-(ii) pair is inversely symmetrical. Given either member one can predict the other by interchanging the features on each side of the arrow and switching their values, and in the case of (c) a conjunction on the right is replaced by a disjunction on the left. The redundant-free matrix (unparenthesized values) does not meet the "distinctiveness" criterion but the segments are still "distinguishable" in the sense discussed by Stanley (1967). If one fully extracts all observable redundancies, an operation which entails replacing a strong condition of "distinctness" by a weaker condition of "distinguishability," the resulting redundant-free matrix reveals that *frontness*

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([-back]) is the nonredundant specification for *i*, *e*, whereas *rounding* ([+round]) is the nonredundant specification for *u*, *o*. Furthermore, this fully reduced matrix is nonarbitrary, unlike the matrices presented previously (see (1)–(3) and the discussion there) where either [back] or [round], but not both, served as the nonredundant feature.

3. THE HIERARCHY FOR [BACK] AND [ROUND]

Jakobson (1968) has observed that, during acquisition, where there are corresponding pairs of front unrounded and back rounded vowels, the former frequently emerge first. He noted further that for language systems with unequal numbers of vowels in the two basic series it is not unusual for there to be more front unrounded vowels than back rounded ones. Martinet (1955) has expressed a corresponding view for the diachronic picture: of the two basic series, front unrounded vowels are the more stable.⁵ For example, he has claimed that Latin *ū* became French *ū* because of the instability of a vowel system containing too many back rounded vowels.

If tongue position is primary for the front unrounded vowels and lip shape for the back rounded ones, then from these initial observations it appears that tongue position is higher-ordered than lip shape.

The spontaneous shift of "mixed" vowels to one of the "basic" series provides further support for this hierarchy. In the history of English, *ū*, *ō* (resulting from umlaut) eventually became *i*, *e*, and in Hungarian *i* shifted to *i*. It is understandable that a *more marked* "mixed" vowel should spontaneously become a *less marked* "basic" vowel. But for both series of mixed vowels the preference was a change to front unrounded rather than to back rounded, that is, the resulting vowel is marked for tongue position and unmarked for lip shape, rather than marked for lip shape and unmarked for tongue position.

Finno-Ugric vowel harmony further suggests that [back] is higher-ordered than [round]. In some of these languages vowels can harmonize for [back] alone and for both [back] and [round], but not for [round] alone. In Classical Mongolian, only the feature [back] harmonizes—that is, within the word vowels agree in *backness* but there can be mixed rounding (Lightner (1965a)).

In Turkish, suffixes with high vowels harmonize for [back] and [round], whereas suffixes containing nonhigh vowels harmonize only for [back], as shown in (8):⁶

	Singular	Plural	First Singular Possessive
'tooth'	<i>dış</i>	<i>dışler</i>	<i>dışim</i>
'arm'	<i>kol</i>	<i>kollar</i>	<i>kolum</i>
'heart'	<i>gönül</i>	<i>gönüller</i>	<i>gönülüm</i>
'head'	<i>baş</i>	<i>başlar</i>	<i>başım</i>

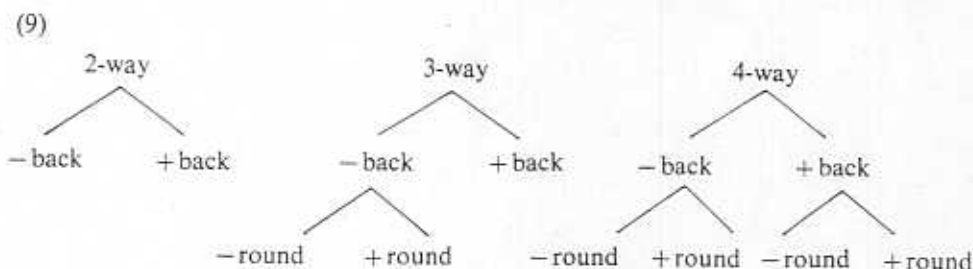
This restriction for nonhigh vowels is tied up with the fact that *ö*, *o* in Turkish do not appear in noninitial syllables. That is, in such positions the feature [round]

⁵ Martinet's explanation for the stability of front vowels is a physiological one. Where there are equal numbers of front and back vowels, since there is more "space" toward the front of the oral cavity than farther back, the articulatory distance between vowels of the same series is more compressed for back vowels than for front ones.

⁶ Data from Gleason (1955).

is not available for marking. Thus, for noninitial nonhigh vowels there can be an opposition in tongue position but not in lip shape.

Hungarian has two-way (e.g., *val* ~ *vel*), three-way (e.g., *hoz* ~ *höz* ~ *hez*), and four-way (e.g., *ok* ~ *ök* ~ *ak* ~ *ek*) harmonizing suffixes. Two-way suffixes harmonize only for backness; three-way suffixes for backness and, for front vowels only, for rounding; and four-way suffixes for both features. This is schematized in (9):



The Hungarian data show not only that rounding harmony presupposes backness harmony, but also that rounding for back vowels presupposes such harmony for front vowels.

Similar relationships between tongue position and lip shape appear to hold for Germanic umlauting. For most languages there is only *i*-umlaut, but Icelandic has both *i*-umlaut and *u*-umlaut. Hence, for this family of languages, *u*-umlaut presupposes *i*-umlaut. These implications do not seem to hold for palatalization and labialization. Trubetzkoy cites quite a few languages with labialized consonants which do not also have a palatalized series. However, Martinet (1955) has noted that, if a language has both palatalized and labialized consonants and subsequently one of these series is lost, it will be the labialized one. A similar phenomenon occurs in the Old Irish "infected" consonants. Sequences of "palatalized" consonants can occur before rounded vowels, but sequences of "labialized" consonants are replaced by "palatalized" ones before front vowels.

If it is the case that tongue position is primary for front vowels whereas lip shape is primary for rounded ones and, furthermore, that tongue position is higher on the hierarchy, these observations ought to be reflected in a system of markedness. In particular, all front unrounded vowels would be marked for frontness (i.e., for [-back]) but unmarked for rounding, whereas all back rounded vowels would be marked for rounding (i.e., for [+round]) but unmarked for backness. Front rounded vowels, with the tongue position of *i*, *e*, *æ* and the lip shape of *u*, *o*, *ɔ*, would be marked for both backness and rounding. Since *a* has neither the tongue position of front vowels nor the lip shape of rounded ones, it would be unmarked for these features. The resulting specifications are shown in (10):

(10)

	<i>i</i>	<i>e</i>	<i>æ</i>	<i>u</i>	<i>o</i>	<i>ɔ</i>	<i>ū</i>	<i>ö</i>	<i>œ</i>	<i>a</i>
back	M	M	M	U	U	U	M	M	M	U
round	U	U	U	M	M	M	M	M	M	U
high	U	M	U	U	M	U	U	M	U	U
low	U	U	M	U	U	M	U	U	M	U

For vowels which are marked for [back] and/or [round], the preferred vowel height is *high* (i.e., maximally opposed to low *a*). High vowels, then, are unmarked

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For the vowels in (10), our markings for the features [high] and [low] are identical to those of Chomsky and Halle (1968). Similarly, our markings for [back] and [round] for the low vowels coincide with theirs. The difference resides in the nonlow vowels. Chomsky and Halle specify these as [-back] or [+back]. The "basic" vowels are then unmarked for rounding, whereas the "mixed" vowels are marked for this feature. In our system, on the other hand, all front vowels are marked for the feature [back], whereas all back vowels are unmarked for this feature, and all rounded vowels are marked for the feature [round] whereas all unrounded vowels are unmarked for this feature. Actually, our treatment is not so radically different from Chomsky and Halle's. They specify *e* as [Mback, Uround], *ɔ* as [Uback, Mround], and *æ* as [Mback, Mround]. We have merely extended these specifications to the nonlow vowels of the same series.

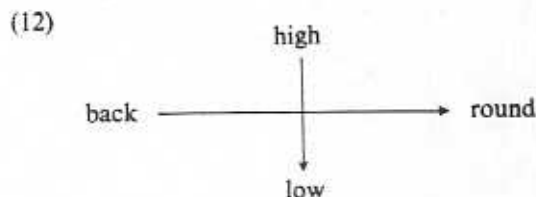
This revised system seems to us to have several advantages:

- (a) Only M's and U's appear in matrices, rather than M's, U's, +'s, and -'s.
- (b) All vowels of the same series are marked identically, rather than nonlow vowels being marked differently from low ones. For example, in our system *u*, *o*, *ɔ* are all [Uback, Mround], whereas for Chomsky and Halle *u*, *o* are [+back, Uround] but *ɔ* is [Uback, Mround].
- (c) As a consequence of (b), the marking conventions for replacing U's and M's by +'s and -'s are simpler for the features [back] and [round], as shown in (11):

- (11) [Uback] → [+back]
 [Uround] → [-round]

- (d) Given that there is a hierarchy for [back] and [round], no two vowels need have the same complexity. Although *i* and *u* each have one M, *i* would be more highly valued since the M is for a higher-ordered feature. Of course, both *i* and *u* are more highly valued than *ū*, which has two M's. Thus we can capture Jakobson's observation that front unrounded vowels are preferred to back rounded ones and that both of these series are preferred to front rounded.

If all vowels can be ordered, it is our belief that the following ordering is appropriate: *a*; *i*, *u*, *e*, *o*, *ū*, *ō*, *æ*, *ɔ*, *æ*.⁷ Note that [high] and [low] also constitute a hierarchy, where [high] precedes [low]. Consequently, mid vowels are more highly valued than low ones since their M is for a higher-ordered feature. However, the high-low hierarchy does not follow the back-round one; rather, the two hierarchies intersect, as shown in (12):

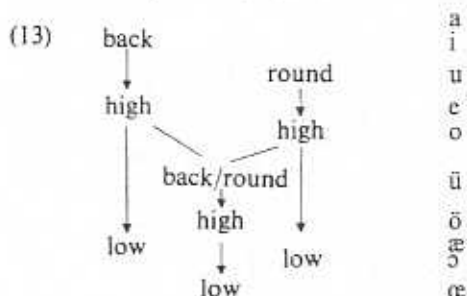


⁷ Our reasons for ordering *ū*, *ō* before *æ*, *ɔ* are twofold: (a) both Trubetzkoy and Hockett (1955) cite more languages having seven-vowel systems of the type *i*, *e*, *ū*, *ō*, *a*, *u*, *o* than *i*, *e*, *æ*, *a*, *ɔ*, *o*, *u*; (b) Martinet observes that vowel systems containing *u*, *o*, *ɔ* may shift to *ū*, *u*, *o* (e.g., Latin to French). The relative ordering of vowels is, in any case, an empirical question. A different ordering would not change the feature hierarchy but only the conditions governing which features can be marked first.

The following conditions determine the order in which features are available for marking:⁸

- (a) Each tonality feature (but not both together) is separately available for marking before any height feature
- (b) [high] is available for marking before both tonality features can be simultaneously marked
- (c) Both tonality features are simultaneously marked in preference to [low]

The diagram in (13) illustrates the relevant ordering:



We have not yet considered the unrounded central vowels *i* and *ɛ*. It is evident that, if front unrounded vowels are specified as [Mback, Uround], back rounded vowels as [Uback, Mround], and front rounded vowels as [Mback, Mround], the central vowels in question can only be [Uback, Uround]. These specifications are, of course, shared with *a*, so that *i* and *ɛ* must be differentiated from *a* through the height features. To the matrix in (10) we now add the columns in (14) for *i* and *ɛ*:

(14)

	<i>i</i>	<i>ɛ</i>
back	U	U
round	U	U
high	M	U
low	U	M

It would appear that *i* and *ɛ* have simpler specifications than several of the more common vowels. For example, both *i* and *e* are marked for the feature [high]; but, while *e* is also marked for [back], *i* is marked for no other feature. How, then, can it be claimed that the specifications we have given are appropriate for these central vowels?

According to Jakobson (1968), in the acquisition of vowels there are two possible progressions: the two vowels which appear after *a* may differ in tonality (*i* and *u*) or they may differ in height (*i* and *e*). He further notes that within the languages of the world a minimal vowel system can be based either on distinctions in tonality (*i*, *a*, *u*) or, as in some Caucasian languages, on distinctions in height (*i*, *ɛ*, *a*). In either case, the three vowels should minimally differ by the same number of specifications. This is just what happens under the system presented here, as shown in (15):

(15)

	<i>i</i>	<i>u</i>	<i>a</i>		<i>i</i>	<i>ɛ</i>	<i>a</i>
back	M	U	U	high	M	U	U
round	U	M	U	low	U	M	U

⁸ See Chomsky and Halle's conditions on vowel patterns cited previously.

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Where the three vowels differ in tonality, the vowels other than *a* are marked for either [back] or [round], and all three vowels are unmarked for height features. Where the three vowels differ in height, the vowels other than *a* are marked for either [high] or [low], and all three vowels are unmarked for tonality features. Thus there is a type of symmetry between the two different three-vowel patterns.

Having shown that the distribution of M's and U's for the central vowels is appropriate, we must now show how these vowels are evaluated properly. If a vowel system has more than three vowels, then it must make distinctions in both tonality and height. For such systems the expected situation is that distinctions in vowel height will be restricted to noncentral vowels. In these cases vowels which are marked for either the feature [high] or [low] are *always* marked for at least one of the features [back] and [round]. Consider what happens if a vowel system contains more than three vowels, among which are the nonlow central vowels. The vowels *i* and *ɛ* would be marked for height *without* also being marked for any of the tonality features. Consequently, they would not conform to the expected conditions on vowel systems—in particular, our condition (a). Notice that *a* never violates these conditions. Although it is unmarked for tonality features, it is never marked for height features.

The marking conventions for the height features cannot apply to *i* and *ɛ*. These conventions are as in (16), for vowels other than *a*:⁹

- (16) [Ulow] → [-low]
 [+low] → [-high]
 [Uhigh] → [+high]

For central vowels, on the other hand, the marking conventions for the height features are those in (17):

- (17) [Uhigh] → [-high]
 [+high] → [-low]
 [Ulow] → [+low]

The complexity of nonlow central vowels, then, arises from the following: (a) they are marked for height features without also being marked for tonality features, and (b) the marking conventions for the height features and the order in which they apply are not the same as for the noncentral vowels.

4. EPILOGUE

Although we have used the feature [back] for characterizing the front/back dimension, it appears that the proper feature should instead be [front]. First, if frontness is primary for vowels such as *i*, *e*, *æ*, then it is natural that such vowels should be marked for being *front* rather than for being *nonback*. And, whereas the vowels *ü*, *ö*, *ø* are front vowels, the vowels *i*, *ɛ*, *a* are not usually "back" in the traditional sense but

⁹ We assume that the first marking convention is [Ueverything] → *a*. All following marking conventions, then, apply to vowels which are marked for at least one feature. This constraint captures the observation that within a markedness system *a*, as the unmarked vowel, behaves differently from the other vowels. Any set of marking conventions which attempts to interpret *all* the U markings of *a* along with the U's and M's of the other vowels becomes excessively complex. For noncentral vowels, values are assigned to [low] before being assigned to [high] because of the rule [+low] → [-high]. The order in which the marking conventions apply has nothing to do with the feature hierarchy: the particular order allows the simplest set of marking conventions.

most often "central"; hence, [-front] is a more appropriate designation for central and back vowels than is [+back]. Second, since consonants can be palatalized not just before *i* but before any front vowel, palatalized consonants could be characterized as [+front], as assimilation to the front tongue position, rather than as [+high] as in Chomsky and Halle. We could then impose as a condition on consonant systems that whenever [+front] is used as a contrastive feature, as in Russian, all consonants, both palatalized and plain, automatically become [+high]. As a consequence, plain consonants which are [-front] would become velarized, i.e., [-front, +high].

With this system, consonants which are *not* [-anterior, -coronal] (and neither palatalized nor velarized) would be specified as [-front, -high, -low], palatal or palatalized consonants would be [+front, +high], velar or velarized consonants would be [-front, +high], and pharyngeal or pharyngealized consonants would be [-front, +low]. Uvulars would be distinguished from velars through the feature [distributed], which would fill a gap in the Chomsky and Halle system, where [distributed] does not play a role for [-anterior, -coronal] consonants. Furthermore, this treatment would eliminate the potential, but apparently never realized, series of uvularized consonants which Chomsky and Halle cite.

REFERENCES

- Bloomfield, L. (1964), "Menomini morphophonemics," *Études phonologiques dédiées à la mémoire de M. le Prince N. S. Trubetzkoy*, University, Alabama: University of Alabama Press.
- Chomsky, N., and M. Halle (1968), *The Sound Pattern of English*, New York: Harper & Row.
- Gleason, H. A. (1955), *Workbook in Descriptive Linguistics*, New York: Holt, Rinehart and Winston.
- Halle, M. (1959), *The Sound Pattern of Russian*, The Hague: Mouton.
- Hockett, C. F. (1955), *A Manual of Phonology*, *International Journal of American Linguistics*, Memoir 11, Baltimore: Waverly Press.
- Hyman, L. (1970), "How concrete is phonology?" *Language*, 46, 58-76.
- Jakobson, R. (1968), *Child Language, Aphasia, and Phonological Universals*, The Hague: Mouton.
- Jakobson, R., C. G. M. Fant, and M. Halle (1965), *Preliminaries to Speech Analysis*, Cambridge, Mass.: M.I.T. Press.
- Lightner, T. (1965a), "On the description of vowel and consonant harmony," *Word*, 21, 244-250.
- Lightner, T. (1965b), *Segmental Phonology of Modern Standard Russian*, unpublished Ph.D. dissertation, M.I.T.
- Martinet, A. (1955), *Economie des changements phonétiques*, Berne: Francke.
- Schane, S. A. (1968), *French Phonology and Morphology*, Cambridge, Mass.: M.I.T. Press.
- Stanley, R. (1967), "Redundancy rules in phonology," *Language*, 43, 393-436.
- Trubetzkoy, N. S. (1957), *Principes de phonologie*, Paris: Klincksieck.

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