

On the Description of Vowel and Consonant Harmony*

Languages with vowel (or consonant) harmony impose a limitation on the specification of certain features of vowels (or consonants) within a word. Finnish, for example, shows a vowel harmony in which the vowels of a word are either all grave (back) or all acute (front): *ulkoa* 'from outside', but *hyvää yötä* 'good night'. NW Karaitic is reported to have a consonant harmony in which the consonants of a word are either all sharp (palatalized) or all plain (non-palatalized): *kuŋŋarɕan* 'from days', but *kunlardan* 'from servants'.¹

Two different methods of describing vowel (consonant) harmony have been proposed by earlier investigators: one method (§1 below) treats harmony as a form of assimilation, whereas the other method (§2 below) treats harmony as a manifestation of an inherent property of root-morphemes. In this article we shall examine both methods of description and shall show the inadequacy of the description which regards harmony as a form of assimilation. Because of the almost exceptionless nature of vowel and consonant harmony in Classical (pre-sixteenth century) Mongolian, we shall confine our discussion to this language, although the nature of both methods of description is general and is applicable to languages such as Finnish or Turkish in which the harmony is somewhat obscured by concomitant phenomena.²

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¹ R. Jakobson, G. Fant, and M. Halle, *Preliminaries to Speech Analysis* (Cambridge, 1952), p. 42.

² Thus, e.g., the regularity of vowel harmony in Turkish is obscured by the presence of a large number of Arabic and Persian loan words which do not show vowel harmony. R. Lees, *The Phonology of Modern Standard Turkish* (Indiana University Publications, Vol. 6 of the Ural and Altaic Series, The Hague, 1961), p. 14, is certainly correct in requiring a "diacritic" to distinguish native from borrowed morphemes. In Finnish, the har-

Classical Mongolian
segment
diffuse
grave:
flat:

TABLE I. THE

All segments are assumed to have features compact, strident, voiceless.

In Classical Mongolian except that acute *i* occurs

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acute
i with
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§1. The first method of describing vowel in a word by the gravity of the remaining vowels is a rule:⁴

mony is obscured not only by the presence of vowels specially treated; cf., e.g., *tällainen* (sub-standard).

³ In this article phonological features are classified according to the *classement phonologique* (pp. 272-279; Jakobson, *Foundations of Language* (The Hague, 1961), *International Journal of Linguistics*, 1962, 1-12). Letter symbols used throughout are those considered abbreviations in the

the complex $\left\{ \begin{array}{l} + \text{vocalic} \\ - \text{consonant} \\ - \text{diffuse} \\ + \text{grave} \\ - \text{flat} \end{array} \right.$

⁴ This method of describing vowel harmony in Mongolian; see, e.g., N. Trubetzkoy, *Grundzüge der Phonologie* (Halle, 1939), p. 100; K. Grønbech and J. Krueger, *Phonology of Mongolian* (Copenhagen, 1955), p. 100; N. Trubetzkoy, *Phonology of Mongolian* (The Hague, 1961), pp. 88, 93, 95, 251.

Classical Mongolian contained the following vowel phones:³

segment:	<i>u</i>	<i>ü</i>	<i>i</i>	<i>o</i>	<i>a</i>	<i>ö</i>	<i>e</i>
diffuse:	+	+	+	-	-	-	-
grave:	+	-	-	+	+	-	-
flat:	+	+	-	+	-	+	-

TABLE I. THE VOWEL PHONES OF CLASSICAL MONGOLIAN

All segments are assumed to be specified [$\begin{smallmatrix} + & \text{vocalic} \\ - & \text{consonantal} \end{smallmatrix}$]; omitted are specifications for the redundant features *compact*, *strident*, *voiced*, and so on.

In Classical Mongolian vowels in a word are either all grave or all acute, except that acute *i* occurs in words with both grave and acute vowels:

grave:	uyuta	'bag'
acute:	köbegün	'son, boy'
<i>i</i> with grave:	qubilyan	'transformation'
<i>i</i> with acute:	kötelbüri	'instruction'

§1. The first method of describing these facts is to require that the first vowel in a word be specified distinctively for gravity, and to predict the gravity of the remaining vowels in the word by application of an assimilation rule:⁴

mony is obscured not only by foreign loans but also by certain suffixes which must be specially treated; cf., e.g., the suffix *-lainen* with grave *a* in both *tuollainen* 'that kind of' and *tälläinen* (sub-standard *tälläinen*) 'this kind of'.

³ In this article phonological representations are given in terms of feature complexes. For discussion of the feature theory used here, see Jakobson, "Observations sur le classement phonologique des consonnes," *Selected Writings* (The Hague, 1962), I, pp. 272-279; Jakobson, Fant, and Halle, *Preliminaries*; Jakobson and Halle, *Fundamentals of Language* (The Hague, 1956); N. Chomsky, "Review of *Fundamentals of Language*," *International Journal of American Linguistics* XXII (1957), 234-242. The letter symbols used throughout this article have no status in themselves and are to be considered abbreviations for distinctive feature complexes; thus *a* is an abbreviation for

the complex $\left[\begin{smallmatrix} + & \text{vocalic} \\ - & \text{consonantal} \\ - & \text{diffuse} \\ + & \text{grave} \\ - & \text{flat} \end{smallmatrix} \right]$, *ö* for the complex $\left[\begin{smallmatrix} + & \text{vocalic} \\ - & \text{consonantal} \\ - & \text{diffuse} \\ - & \text{grave} \\ + & \text{flat} \end{smallmatrix} \right]$ and so on.

⁴ This method of describing vowel harmony is used in standard works on Classical Mongolian; see, e.g., N. Poppe, *Grammar of Written Mongolian* (Wiesbaden, 1954), K. Grønbech and J. Krueger, *An Introduction to Classical (Literary) Mongolian* (Wiesbaden, 1955). N. Trubetzkoy, *Grundzüge der Phonologie* (Göttingen, 1958) used this method to describe vowel harmony in Mongolian (p. 104), in Finno-Ugric and Turkic languages (pp. 88, 93, 95), and in other languages such as Ibo, Lambda, etc. (pp. 250-251).

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$$(1) \left[\begin{array}{l} +\text{vocalic} \\ -\text{consonantal} \end{array} \right] \rightarrow [\alpha\text{grave}] \text{ in env: } \left[\begin{array}{l} +\text{vocalic} \\ -\text{consonantal} \\ \alpha\text{grave} \end{array} \right] (C_0V)C_0\text{---}$$

In this rule we have used α as a variable ranging over the values + and -, the symbol V to represent any vowel segment, the symbol C_0 to represent any number of non-vowel segments, and parentheses to enclose optional elements.⁵ We apply this rule to the abstract representations of several words below. Capital letters are abbreviations for vowel archiphonemes not specified for gravity; thus *U* is an abbreviation for

$$\left[\begin{array}{l} +\text{vocalic} \\ -\text{consonantal} \\ +\text{diffuse} \\ +\text{flat} \end{array} \right], A \text{ an abbreviation for } \left[\begin{array}{l} +\text{vocalic} \\ -\text{consonantal} \\ -\text{diffuse} \\ -\text{flat} \end{array} \right], \text{ and so forth.}$$

$$\begin{array}{llll} u\gamma\text{uta:} & u\gamma\text{UtA} & \rightarrow 1 \rightarrow & u\gamma\text{uta} \\ k\ddot{o}b\ddot{e}g\ddot{u}n: & k\ddot{o}b\text{AgUn} & \rightarrow 1 \rightarrow & k\ddot{o}b\ddot{e}g\ddot{u}n \\ k\ddot{o}t\ddot{e}l\ddot{b}\ddot{u}r\ddot{i}: & k\ddot{o}t\text{AlbUrI} & \rightarrow 1 \rightarrow & k\ddot{o}t\ddot{e}l\ddot{b}\ddot{u}r\ddot{i} \\ q\ddot{u}b\ddot{i}l\ddot{y}an: & q\ddot{u}b\text{Il}\gamma\text{An} & \rightarrow 1 \rightarrow & q\ddot{u}b\ddot{i}l\ddot{y}an \quad \star \end{array}$$

It may be seen that application of rule (1) has produced a phonetically incorrect grave vowel **i* in the derivation of *qubilyan*. In order to derive acute *i*, we require application of the following rule:

$$(2) \left[\begin{array}{l} +\text{vocalic} \\ -\text{consonantal} \\ +\text{diffuse} \\ -\text{flat} \end{array} \right] \rightarrow [-\text{grave}]$$

The full derivations of *qubilyan* and *kötelbüri* are as follows (note that rule (2) must apply after rule (1) in order to derive correct phonetic representations):

$$\begin{array}{l} q\ddot{u}b\ddot{i}l\ddot{y}an: \quad q\ddot{u}b\text{Il}\gamma\text{An} \rightarrow 1 \rightarrow q\ddot{u}b\ddot{i}l\ddot{y}an \rightarrow 2 \rightarrow q\ddot{u}b\ddot{i}l\ddot{y}an \\ k\ddot{o}t\ddot{e}l\ddot{b}\ddot{u}r\ddot{i}: \quad k\ddot{o}t\text{AlbUrI} \rightarrow 1 \rightarrow k\ddot{o}t\ddot{e}l\ddot{b}\ddot{u}r\ddot{i} \rightarrow 2 \rightarrow \text{vacuous} = k\ddot{o}t\ddot{e}l\ddot{b}\ddot{u}r\ddot{i} \end{array}$$

⁵ In formulating rule (1) we have followed the conventions outlined by M. Halle, "Phonology in Generative Grammar," *Word* XVIII (1962), pp. 54-72. For discussion of the use of variables in phonological rules, see M. Halle, "A Descriptive Convention for Treating Assimilation and Dissimilation," *Quarterly Progress Report No. 66* (Research Laboratory of Electronics, MIT), July, 1962, pp. 295-296, and T. Bever, "Formal Justification of Variables in Phonemic Cross-classifying Systems," *Quarterly Progress Report No. 69* (Research Laboratory of Electronics, MIT), April, 1963, pp. 200-202.

This method of account of a grave, diffuse, no words whose first vowel

ičegüri: ičA
BUT: *čilayun: čilA*

In spite of the initial for two reasons.

In the first place, the velar harmony which vowels have grave velars *k* and *g*. In other velar assimilation words *adAG, degere* 'above' from *GadAnA, gerüd* 'from

In the second place, to which remaining vowels have chosen the final vowel assimilation would the roots) and in following to postulate both postulation of both just as natural (and just assimilation of vowels

§2. The second method avoids the difficulties:

With each root we binary feature *GRAV* (+GRAVE) or the fused with the binary *č* is a phonological feature features are properties abstract idiosyncratic pro

⁶ Although the descriptive Mongolian contained two only in words with grave vowels. See Poppe, *Gramm*. For further discussion of

⁷ F. de Saussure, *Cours* of vowel harmony in

⁸ A variant of the method Components," *Structural* 3-w.

This method of accounting for vowel harmony requires the postulation of a grave, diffuse, non-flat vowel *ɪ* in order to explain the existence of words whose first vowel is *ɪ* and whose remaining vowels are grave:⁶

ičegüri: ičAgUrI → 1 → ičegüri 'shame'

BUT: *čilayun*: čilAγUn → 1 → čilayun → 2 → čilayun 'stone'

In spite of the initial attractiveness of this description, we must reject it for two reasons.

In the first place, this description presents a difficulty in accounting for the velar harmony which accompanies vowel harmony. Words with grave vowels have grave velars *q* and *γ*; words with acute vowels have palatal velars *k* and *g*. In other words, within the framework of this description, velar assimilation would have to be both progressive (*adaγ* 'end' from *adAG*, *degere* 'above' from *deGARa*, etc.) and regressive (*γadana* 'outside' from *GadANA*, *gerüd* 'tents' from *GerUd*, etc.).

In the second place, the choice of the first vowel of the word as the vowel to which remaining vowels assimilate is arbitrary. We could equally well have chosen the final vowel of the root as the vowel specified for gravity;⁷ assimilation would then occur both in preceding vowels (of polysyllabic roots) and in following vowels (of suffixes and endings). If we are required to postulate both progressive and regressive assimilation of velars, a postulation of both progressive and regressive assimilation of vowels seems just as natural (and just as arbitrary) as a postulation of only progressive assimilation of vowels.

§2. The second method of accounting for vowel and velar harmony avoids the difficulties associated with the method given above.⁸

With each root we shall associate an abstract marker specified for the binary feature *GRAVE*. Each root will thus carry either the marker {+GRAVE} or the marker {-GRAVE}. This marker is not to be confused with the binary distinctive feature *grave*. The distinctive feature *grave* is a phonological feature like *vocalic*, *diffuse*, and so forth; distinctive features are properties of sound segments. The marker *GRAVE* is an abstract idiosyncratic property of roots, analogous to the markers *ANIMATE*,

⁶ Although the description given here is synchronic, it is interesting that Proto-Mongolian contained two diffuse, non-flat (unrounded) vowels—grave *ɪ* which occurred only in words with grave vowels, and acute *i* which occurred only in words with acute vowels. See Poppe, *Grammar*, p. 11, and Grønbech and Krueger, *An Introduction*, p. 18. For further discussion of the vowel *ɪ* in Proto-Mongolian, see §2 below.

⁷ F. de Saussure, *Cours de linguistique générale* (Paris, 1960), p. 315, used this description of vowel harmony in Ural-Altai languages.

⁸ A variant of the method given below may be found in Z. Harris, "Phonemic Long Components," *Structural Linguistics* (Chicago, 1951), pp. 125-149.

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TRANSITIVE, and others; the markers *ANIMATE*, *TRANSITIVE* have primarily syntactic reflexes, the marker *GRAVE* primarily phonological reflexes.

If we associate this abstract marker with each root of the language, we no longer need to specify the feature *grave* for any vowel or velar. In addition to a specification for this abstract marker, we now require only the following basic vowel and velar segments:

segment:	<i>U</i>	<i>I</i>	<i>O</i>	<i>A</i>	<i>G</i>	<i>K</i>
vocalic:	+	+	+	+	-	-
consonantal:	-	-	-	-	+	+
voiced:					+	-
diffuse:	+	+	-	-		
flat	+	-	+	-		
compact					+	+

TABLE II. THE VOWEL AND VELAR SEGMENTS OF CLASSICAL MONGOLIAN

Rule (1) of page 3 may now be written as follows:⁹

$$\begin{array}{l}
 (1a) \left[\begin{array}{l} + \text{vocalic} \\ - \text{consonantal} \end{array} \right] \\
 (1b) \left[\begin{array}{l} - \text{vocalic} \\ + \text{consonantal} \\ + \text{compact} \\ - \text{strident} \end{array} \right]
 \end{array}
 \left. \vphantom{\begin{array}{l} (1a) \\ (1b) \end{array}} \right\} \rightarrow [\alpha\text{grave}] \left\{ \begin{array}{l} \text{when the root is} \\ \text{specified } \{\alpha\text{GRAVE}\} \end{array} \right.$$

⁹ In a formal description, rules (1a) and (1b) will be somewhat differently stated. We assume as a fact about language that each phonological segment of a word is associated with the abstract markers of the root. Since this is a general statement about language, independent of any one individual language, it may be stated once in the meta-theory of grammar and need not be stated in the individual grammars of each language. Given this, rules (1a) and (1b) assume the following form:

$$\begin{array}{l}
 (1a) \left[\begin{array}{l} + \text{vocalic} \\ - \text{consonantal} \end{array} \right] \\
 (1b) \left[\begin{array}{l} - \text{vocalic} \\ + \text{consonantal} \\ + \text{compact} \\ - \text{strident} \end{array} \right]
 \end{array}
 \left. \vphantom{\begin{array}{l} (1a) \\ (1b) \end{array}} \right\} \rightarrow [\alpha\text{grave}] \text{ in env: } \left[\overline{\alpha\text{GRAVE}} \right]$$

For theoretical discussion and justification of these assumptions about language, see N. Chomsky and M. Halle, *The Sound Pattern of English* (in preparation).

We will still require an acute vowel *i*. Application following type:

uyuta [the root is m
→ 1b → uyuta
köbegün [the root is
KöbeGün → 1
qubilyan [the root is
KubilGan → 1
kötelbüri [the root is
Kötelbüri → 1
ičegüri [the root is
Güri → 1b →
čilayun [the root is
čilaGun → 1b
adayi [the root is n
→ 1b → adayı

Rule (2) did not apply because *i* occurred in fortis chronically we may say Mongolian developed from 1

§3. Returning now to the notion of harmony as an element is to be considered whether the second vowel the one presented by Cl be arbitrary, and the result of both regressive and ɣ

What is needed, then, to capture the notion of / contain both grave and East the vowels of a word. The postulation of abs

¹⁰ A formal statement of this is pp. 53-54.

¹¹ M. Halle, "Questions of Phonology," Vol. 13, Serie X, 1959, p. 51

¹² Jakobson, Fant, and F

We will still require application of rule (2) in order to account for the acute vowel *i*. Application of these three rules will give derivations of the following type:

- uγuta* [the root is marked {+ GRAVE}]: UGUtA → 1a → uGuta
→ 1b → uγuta
köbegün [the root is marked {- GRAVE}]: KObAGUn → 1a →
KöbeGün → 1b → köbegün
qubilγan [the root is marked {+ GRAVE}]: KUβIIIGAn → 1a →
KubīlGan → 1b → qubilγan → 2 → qubilγan
kötelbüri [the root is marked {- GRAVE}]: KÖtAlbUrI → 1a →
Kötelbüri → 1b → kötelbüri
ičegüri [the root is marked {- GRAVE}]: İčAGUrI → 1a → iče-
Güri → 1b → ičegüri
čilayun [the root is marked {+ GRAVE}]: čIIAGUn → 1a →
čīlaGun → 1b → čilayun → 2 → čilayun
adaγi [the root is marked {+ GRAVE}]: AdAGI → 1a → adaGī
→ 1b → adaγi → 2 → adaγi 'the end (accusative)'

Rule (2) did not apply in the grammar of Proto-Mongolian, in which grave *i* occurred in forms like *qubilγan*, *čilayun*, or *adaγi* (cf. fn. 6). Diachronically we may say that in terms of vowel harmony, Classical Mongolian developed from Proto-Mongolian by the addition of rule (2).

§3. Returning now to general considerations, we can see that interpretation of harmony as an assimilation process leads us to question which segment is to be considered basic—whether the first vowel of the root, whether the second vowel of the root and so forth. In clear cases, such as the one presented by Classical Mongolian, the answer to this question will be arbitrary, and the resulting description will require complex statements of both regressive and progressive assimilation.¹⁰

What is needed, then, is a linguistic formalization of statements which capture the notion of *harmony*, statements like "a Finnish word cannot contain both grave and acute vowels"¹¹ or "in some languages of the Far East the vowels of a word unit must be either all compact or all diffuse."¹² The postulation of abstract morpheme-markers which, by application of

¹⁰ A formal statement of rules of this type for Turkish is given in Lees, *The Phonology*, pp. 53-54.

¹¹ M. Halle, "Questions of Linguistics," *Nuovo cimento*, N. 2 del Supplemento al Vol. 13, Serie X, 1959, p. 514.

¹² Jakobson, Fant, and Halle, *Preliminaries*, p. 41.

rules like (1a) and (1b), govern the specification of the harmonic features provides a means of formalizing these intuitively correct statements.

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² Leonard Bloomfield, *L*

NOTES AND REVIEWS

A NOTE ON VOWEL HARMONY¹

KARL E. ZIMMER

In a recent article² Theodore M. Lightner argues for the description of vowel (and consonant) harmony in terms of markers (e.g. {+GRAVE}, {-GRAVE}) that are associated with roots and to which phonological rules refer in such a way as to enter the appropriate values for the distinctive features involved in the feature complexes that underlie the words of the language.³ Thus, to use an example from Classical Mongolian given by Lightner, the rule

$$(1a) \left[\begin{array}{l} +\text{vocalic} \\ -\text{consonantal} \end{array} \right] \rightarrow$$

$$(1b) \left[\begin{array}{l} -\text{vocalic} \\ +\text{consonantal} \\ +\text{compact} \\ -\text{strident} \end{array} \right] \rightarrow$$

[α grave] {when the root is specified {α GRAVE}}

(in which α is a variable ranging over the values + and -) will rewrite the root UGUta *bag*, marked {+GRAVE}, as uγuta: Rule (1a) first enters the feature +grave for each segment to which it applies, i.e. it re-writes U (+vocalic, -consonantal, +diffuse, +flat) as u (+vocalic, -consonantal, +diffuse, +flat, +grave) and A

¹ In writing the present paper I have profited greatly from discussions with Wallace Chafe and William Wang of the Department of Linguistics, University of California, Berkeley. This acknowledgement is of course not to be taken as a claim that they necessarily agree with everything I have to say.

² On the Description of Vowel and Consonant Harmony, Word 21.244-250 (1965).

³ In essence this proposal is equivalent to the analysis of Turkish vowel harmony in terms of prosodies given by Natalie Waterson in her article Some Aspects of the Phonology of the Nominal Forms of the Turkish Word, Bulletin of the School of Oriental and African Studies 18.578-591 (1956). Cf. also John Lyons, Phonemic and Non-Phonemic Phonology: Some Typological Reflections, IJAL 28.127-134 (1962).

(+vocalic, -consonantal, -diffuse, -flat) as a (+vocalic, -consonantal, -diffuse, -flat, +grave), and Rule (1b) then enters the same feature for the only segment to which it applies, namely G, re-writing it as γ (-vocalic, +consonantal, +compact, -strident, +voiced is re-written as -vocalic... +voiced, +grave). Lightner advocates this method of description as against one in which "the first vowel in a word [is] specified distinctively for gravity, and... the gravity of the remaining vowels in the word [is determined] by application of an assimilation rule."⁴ His argument can be summarized as follows: The description using an assimilation rule runs into difficulties in accounting for the 'velar harmony' which accompanies vowel harmony; words with grave vowels have 'grave velars' q and γ, while words with acute vowels have 'palatal velars' k and g, and since these consonants can occur word-initially, a rule for regressive assimilation would be needed in addition to the progressive assimilation rule for vowels and for non-initial consonants.⁵ Furthermore, the choice of the

⁴ The rule in question is formulated as follows:

$$\left[\begin{array}{l} +\text{vocalic} \\ -\text{consonantal} \end{array} \right] \rightarrow$$

$$[\alpha \text{ grave}] \text{ in env.: } \left[\begin{array}{l} +\text{vocalic} \\ -\text{consonantal} \\ \alpha \text{ grave} \end{array} \right] (C_0 V) C_0$$

(C₀ represents any number of non-vowel segments.)

⁵ The terms in quotes are Lightner's. Strictly speaking, if q and γ are to be analyzed as +grave, while k and g are assigned the feature specification -grave, the latter pair of sounds should be palatal (as e.g. in Turkish). But in Mongolian the distinction seems rather to be one between postvelar q and γ and midvelar k and g, and it is thus probably not the case that the 'velar harmony' involves the same distinctive feature as the vowel harmony, namely gravity. For the sake of the argument I shall, however, assume that the following feature specifications are correct:

	q	γ	k	g
grave	+	+	-	-

first vowel of t vowel is arbitrary equally well have require a progressive vowels in suffix the non-final vowel required," Lightner both progressive of velars, a post and regressive; just as natural postulation of (of vowels."

One can of argument. Their late progressive namely the fact determined in t vice versa; and tion rule works hard to see v matters by ad rule for roots t needed for suffix more, consonant by the same t which gravity consonant, is gravity, and t vowels and 've progressive as would be deriv outside would. From the point generative) Ar presumably co of statements, the other to fu not concerned here.

(It is perhaps

⁶ This is in fact the rules for 'C 46) as given in Modern Standard and The Hague, that Lees' rules harmony involve assimilation, but

first vowel of the root as the determining vowel is arbitrary; the last vowel could equally well have been chosen, which would require a progressive assimilation rule for the vowels in suffixes and a regressive one for the non-final vowels of the root. "If we are required," Lightner concludes, "to postulate both progressive and regressive assimilation of velars, a postulation of both progressive and regressive assimilation of vowels seems just as natural (and just as arbitrary) as a postulation of only progressive assimilation of vowels."

One can of course quarrel with this argument. There is a good reason to postulate progressive assimilation of vowels, namely the fact that suffix vowels can be determined in terms of root vowels but not vice versa; and since a progressive assimilation rule works for root vowels as well, it is hard to see why one should complicate matters by adding a regressive assimilation rule for roots to the progressive one that is needed for suffix vowels anyway. Furthermore, consonant harmony can be handled by the same rule if the first segment for which gravity is relevant, be it vowel or consonant, is specified distinctively for gravity, and the gravity of the subsequent vowels and 'velars' is determined in terms of progressive assimilation.⁶ Thus *adag end* would be derived from *adAG*, while *γadana* outside would be derived from *γAdAnA*. From the point of view of traditional (= pre-generative) American phonology this would presumably constitute an undesirable mixing of statements, one relating to allophones and the other to full-fledged phonemes, but I am not concerned with that particular objection here.

(It is perhaps worth noting at this point,

⁶ This is in fact what Robert B. Lees does in the rules for 'Gravity Harmony' (Rules 45 and 46) as given in his monograph *The Phonology of Modern Standard Turkish*, Bloomington, Ind., and The Hague, 1961. Lightner states in a footnote that Lees' rules for Turkish vowel and consonant harmony involve both progressive and regressive assimilation, but he is mistaken on this point.

however, that for Classical Mongolian⁷ there is evidence that, to put it informally, the vowels are determined by a vowel harmony rule and then in turn determine the distribution of q and k and of γ and g.⁸ Classical Mongolian has a seven-vowel system, in which all the possible combinations of high-low, front-back, and rounded-unrounded occur with the exception of 'high back unrounded' (i, which is assumed for an earlier stage, had merged with its front counterpart i by the Classical Mongolian period). Both of Lightner's rules, i.e. Rule (1a) and the rule given in footnote 4, generate a high back unrounded vowel, which is then re-written as a high front unrounded one by another rule. However, in Classical

⁷ I am using the term 'Classical Mongolian' in the sense in which Nicholas Poppe defines it in his *Grammar of Written Mongolian* (Wiesbaden, 1954), i.e. to refer to the language of the seventeenth and subsequent centuries (cf. Poppe 3). Lightner writes that he is describing 'Classical (pre-sixteenth century) Mongolian', which would seem to correspond to what Poppe occasionally calls 'the pre-classical language'. While it seems to me that the point I want to make here also applies to the pre-classical language, there are orthographic differences between the two periods which make the situation at the earlier stage somewhat less clear-cut (see below); but in any case the following remarks apply to Classical Mongolian of the seventeenth century, i.e. to the period after the orthographic reform.

⁸ A similar point can incidentally be made for Turkish on the basis of the by and large predictable (in terms of vowels) distribution of the velar and palatal stops in loan words that violate vowel harmony (e.g. in *gazete newspaper*, where the back vowel in the first syllable is followed by two front vowels, and which is thus not vowel-harmonic, the g stands, predictably, for a velar stop, while the g in *günah sin*, which again is not a vowel-harmonic word, stands just as predictably for a palatal stop). There are a number of exceptions to this statement, and the distribution of the two laterals poses some additional problems, but it seems to me undeniable that rules (such as those given by Lees in the work referred to above) which treat vowel and consonant harmony together, and must therefore be prevented from applying to stems that violate vowel harmony, miss a valid generalization about the consonants.

Mongolian only the letter representing either *k* or *g* (let us designate it by the symbol $\langle K \rangle$), not the letters for *q* and γ , occurs before $\langle i \rangle$ in both front-vowel and back-vowel words, so that it would appear to be the vowel *i* and not the general harmonic character of the word with respect to gravity that determines the phonetic nature of the consonants in question.⁹ One exception to this is the orthographic sequence $\langle \gamma i \rangle$, which occurs just in case the $\langle \gamma \rangle$ is stem-final and the $\langle i \rangle$ is suffix-initial. I do not know whether this orthographic sequence should be taken as having represented at any time in the history of Classical Mongolian a phonetic sequence distinct from that represented by $\langle Ki \rangle$ (where $\langle K \rangle$ has the value *g*) after a back vowel; it is certainly not implausible to assume that its use has at all times been due to a convention which keeps the spelling of the stem constant in all its occurrences without necessarily thereby indicating phonetic invariance. With regard to the preclassical language the situation appears to be the following: *i* and \bar{i} were never distinguished orthographically (a distinction that is also absent in the Uyghur script on which the Mongolian one is based), but the occurrence of $\langle K \rangle$ in front-vowel words and of $\langle q \rangle$ and $\langle \gamma \rangle$ in back-vowel words before the same letter $\langle i \rangle$ is taken to be evidence of the existence of the *i*- \bar{i} opposition at the time the writing system was developed, i.e. $\langle i \rangle$ is assumed to have at one time represented both *i* and \bar{i} . The spellings $\langle qi \rangle$ and $\langle \gamma i \rangle$ in back-vowel words, which were replaced by $\langle Ki \rangle$ in Classical Mongolian, persisted throughout the pre-classical period, but there seems to be no particular reason why one should believe that they represent, for that portion of this period which followed the $\bar{i} > i$ merger, anything more than an orthographic tradition which no longer accurately reflected the phonetic facts. In other words, the conventions of the writing system need not, as far as I can see,

⁹ For data relevant to the present argument cf. Poppe 14-15.

be taken as evidence that the replacement of *q* by *k* and of γ by *g* in the environment in question took place as a development separate from and subsequent to the change of \bar{i} to *i*, and that there was a stage at which *q* and γ occurred before *i*.¹⁰

To return to the question of the choice of rules for the description of vowel harmony: Although Lightner's arguments in favor of what might be called root-marker rules for vowel harmony (and associated consonant harmony) do not, as I have attempted to show above, appear to be compelling, there may of course nevertheless be good reasons which would support the solution he advocates. One such reason would be furnished by the existence of languages with vowel harmony that have both prefixes and suffixes with determined vowels; clearly such languages would require both progressive and regressive assimilation rules for the affix vowels, whereas a single root-marker rule can handle both prefixes and suffixes.¹¹ Languages that meet this requirement do in fact exist. One is Igbo, and as far as I can judge from looking at descriptions of the relevant data, the sort of rule proposed by Lightner would be eminently appropriate in this case (at least for what Joseph Greenberg calls the two 'principal grades' of vowels, characterized, according to him, by 'relative height' and 'relative lowness').¹² Another language in which conditioning of vowels is both progressive and regressive is Nez Perce,

¹⁰ I am most grateful to James Bosson of the Department of Oriental Languages, University of California, Berkeley, for answering my many questions about Mongolian. The use I am making of the information with which he has provided me is of course my own responsibility.

¹¹ In terms of general phonological theory one could presumably also argue that if rules for vowel harmony must in some cases determine the vowels of suffixes and in others those of prefixes, whether or not these occur in the same language, a type of rule that will deal with both cases equally is to be preferred to one that must take a different form in each one of the two cases.

¹² Cf. Joseph H. Greenberg, *Vowel Harmony in African Languages*, Actes du second colloque

and although language appears somewhat difficult by Lightner's description as a phenomenon seems to

A further argument might be based on the statement that 'vowel harmony' aside from corresponding to a generalization of Lightner's to the segment of an abstract marking system enables us to

[+vocalic
-consonantal]

and it is now known that fewer terms while the number of lexicon remain

international conference in Dakar 12-16 August 1965, also J. Carno, *African Languages*, Greenberg, after seeing my paper, has just published an article in the *Journal of African Studies* (mimeographed) on the articulatory features of the articulatory system in Akan, Igbo, and found not in relation to laxness, but to tongue, the vowel called 'relative height' is characterized by a high feature while the 'relative lowness' is characterized by a low feature.

¹³ Cf. Haruo, *Proto-Saharan Languages*. Nez Perce feature that the vowel harmony in this case one 'root-marker' might

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and although the rules required for this language apparently require a formulation somewhat different from the one suggested by Lightner for Mongolian, what can be described as an essentially prosodic treatment seems to be indicated here too.¹³

A further argument for root-marker rules might be based on the criterion of economy of statement. Let us, leaving the 'velar harmony' aside, compare Rule (1a) and the corresponding assimilation rule, first adopting a general convention suggested by Lightner to the effect that each phonological segment of a word is associated with the abstract markers of the root. This convention enables us to re-state Rule (1a) simply as:

[+vocalic
-consonantal] → [α grave] in env.: [α GRAVE],

and it is now obvious that Rule (1a) mentions fewer terms than the assimilation rule, while the number of terms mentioned in the lexicon remains the same (a system that

international de linguistique négro-africaine, Dakar 12-16 avril 1962, Dakar, 1963, 33-37. Cf. also J. Carnochan, *Vowel Harmony in Igbo*, *African Language Studies* 1.155-163 (1960). Greenberg, after seeing an earlier version of the present paper, has just called to my attention an unpublished article by J. M. Stewart of the Institute of African Studies, University of Ghana, entitled *Tongue Root Position in Akan Vowel Harmony* (mimeographed, 1966?). According to Stewart, the articulatory basis for the vowel harmony of Akan, Igbo, and other African languages is to be found not in relative tongue height or in tenseness vs. laxness, but in the position of the root of the tongue, the vowels that have been variously called 'relatively high' and 'tense' being characterized by a pushing forward of the tongue root while the 'relatively low' or 'lax' vowels are characterized by the absence of this articulatory feature.

¹³ Cf. Haruo Aoki, *Nez Perce Vowel Harmony and Proto-Sahaptian Vowels*, to appear in *Language*. Nez Perce incidentally has the interesting feature that the morpheme which determines the vowel harmony of a word need not be the root. In this case one could therefore hardly speak of 'root-markers'; the more general term 'morpheme-marker' might be used instead.

uses the assimilation rule must specify gravity for the first vowel of the root, while a system using the root-marker rule need not do so, but must specify a value for the marker (GRAVE). What is not so clear to me is how a simplicity measure that relies on the counting of distinctive phonological features is to deal with root-markers. To assume that a root-marker is to be counted as equivalent to one phonological feature seems quite arbitrary—just as arbitrary, in fact, as counting it as .5, 2, 10, or any other number. I do not see, therefore, how the usual feature-counting measure can be applied in this case in any motivated way; which is not to say, of course, that some reasonable measure could not be devised that would assign a higher value to one of the rules in question in a non-arbitrary way.¹⁴ But quite apart from this problem, there is a strong point that can be made in favor of the root-marker rule, namely that it is not constrained, as is the assimilation rule, to refer to the quite irrelevant matter of intervening consonants between vowels. These consonants clearly have nothing to do with vowel harmony, and a rule should be given credit for not having to mention them. This appears to be a good reason for preferring the root-marker rule even though the question of establishing a rate of exchange for root-markers and phonological distinctive features remains in abeyance.

It would nevertheless be premature to assume that we should at this point give our wholehearted allegiance to the root-marker or prosodic school of thought, for in spite of Lightner's claim that "the nature of both methods of description is general and is applicable to languages such as Finnish or Turkish in which the harmony is somewhat

¹⁴ In her article *On System-Structure Phonology*, *Lg.* 41.601-609 (1965), Victoria Fromkin advocates a prosodic solution to the description of vowel harmony in Twi on the grounds of both economy of features and general revealingness. She does not, however, discuss the problem of just what we should assume the 'feature-economic' value of prosodic markers to be.

obscured by concomitant phenomena [such as loan words],¹⁵ there are in fact types of vowel harmony for the description of which the root-marker type of rule would appear to be less appropriate than a directional assimilation rule.

One example of such a phenomenon is provided by the so-called labial harmony in Turkish. The relevant facts can be summarized as follows: Turkish has eight vowels, *i e ü ö ı a u o*, the articulatory features involved being front-back, unrounded-rounded, and high-low.¹⁶ All eight vowels can occur in monosyllables and in the first syllable of roots with more than one syllable, but *ö* and *o* do not occur in non-initial syllables of native roots or in suffixes (with the exception of the verbal suffix *-[High V]yor*). In terms of progressive assimilation the vowel harmony can be described by using two morphophonemes, *I* (representing the high vowel alternation *i ~ ü ~ ı ~ u*) and *E* (representing the unrounded low vowel alternation *e ~ a*), in non-initial syllables. With very few exceptions the vowels in words containing roots of Turkic origin will be either all +grave or all -grave; but any word with a rounded vowel in the first syllable will have vowels exhibiting the feature +flat only up to and including the vowel preceding the first *E* encountered in going through the word from left to right. Thus:

<i>somIn</i> → <i>somun</i>	<i>loaf</i>
<i>somIn-ImIz</i>	<i>our loaf</i>
→ <i>somunumuz</i>	
<i>somIn-ImIz-I</i>	<i>our loaf (acc.)</i>
→ <i>somunumuzu</i>	
<i>tütIn</i> → <i>tütün</i>	<i>tobacco</i>
<i>tütIn-ImIz-I</i>	<i>our tobacco (acc.)</i>
→ <i>tütünümüzü</i>	

but:

<i>somIn-IEr-ImIz-I</i>	<i>our loaves (acc.)</i>
→ <i>somunlarimizi</i>	
<i>tütIn-IEr-ImIz-I</i>	<i>our tobaccos (acc.)</i>
→ <i>tütünlerimizi</i>	

¹⁵ I am using the letter 'ı' of Turkish orthography to represent the high back unrounded vowel.

Any *E* thus 'switches' +flat to -flat for the remainder of the word, and the description of labial harmony in Turkish is clearly best formulated in terms of a rule which refers to the immediately preceding vowel rather than to some marker associated with the word root, for any rule of the latter type would have to refer to the phonological environment too, in addition to incorporating a mention of a marker such as {+FLAT}.

Let us now look briefly at gravity harmony in Turkish. As has already been remarked words with roots of native origin are by and large harmonic with respect to this feature;¹⁶ however, there is a good reason for treating gravity harmony too in terms of a progressive assimilation rule, namely the fact that the vowels in suffixes occurring with non-harmonic roots are determined in the great majority of cases by the last vowel of the root (e.g. *pilotlar pilots*, *buketler bouquets*).

To sum up: While root-marker rules are clearly to be preferred for the description of vowel-harmonic phenomena such as are encountered in Igbo, there do exist systems of vowel harmony, such as the labial harmony of Turkish, for which such rules are not an appropriate descriptive device and which require directional assimilation rules.¹⁷ In Mongolian there is apparently no obvious

¹⁶ Notice however that the vowel *o* in the verbal suffix *-Iyor* switches -grave to +grave (e.g. *düş-Iyor-Im* → *düşüyorum I am falling*). In addition it of course switches -flat to +flat (e.g. *var-Iyor-Im* → *varıyorum I am arriving*). The switching effects of this morpheme would seem to constitute another argument for the description of Turkish vowel harmony in terms of progressive assimilation.

¹⁷ It might be noted that any system of vowel harmony can in principle be described in terms of assimilation rules, even though such a description may under certain conditions be uneconomical. On the other hand a system such as the labial harmony in Turkish cannot be described by root-marker or morpheme-marker rules unless these are modified in such a way as to become in fact directional assimilation rules. But this fact is not, it seems to me, a compelling argument for regarding assimilation rules as the basic type of vowel harmony rules.

structural features both prefixes or of 'harmony' on the other, one or the other as has been. Such rules are in simpler, they would be e.g. golian. Such unmarked; assimilation; some languages. One might. Lightner the some sense of more adequate the basic form harmony.

UNIVERSITY

DIE NORDEUROPEISCHEN SPRACHEN: EINE SYNTAXISCHE UND IHRE ANWENDUNG. Jürgen Pinnow, 1964. Pp. 100.

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The entire American Indian and 1960 corpora. This is one reminder of man-speaking. Boas, the scientific publication of a pleasant study. The author, Freie Universität, linguists he pioneered in (Versuch einer Kharia-Sprache has also written a language (28.61).

Pinnow's list of contents

structural feature, such as the existence of both prefixes and suffixes on the one hand, or of 'harmony switching' within the word on the other, that would force one to adopt one or the other type of description; but if, as has been suggested above, root-marker rules are in fact in some general sense simpler, then it is rules of this kind that would be chosen for languages like Mongolian. Such rules could be considered as unmarked; it would be the directional assimilation type of rule that would require some language-specific reason for adoption. One might therefore after all agree with Lightner that a root-marker rule does in some sense capture the notion of harmony more adequately and is to be considered as the basic format for the description of vowel harmony.

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DIE NORDAMERIKANISCHEN INDIANERSPRACHEN: EIN ÜBERBLICK ÜBER IHREN BAU UND IHRE BESONDERHEITEN. By Heinz-Jürgen Pinnow. Wiesbaden: Otto Harrassowitz, 1964. Pp. xiv, 138. 2 maps.

KARL-HEINZ GURSKY

The entire German literature on North American Indian languages between 1900 and 1960 consists of about half a dozen papers. This is a deplorable fact, especially if one remembers how great an influence German-speaking scholars—Buschmann, Gatschet, Boas—had during the beginnings of the scientific study of these languages. The publication of Pinnow's book, therefore, was a pleasant surprise to German Americanists. The author is Professor of Indology at the Freie Universität Berlin. To American linguists he is probably known best for his pioneering monograph on Munda linguistics (*Versuch einer historischen Lautlehre der Kharia-Sprachen*, Wiesbaden, 1959), but he has also written two papers on North American languages (abstracts in *IJAL* 27.259 and 28.61).

Pinnow's book contains an extensive table of contents (v-viii), a foreword (ix-xiv), a

long introduction with a detailed classification of the North American languages (1-34), a survey of the most important and characteristic features of the grammatical structures of these languages (35-95), then as an illustration of these features a text in Tlingit with extensive annotations (96-105), an appendix on writing systems developed for North American languages with four tables (105-112, 135-138), another appendix on transcription systems which are or were used by Americanists (113-118), a list of the more important languages with a selected bibliography (119-138), and finally two maps.

In his foreword Pinnow explains that he has written his book mainly for two groups of potential readers: first for those who are primarily interested in the culture and history of North American Indians but who also want to obtain some insight into the nature of the languages of these people; second for German linguists who want to obtain some orientation in these languages which, because of their highly complicated structures, radically different from European models, are of great importance for generalizations about the phenomenon language. The disparity between these two kinds of readers was of course a great impediment to the author. On the one hand Pinnow had to explain such basic concepts as 'phoneme' and 'morpheme'; on the other hand he wanted to give information which was useful to the linguist also. Pinnow has mastered this difficulty as well as might reasonably be expected.

In his introduction Pinnow delineates the two main difficulties which everyone who wishes to become acquainted with North American languages has to overcome: first the fact that modern structuralist descriptions are inaccessible to a nonlinguist because of their highly technical terminology, and second the great diversity of these languages. Then Pinnow gives a very detailed genetic classification of the North American Indian languages. He follows Sydney Lamb's classification but gives more subgroups, often down to the level of dialects. For each language he states in his classification the original

TWO PROPOSALS CONCERNING THE SIMPLICITY METRIC IN PHONOLOGY

1. A standard example for the influence of context on the variation of speech sounds is the determination of front and back allophones of the velar stops in languages like English. There must be few students of linguistics who have not been confronted in introductory courses with pairs like *keep* vs. *cool* or *peak* vs. *Luke*, *give* vs. *good* or *dig* vs. *dog*. A statement about this variation might take the form:

I. A velar stop varies in the dimension front to back (grave-ness) according to the quality of the preceding or following vowel. How might this statement be rendered in a generative phonology of English, a theory which is intended to reflect generality of statement in shortness of rules? The best that we can do is the following.¹

Rule 1.1

$$\begin{bmatrix} -\text{cnt} \\ +\text{hi} \end{bmatrix} \rightarrow [\approx\text{grv}] / \left\{ \begin{array}{l} \begin{bmatrix} -\text{cns} \\ \approx\text{grv} \end{bmatrix} \text{ — } \\ \text{— } \begin{bmatrix} -\text{cns} \\ \approx\text{grv} \end{bmatrix} \end{array} \right\}$$

1-The theory of phonology assumed here is essentially that developed by Morris Halle and associates, see Chomsky and Halle, 1968, and Harms, 1968. The features used in most of the examples follow modifications introduced by McCawley, 1967. Note in particular the use of the features *high* (*hi*): [+hi] replaces [+dif] for vowels, [-dif] ([+cmp]) for consonants; the features *obstruent* (*obst*), *syllabic* (*syl*), and *consonantal* (eliminating *vocalic*) for a four-way classification of segments: vowels are [+syl, -cns], (and [-obst]); glides are [-cns, -syl] (and [-obst]); liquids and nasals are [+cns, -obst]; stops, spirants, affricates are [-obst] (and [+cns, -syl]). An earlier version of this paper was read at the Winter meeting of the Linguistic Society of America, December, 1966. I am indebted to Robert T. Harms for discussion and clarification of many of the problems raised in the paper.

It is apparent that we Generalization. For the abbreviatory devices, v the same way as a rule hypothetical statement:

II. A velar stop varies in the dimension front to back (grave-ness) of a preceding vowel.

Rule 1.2

$$\begin{bmatrix} -\text{cnt} \\ +\text{hi} \end{bmatrix} \rightarrow$$

I think it is obvious that the first statement is more general. Hence, we should be able to capture the variation more highly (given a low number of rules) than II. My first proposal is a generalization which can be applied to all languages and which can be applied to all environments. It is a statement which can be applied to all environments to express the greater generality of the first statement. I will capture the obvious fact specified in both parts of the first statement by eliminating the abbreviatory devices. The convention that will be the following. For a significant number of languages which can be easily adapted to the proposed notation, I will present some historical examples of the neighborhood convention.²

2. Let us first state the first statement. I will abbreviate by our convention. First, the order of the features. If we have an environment, we must make some stipulations.

With regard to the first statement, the velar stops in English vary in the dimension front to back specification can apply to all environments. It occurs between vowels. It makes no difference, of course, if the two vowels are different. For example, *becalm*, etc. It is appar-

termines the value of the stop. Thus, we tentatively decide that the abbreviation will be an abbreviation for the sequence of rules giving a value first *after* and then *before* a given environment, since whatever value is given to a segment which follows the determining segment, it will be changed by the second rule abbreviated by the convention.

Second, suppose we have a rule that involves an environment consisting of several segments, schematically 'a₁a₂...a_n'. The question is this: Given an abbreviated rule 'c → d / a₁a₂...a_n' should this be defined as the abbreviation of Rule A or B?

$$A. c \rightarrow d / \left\{ \begin{array}{l} a_1 a_2 \dots a_n \text{---} \\ \text{---} a_1 a_2 \dots a_n \end{array} \right\} \quad B. c \rightarrow d / \left\{ \begin{array}{l} a_1 a_2 \dots a_n \text{---} \\ \text{---} a_n \dots a_2 a_1 \end{array} \right\}$$

There seems to be fairly clear evidence that the second alternative is correct, that is, that the neighborhood abbreviation should be read 'after a certain environment or before the mirror-image of that environment.' I shall present below several cases where this decision works. I know of no rules involving a sequence of several segments where a particular specification is made after or before that sequence in the same order (which seems inherently implausible).

3. Let us now consider some examples of rules of this sort drawn from a number of languages. My reasoning here is that a notational convention can be partly justified by finding many examples of its use. It is true, as Kiparsky (1968) has argued, that there is no limit to the number of absurd notational conventions that could be invented and for which widespread 'use' could be found in the languages of the world. Thus, the value of examples such as those given here is dependent partly on the feeling of the linguist that what is expressed is somehow a valid generalization. Beyond that, however, the examples have a certain negative evidential value in that we would be suspicious of abbreviatory conventions for which we could not find fairly widespread employment.

3.1. The following statements are frequently made about the assimilations of voicing of stops and spirants in Modern Dutch

(e.g. Koolhoven 1962:19

I. In a sequence of so is the other.

II. In a sequence c the voicing value of the

III. A sequence of t The regularities underlying by two ordered rules:

$$\begin{array}{l} \text{Rule 3.1} \quad \left[\begin{array}{l} +\text{obst} \\ +\text{cont} \end{array} \right] \\ \text{Rule 3.2} \quad \left[-\text{obst} \right] \end{array}$$

In the first rule all spirants other obstruents. In the they occur in the environments will not undergo voiceless.

Without the use of t necessary to repeat the would be no way to achieved in the rules for were made voiceless t struents were voiced at be noted that the order viated rules) can play n lar value is assigned t for settling the questi- rules involving Greek-like).

2-Aert Kuipers has pointed out that the assimilations about Dutch are oversimplified. At least, there appears to be in compounds and must tal ever turns out to be the statements above in seven but it is likely that they cluding some necessary re

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$$B. c \rightarrow d / \left\{ \begin{array}{l} a_1 a_2 \dots a_n \text{---} \\ \text{---} a_n \dots a_2 a_1 \end{array} \right\}$$

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(e.g. Koolhoven 1962:19)²:

- I. In a sequence of two stops, if one of the stops is voiced, so is the other.
- II. In a sequence of a stop and a spirant, the stop determines the voicing value of the spirant.
- III. A sequence of two spirants is always voiceless.

The regularities underlying these statements can be character-
 ized by two ordered rules:

$$\begin{array}{l} \text{Rule 3.1} \quad \left[\begin{array}{l} +\text{obst} \\ +\text{cnt} \end{array} \right] \rightarrow [-\text{vce}] / [+ \text{obst}] \\ \text{Rule 3.2} \quad [+ \text{obst}] \rightarrow \left[\begin{array}{l} +\text{vce} \\ -\text{cnt} \\ +\text{vce} \end{array} \right] \end{array}$$

In the first rule all spirants are made voiceless in clusters with
 other obstruents. In the second rule all obstruents are voiced if
 they occur in the environment of a voiced stop. Clusters of spi-
 rants will not undergo Rule 3.2, hence will correctly remain
 voiceless.

Without the use of the neighborhood convention, it would be
 necessary to repeat the specifications in each environment. There
 would be no way to distinguish the degree of generalization
 achieved in the rules from that of two rules in which, say, spirants
 were made voiceless before obstruents or after glides and ob-
 struents were voiced after voiced stops and before /r/. It should
 be noted that the order of expansion (i.e. the order of the abbrevi-
 ated rules) can play no role in rules like these where a particu-
 lar value is assigned to a feature. Hence, the crucial examples
 for settling the question of ordering will have to be found in
 rules involving Greek-letter variables (for assimilations and the
 like).

²Aert Kuipers has pointed out to me that the statements made here
 about Dutch are oversimplified and perhaps incorrect. In his dialect, at
 least, there appears to be a terminal devoicing rule which operates with-
 in compounds and must take effect before the rules given above (or what-
 ever turns out to be their correct formulation). Since I have seen the
 statements above in several published sources, I have let them stand,
 but it is likely that they must be modified at least to the extent of in-
 cluding some necessary restriction by means of various boundary elements.

3.2. In Modern German, clusters of obstruents are always voiceless within morphemes (and 'words' suitably specified by means of the appropriate boundaries--i.e. there can be sequences of voiceless and voiced obstruents only within compounds). Hence, whenever we have such a cluster it is not necessary to specify the feature of voicing in the underlying segments. We can add this specification by the rule.

Rule 3.3. $[-\text{obst}] \rightarrow [-\text{vce}] / [+ \text{obst}]$

This rule states the fact noted above in the most direct possible way. Suppose we do not have some such device as the neighborhood convention. Using the usual formalism, we would have to repeat the environmental specification twice and again the rule would not reflect the obvious generalization. An alternative formulation might use the framework of a Structural Description and Structural Change:

Rule 3.4. SD: $[\text{+obst}]_1 [\text{+obst}]_2$
 SC: 1, 2 $\rightarrow [-\text{vce}]$

The defect of this notation is that there is no obvious way to show that it is more general than a rule with the same SD but a different SC, say '1 $\rightarrow [-\text{vce}]$ ', in which only one of the segments is affected. Since there are independent reasons for using the neighborhood abbreviation, there is no need to set up a special stipulation for evaluating rules like 3.4.

It should be noted that rules like those given above must be assumed to be embedded within a full analysis of the phonological system of the language in question (in so far as we can anticipate it) and must apply at the appropriate place in the sequence of rules. Thus, in German the phonetic obstruent [v] would seem to provide counter-evidence to the claim made since we have forms like *Zwei*, *quer* with [t^sv, kv] and the like. But there are various reasons for considering phonetic [v] in German as derived from an underlying semivowel /w/ (or perhaps even vowel /u/). The rule above is one small part of the justification for this analysis (Ross 1967, Bach and King, 1966). Further, anomalous forms like *Dschungel*, *Dschunk* will be marked as exceptions to the rule (note that in popular speech they usually have [t^s]).

3.3. Examples like those cited in 1 (front and back allophones of velars) can be matched by many neighborhood assimilations

at the level of phonetic hood of rounded (flat) v more or less rounded. T suspect such a situation labiovelars as plain vel. Similarly, in Russian the mined by the presence of environment (Halle 1959 convention proposed here 3.4. Let us consider n languages exhibit a seri way that the vowels car such that more dominan instance, in Modern Gre the following rule applie Rule 3.5

$V \rightarrow \text{null} /$

That is, any vowel is el ing morpheme boundary vowel except /a/ and ; interesting since it sho two abbreviatory device Peters). That is, if we

and then into

we will get the right re vides our first example of our notation. Any suc of this character and it

dealing with such pheno

obstruents are always voice-suitably specified by means there can be sequences of y within compounds). Hence, is not necessary to specify lying segments. We can add

obst]

e in the most direct possible such device as the neighbor-ism, we would have to on twice and again the rule ization. An alternative of a Structural Description

]

here is no obvious way to rule with the same SD but a h only one of the segments dent reasons for using the o need to set up a special 4.

those given above must be analysis of the phonologi- tion (in so far as we can appropriate place in the se- he phonetic obstruent [v] e to the claim made since ±^sv, kv] and the like. But ing phonetic [v] in German wel /w/ (or perhaps even all part of the justification and King, 1966). Further, chunk will be marked as pular speech they usually

front and back allophones eighborhood assimilations

at the level of phonetic detail. Thus, in the immediate neighbor- hood of rounded (flat) vowels obstruents in English are usually more or less rounded. This is probably a universal rule. We may suspect such a situation to be the source for the Greek reflex of labiovelars as plain velars before or after /u/ (Buck 1933:126). Similarly, in Russian the allophones of certain vowels are deter- mined by the presence of a palatalized consonant in the immediate environment (Halle 1959:73; Rules P 13a, b implicitly use the convention proposed here).

3.4. Let us consider next rules of vowel elision. A number of languages exhibit a series of rules for eliding vowels in such a way that the vowels can be set up in a hierarchy of 'dominance' such that more dominant vowels elide less dominant ones. For instance, in Modern Greek (Koutsoudas 1962:16-17) it seems that the following rule applies:

Rule 3.5

$$V \rightarrow \text{null} / \left\{ \begin{array}{c} a \\ o \\ u \\ i \end{array} \right\} +$$

That is, any vowel is elided by a neighboring /a/ with interven- ing morpheme boundary (+), any vowel except /a/ by /o/, any vowel except /a/ and /o/ by /u/ etc. This rule is especially interesting since it shows the necessary order of expansion of two abbreviatory devices (this was pointed out to me by Stanley Peters). That is, if we expand the environment above first into

$$\left\{ \begin{array}{c} a+ \\ o+ \\ u+ \\ i+ \end{array} \right\}$$

and then into

$$\left\{ \begin{array}{c} a+ \text{---} \\ \text{---} + a \\ o+ \text{---} \\ \text{---} + o \\ \text{etc} \end{array} \right\}$$

we will get the right results, otherwise not. Also, Rule 3.5 pro- vides our first example in support of the 'Mirror-image' character of our notation. Any such rule working across a boundary will be of this character and it is difficult to imagine a rule of the form

$$a \rightarrow b / \left\{ \begin{array}{c} c+ \text{---} \\ \text{---} c+ \end{array} \right\}$$

dealing with such phenomena (e.g. a certain vowel is elided if it

follows a second vowel with intervening boundary or if it precedes the second vowel in prefinal position).

Similarly, in Amharic (extrapolating slightly from the statement in Obolensky et al., 1964:24) the three central vowels reduce when they occur together according to the hierarchy (from most to least dominant): a e i. We can give the following rule to account for these elisions:

Rule 3.6

$$[+syl] \rightarrow null / \left\{ \begin{array}{l} [+syl] \\ [+cmp] \\ [-hi] \\ [+hi] \end{array} \right\} +$$

(Note the order of expansion: first the braces are placed around the segment brackets:

$$\left\{ \begin{array}{l} [+syl] \\ [+cmp] \\ [+syl] \\ [-hi] \\ [+syl] \\ [+hi] \end{array} \right\} +$$

then we proceed as above. I am assuming it is not necessary to specify [-tns] or whatever is used to distinguish the central vowels because of rules inserting glides between other vowels).³

3.5. A number of languages like German exhibit neutralization of voicing oppositions and the like before word boundaries. Sometimes, however, such neutralizations (as well as allophonic variations) are determined merely by the presence of a word boundary (hence, the common phrase in phonological descriptions 'initially and finally'). Thus, in Tübatulabal voiced stops and affricates occur only in 'intersyllabic, syllable-initial position' (Swadesh and Voegelin 1939), and we may state a rule:

$$\text{Rule 3.7. } [-cnt] \rightarrow [-vce] / \left\{ \begin{array}{l} \neq \\ [+obst] \end{array} \right\}$$

Similarly, in Amharic geminate consonants are simplified initially and finally (but only after a rule lengthening vowels before single consonants).

I have by no means exhausted the number of examples of situations where neighborhood rules seem to offer the best method

³-I have drawn here upon work done on Amharic by Marvin Bender at the University of Texas at Austin.

of expressing the regular logical rules.⁴ One particular of various kinds of 'vowel' the second convention to cushion until a later part 4. So far my argumentation have been of two sorts based on the 'linguist's' than another. And on the examples that show that us now consider some sort that the convention does not. This evidence is 4.1. An important type special rule becomes general is a matter of historical observed in the making. On Martha's Vineyard the /ay/ was followed by a the environment of a rule vowel /a/ was simplified graveness specification:

⁴-See Becker 1967 for some dialects. In a paper read at Kazazis discussed an inter reduction of /i/ to a glide layer of vocabulary the old convention posited here, is opposite. This would seem sider in line with the ques of such rules as considered, verse the values for 'syl' is then the order of environment haltz (personal communication which can be neatly handled sumably to be discussed in It may be, incidentally, the clude more constraints on particular orders of environment actual segments specified. ing stops, but in most languages lowered by (nonsyllabic) nas occur, e.g. German Bank ([

...rvening boundary or if it precedes
 ...tion).
 ...ating slightly from the statement
 ...the three central vowels reduce
 ...ding to the hierarchy (from most
 ...in give the following rule to ac-

$$\left[\begin{array}{l} +syl \\ +cmp \\ -hi \\ +hi \end{array} \right] +$$

...st the braces are placed around

...ssuming it is not necessary to
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 ...glides between other vowels).³
 ...German exhibit neutralization
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$$\left\{ \begin{array}{l} \neq \\ [+obst] \end{array} \right\}$$

...sonants are simplified initially
 ...lengthening vowels before single

...e number of examples of situ-
 ...eem to offer the best method

...on Amharic by Marvin Bender at

of expressing the regularities apparent at various levels in phono-
 logical rules.⁴ One particularly interesting set of facts are those
 of various kinds of 'vowel harmony,' but since such rules involve
 the second convention to be considered here, I shall defer dis-
 cussion until a later part of this paper (7.).

4. So far my arguments in favor of the neighborhood conven-
 tion have been of two sorts. On the one hand, they have been
 based on the 'linguist's intuition' that one rule is more general
 than another. And on the other hand, I have given a sampling of
 examples that show that the convention is a useful device. Let
 us now consider some stronger evidence in support of the idea
 that the convention does indeed capture 'significant generaliza-
 tions.' This evidence is drawn from the history of German.

4.1. An important type of sound change is that in which a
 special rule becomes generalized. That such changes take place
 is a matter of historical fact. Moreover, such changes have been
 observed in the making. William Labov (1965) cites two cases.
 On Martha's Vineyard a centralization of the first element of
 /ay/ was followed by a centralization of /aw/, that is to say,
 the environment of a rule producing this variant of the compact
 vowel /a/ was simplified --i.e. generalized--by dropping the
 graveness specification:

4-See Becker 1967 for several instructive examples in three German
 dialects. In a paper read at the Winter meeting of the LSA, 1966, Kostas
 Kazasis discussed an interesting problem in Modern Greek involving the
 reduction of /i/ to a glide before and after another vowel, where in one
 layer of vocabulary the order of environments is as in the neighborhood
 convention posited here, in the other ('nonlearned' forms) it is just the
 opposite. This would seem to be an especially interesting case to con-
 sider in line with the question of historical evidence for the generality
 of such rules as considered in the next section. Note also that if we re-
 verse the values for 'syl' in this case, that is, start with underlying /i/,
 then the order of environments will be just the opposite. James Fidel-
 holtz (personal communication) has pointed out several cases in Micmac
 which can be neatly handled with the neighborhood convention, pre-
 sumably to be discussed in his M.I.T. dissertation on Micmac phonology.
 It may be, incidentally, that when phonological theory is enriched to in-
 clude more constraints on the substance of rules, it will turn out that
 particular orders of environment and affected segment will depend on the
 actual segments specified. Thus, nasals typically assimilate to follow-
 ing stops, but in most languages that I know of where stops can be fol-
 lowed by (nonsyllabic) nasals, the corresponding assimilation does not
 occur, e.g. German *Bank* ([ŋk]) but *Knabe* ([kn]).

/ — [-cns]
[-syl]

ric (based on counting feature
the greater generality of the
n New York (Labov 1965:106)
ription) was followed by raising
wel /oh/. For an example from
b (orthographic *th, dh, ð* etc.)
took place first medially and
o all positions (Braune-Mitzka

rich languages are learned and
s of rule generalization seem
cases given by Labov above--
and contiguous dialects A and
s dialect in some sense. Sup-
und change of a very restrict-
e with a special environment,
ls if immediately followed by
ers of B under the influence
amar. On a priori grounds it
will be at least as general as
will be more general, highly

Thus, in the case considered
ering both /i/ and /u/ before
any segment marked [+nas]).
a rule with a more restricted
rster of [n] and a stop,' or
se the latter we would have
d just the accidental set of
h a rule, and furthermore ad-
actly the heard forms. (Cf.
and examples of the process

hat I believe to be the fal-
of argument. A very general
ain dialect. Contiguous dia-
) more and more specialized
re argument is then that the
hows the most general form

of the rule and spread from the area of 'strongest' effect gradual-
ly becoming attenuated as it spread (like ripples in a pond).
Some examples of this are the High German sound shift, the
monophthongization of *ai* and *au* in Old High German and Old
Saxon, and the NHG diphthongization of high tense vowels. (For
typical arguments of this sort we may take A. Bach 1956: §§ 59,
70). Thus in Old Saxon *ai* and *au* were monophthongized every-
where, but in the OHG area only in special environments. Assum-
ing that there is a direct connection, to believe the traditional
account we must imagine that speakers of Old High German con-
servatively borrowed rules in such a way as to apply them only
before /x r w/ and /x r/ and dentals respectively! It seems to
me obvious that quite the opposite direction of spread must have
obtained.

Kiparsky (1968) has stated an almost diametrically opposed
view according to which adults borrow rules in a more special-
ized form (while children generalize when learning their lan-
guage--we might call this the Theory of Generative Children and
Taxonomic Adults). As Becker (1967) has pointed out, Kiparsky's
one example--NHG diphthongization--breaks down. Since we have
two theories leading to opposite interpretations and factual
claims, we must look to independent evidence to settle the ques-
tion. The cases given by Labov seem to contradict Kiparsky's
claim directly. In the historical examples we must consider docu-
mentary evidence. In the case of the German monophthongization
there does not seem to be any clear evidence one way or the
other,⁵ while the High German sound shift would obviously dem-
and a full-scale study. Most accounts are shot through and
through with interpretations so that it is exceedingly difficult to
evaluate the statements made in the handbooks. Since there are
clear cases of rule generalization and no clear cases of speciali-
zation, I conclude that the former type of change is the expected
mechanism and use the hypothesis as a necessary part of the

⁵We have much fuller and older documentation for Old High German
than for Old Saxon. It is possible to follow the change in OHG documents
from about 765 (Braune-Mitzka 1963: §§ 43, 45). The OS *Heliand* is dated
at about 830, the *Genesis* later but the manuscripts are considerably
later and most of the smaller texts come from the tenth and eleventh
centuries (Halhousen 1921: §§ 13-20). As with the HG sound shift I can
do no more than raise questions here that must be answered if possible
by detailed philological work.

argument below. (To say that rules can be both generalized and specialized without adding some further factors determining one or the other effect is, of course, to say exactly nothing. For some discussion of this whole problem see Becker 1967).

4.2. If the above reasoning is correct, then various sound changes that can be expressed as differences in rules can be used as evidence for the hypothesis that the neighborhood convention expresses a significant generalization.

In the OHG area, the following sound changes took place in the order given (over a period of about 200 years, the last two approximately contemporaneous):

- A. ai > ei
- B. au > ou
- C. ua > uo (< \bar{u})
- D. ia > ie (< \bar{e}_2)

It is crucial to the following argument to show that these sound changes have their counterparts throughout the period as actual synchronic rules in the phonology of the language. The full justification for this cannot be presented here but only briefly sketched. The evidence for the first two involves a consideration of the system of rules for the forms of strong verbs, which in Old High German (as in all the older Germanic dialects) are still completely phonologically predictable. The assumption of underlying diphthongs of the form *au*, *ai* (or possibly *aw*, *ay*) can be shown to yield a simpler set of rules for the preterit and past participle forms, since we have complete parallelism throughout for the first three classes (and partial parallelism for all of the first five classes--note that \bar{i} is derived from underlying *ei*):

I	reit-	roit	rit-	
II	fleug-	flaug	flug-	(-flog-)
III	helf-	half	hulf-	(-half-)
IV	stel-	stal		(-stol-)
V	geb-	gab		

With some simple rules of adjustment of the sort considered here all the strong verbs can be handled with two or three rules. The total set of rules then can be shown to be much simpler than would be the rules which did not incorporate the synchronic correspondents to A and B above. Further support comes from the rules for *a/e* umlaut. The *ua* and *ia* are not underlying forms but intermediate between systematic phonemic and phonetic. The justification of rules corresponding to C and D is rooted in the treatment of the so-called 'reduplicating' verbs (which again can

be made quite simple)

Now, the series of just a progressive ger

Rule 4.1 $\left[\begin{array}{l} +\text{syl} \\ +\text{cmp} \end{array} \right]$

Rule 4.2 $\left[\begin{array}{l} +\text{syl} \\ +\text{cmp} \end{array} \right]$

Rule 4.3 $\left[\begin{array}{l} +\text{syl} \\ +\text{cmp} \end{array} \right]$

Rule 4.2 is more general counting Greek letter minuses. But 4.3 can if we adopt the neighborhood evaluated as more general way that the environment rule as 4.2.

5. The second situation which the determining from the segment under segments. Consider the

I. A mid front vowel followed by a high front

II. A mid front vowel high front vowel.

Since Statement II in would appear to be more lowing:

Rule 5.1 $\left[\begin{array}{l} +\text{syl} \\ -\text{grv} \\ -\text{cmp} \end{array} \right]$

Rule 5.2 $\left[\begin{array}{l} +\text{syl} \\ -\text{grv} \\ -\text{cmp} \end{array} \right]$

I am not aware of any like 'X' in the simplified choose to count them more than 5.1. If we do not, in either case the general the metric.

is can be both generalized and further factors determining one say exactly nothing. For some (see Becker 1967).

correct, then various sound differences in rules can be basis that the neighborhood generalization.

sound changes took place in about 200 years, the last two

(< ̅)

(< ̅₂)

argument to show that these arts throughout the period as nology of the language. The resented here but only briefly two involves a consideration of strong verbs, which in Old Germanic dialects) are still le. The assumption of under- (or possibly aw, ay) can be les for the preterit and past plete parallelism throughout ial parallelism for all of the derived from underlying ei):

it-
lug- (-flog-)
ulf- (-holf-)
(-stol-)

of the sort considered here with two or three rules. The n to be much simpler than rporate the synchronic cor- ter support comes from the re not underlying forms but onemic and phonetic. The o C and D is rooted in the ng' verbs (which again can

be made quite simple).

Now, the series of changes given above can be shown to be just a progressive generalization of a single rule:

$$\text{Rule 4.1} \quad \begin{bmatrix} +\text{syl} \\ +\text{cmp} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{cmp} \\ -\text{grv} \end{bmatrix} / \text{---} \begin{bmatrix} -\text{cns} \\ +\text{hi} \\ -\text{grv} \end{bmatrix}$$

$$\text{Rule 4.2} \quad \begin{bmatrix} +\text{syl} \\ +\text{cmp} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{cmp} \\ \alpha\text{grv} \end{bmatrix} / \text{---} \begin{bmatrix} -\text{cns} \\ +\text{hi} \\ \alpha\text{grv} \end{bmatrix}$$

$$\text{Rule 4.3} \quad \begin{bmatrix} +\text{syl} \\ +\text{cmp} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{cmp} \\ \alpha\text{grv} \end{bmatrix} / \begin{bmatrix} -\text{cns} \\ +\text{hi} \\ \alpha\text{grv} \end{bmatrix}$$

Rule 4.2 is more general than 4.1 if we incorporate some way of counting Greek letter variables as less costly than pluses or minuses. But 4.3 can be counted at least as general as 4.2 only if we adopt the neighborhood convention. Furthermore it can be evaluated as more general than 4.2 only if we stipulate in some way that the environment dash '---' is to be counted in such a rule as 4.2.

5. The second situation I would like to consider is that in which the determining environment for some rule is separated from the segment undergoing the rule by an irrelevant stretch of segments. Consider these two statements:

I. A mid front vowel becomes high front when immediately followed by a high front vowel.

II. A mid front vowel becomes high front when followed by a high front vowel.

Since Statement II includes Statement I as a special case it would appear to be more general. Yet as rules we have the following:

$$\text{Rule 5.1} \quad \begin{bmatrix} +\text{syl} \\ -\text{grv} \\ -\text{cmp} \end{bmatrix} \rightarrow [+hi] / \text{---} \begin{bmatrix} +\text{syl} \\ -\text{grv} \\ +\text{hi} \end{bmatrix}$$

$$\text{Rule 5.2} \quad \begin{bmatrix} +\text{syl} \\ -\text{grv} \\ -\text{cmp} \end{bmatrix} \rightarrow [+hi] / \text{---} X \begin{bmatrix} +\text{syl} \\ -\text{grv} \\ +\text{hi} \end{bmatrix}$$

I am not aware of any discussion in print of the role of variables like 'X' in the simplicity metric (but see Harms 1968). If we choose to count them then 5.2 will be evaluated as less general than 5.1. If we do not, then the two rules will be equally simple. In either case the greater generality of 5.2 is not expressed by the metric.

Let us consider, then, that a rule like 5.2 is to be counted as simpler than a corresponding rule without the variable X. A discussion of the exact details of this evaluation seems somewhat academic at the moment, in view of the many problems involved in deciding how to count symbols like 'C₀', 'C₁²' and the like. Since 'X' is defined to be any sequence of segments 'a₁ a₂ ... a_n' with n ≥ 0, we may think of the measure as stipulating that we count in some manner the concatenation sign which is 'officially' present in the Rule 5.1:

$$/ \text{---} \cup \begin{bmatrix} +\text{syl} \\ -\text{grv} \\ +\text{hi} \end{bmatrix}$$

but covered by the variable in 5.2.

Note that the notion of having rules of various 'levels' (depending on the hierarchy of boundary symbols, that is, morpheme-level, word-level rules, etc.), makes it unnecessary to add any special stipulations about the boundary symbols that may be covered by 'X'. Further, a rule like 5.2 makes no sense without such a hierarchy of levels. If 5.2 is a word-level rule then the stretch covered by 'X' may contain any boundaries lower than word boundaries, if phrase-level, then any boundaries lower than phrase level and so on (on the hierarchy of boundary-symbols see McCawley 1965, also Harms 1968).

5.1 Since I am not introducing a new notational convention here, but rather suggesting a method of evaluating rules involving an already widely used device, it will be unnecessary to adduce examples in any great number. The most obvious use for variables like 'X' is, perhaps, in rules for vowel-harmony and the like, where a value of some segment determines the value of all the other segments of a certain type in a 'word.' The two rules for vowel harmony in Turkish, for example, differ precisely in that 'graveness-harmony' involves an X-variable, while 'flatness-harmony' does not:

$$\text{Rule 5.3 } [+syl] \rightarrow [\alpha\text{grv}] / \begin{bmatrix} +\text{syl} \\ \alpha\text{grv} \end{bmatrix} X \text{---}$$

$$\text{Rule 5.4 } \begin{bmatrix} +\text{syl} \\ +\text{hi} \end{bmatrix} \rightarrow [\alpha\text{flt}] / \begin{bmatrix} +\text{syl} \\ \alpha\text{flt} \end{bmatrix} C_0 \left(\begin{bmatrix} +\text{syl} \\ +\text{hi} \end{bmatrix} C_0 \right) \begin{bmatrix} \circ \\ \text{---} \end{bmatrix}$$

Thus, two forms like *geldikleri* 'their having come' and *güldükleri* 'their having laughed' (Swift 1963:46) harmonize throughout in graveness, but the flatness of a sequence of high vowels is de-

termined by the immediate context. I have now rewritten 5.4 with 'X' for X-rules are rules and the like. I return to 6. Once again we are dealing with a rule involving an 'X' is measurable.

The regular correspondence analysis of the Ablaut above together with a dialects shows that the following form:

$$\text{Rule 6.1 } \begin{bmatrix} +\text{syl} \\ -\text{cmp} \\ -\text{grv} \end{bmatrix}$$

This rule remains syntactically for essentially the same reason. Apparently later than this 'X':

$$\text{Rule 6.2 } \begin{bmatrix} +\text{syl} \\ -\text{cmp} \\ -\text{grv} \end{bmatrix}$$

(The chronology is questionable, but it should be noted that the rule applies in the opposite direction, by inserting a boundary symbol when the detaching 'C₀' to 'X' immediately contiguous boundaries like OHG *hel* (Saxon) the rule is further defined by the function [-grv] from the end of 7. I now turn to a note on the conventions discussed in the previous section and five tense vowels or tense, but the situation of vowel harmony (as Sapir called it). That is, rather than a

le like 5.2 is to be counted as without the variable X. A dis- is evaluation seems somewhat of the many problems involved like 'C₀', 'C₁' and the like. quence of segments 'a₁ a₂ ... he measure as stipulating that catenation sign which is 'of-

+syl
-grv
+hi

rules of various 'levels' (de- y symbols, that is, morpheme- as it unnecessary to add any undary symbols that may be : 5.2 makes no sense without is a word-level rule then the n any boundaries lower than en any boundaries lower than rchy of boundary-symbols see

a new notational convention of evaluating rules involving ll be unnecessary to adduce ost obvious use for variables, owel-harmony and the like, rmines the value of all the a 'word.' The two rules for ple, differ precisely in that :-variable, while 'flatness-

] X —
o ([+syl] C₀) [o]

having come' and *güldükleri* 5) harmonize throughout in ence of high vowels is de-

terminated by the immediately preceding vowel (if not, that is if we rewrote 5.4 with 'X' we would get **güldükleri*). Other examples for X-rules are rules for stress assignment, consonant-harmony and the like. I return to the question of vowel harmony below (7). 6. Once again we may turn to history for evidence that a rule involving an 'X' is more general than a rule without such a variable.

The regular correspondent for IE *ei* (or *ey*) in Germanic is \bar{i} . An analysis of the Ablaut system of the older dialects as alluded to above together with a consideration of the vowel systems of these dialects shows that we may posit a rule for Proto-Germanic of the following form:

$$\text{Rule 6.1 } \begin{bmatrix} +\text{syl} \\ -\text{cmp} \\ -\text{grv} \end{bmatrix} \rightarrow [+hi] / \text{ — } \begin{bmatrix} -\text{cns} \\ +hi \\ -\text{grv} \end{bmatrix}$$

This rule remains synchronically operative in the older dialects for essentially the same reasons as those sketched above (4.2).

Apparently later this rule was generalized by the insertion of 'X':

$$\text{Rule 6.2 } \begin{bmatrix} +\text{syl} \\ -\text{cmp} \\ -\text{grv} \end{bmatrix} \rightarrow [+hi] / \text{ — X } \begin{bmatrix} -\text{cns} \\ +hi \\ -\text{grv} \end{bmatrix}$$

(The chronology is quite unclear, cf. Hirt 1931, Krause 1963. It should be noted that the generalization here can work in either direction, by inserting 'X' as above where the rule $ei \rightarrow \bar{i}$ now applies when the determining element is in another syllable, or changing 'C₀' to 'X' in which case the rule now applies to immediately contiguous segments). The rule now accounts for alternations like OHG *helfan/ hilfis*. In Old High German (and Old Saxon) the rule is further generalized by striking the specification [-grv] from the environment, so that we also get *hilfu* etc. 7. I now turn to a number of interesting cases in which both of the conventions discussed above can play a role. The first is taken from Diola-Fogny (Sapir 1965). Fogny has a set of five lax and five tense vowels. In any word the vowels are all either lax or tense, but the situation is not exactly a typical case of vowel harmony (as Sapir calls it) since tense vowels are 'dominant'. That is, rather than having a rule with alpha-variables (as in

that such a rule is probably a universal rule that does not need to be stated in the phonology of Classical Mongolian. But even if we accept Lightner's formulation we can maintain the uniform assignment of the gravity value to the first vowel of the root and restate 7.3 as follows:

$$\text{Rule 7.4} \quad \left\{ \begin{array}{l} [+syl] \\ [+obst] \\ +hi \\ [+str] \end{array} \right\} \rightarrow [\alpha grv] / \left[\begin{array}{l} +syl \\ \alpha grv \end{array} \right] X$$

By the conventions assumed above we expand this rule first into

$$\begin{array}{l} \text{Rule 7.4' A. } [+syl] \rightarrow [\alpha grv] / \left[\begin{array}{l} +syl \\ \alpha grv \end{array} \right] X \\ \text{B. } \left[\begin{array}{l} +obst \\ +hi \\ -str \end{array} \right] \rightarrow [\alpha grv] / \left[\begin{array}{l} +syl \\ \alpha grv \end{array} \right] X \end{array}$$

Then into

$$\begin{array}{l} \text{Rule 7.4'' A. } [+syl] \rightarrow [\alpha grv] / \left\{ \begin{array}{l} \left[\begin{array}{l} +syl \\ \alpha grv \end{array} \right] X \text{---} \\ \text{---} X \left[\begin{array}{l} +syl \\ \alpha grv \end{array} \right] \end{array} \right\} \\ \text{B. } \left[\begin{array}{l} +obst \\ +hi \\ -str \end{array} \right] \rightarrow [\alpha grv] / \left\{ \begin{array}{l} \left[\begin{array}{l} +syl \\ \alpha grv \end{array} \right] X \text{---} \\ \text{---} X \left[\begin{array}{l} +syl \\ \alpha grv \end{array} \right] \end{array} \right\} \end{array}$$

The convention for expanding the remaining abbreviations is that rules with 'X' apply first to the longest domain possible, then the next longest etc. (Harms 1968). Now it can be easily seen that 7.4 operates correctly. First all vowels in a word are made to agree in gravity with the first vowel (necessarily the first vowel of the root in Classical Mongolian). The second part of 7.4'' A applies vacuously. Now, the rule (7.4'' B) applies to bring all velars into line with the vowels whether they follow or precede

the vowels.

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7.2. One morpheme fea
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arsal rule that does not need classical Mongolian. But even we can maintain the uniformity of the first vowel of the root and

$$[rv] / \begin{Bmatrix} [+syl] \\ [\neq grv] \end{Bmatrix} X$$

we expand this rule first into

$$v] / \begin{Bmatrix} [+syl] \\ [\neq grv] \end{Bmatrix} X$$

$$] / \begin{Bmatrix} [+syl] \\ [\neq grv] \end{Bmatrix} X$$

$$] / \left\{ \begin{array}{l} \begin{Bmatrix} [+syl] \\ [\neq grv] \end{Bmatrix} X _ \\ _ X \begin{Bmatrix} [+syl] \\ [\neq grv] \end{Bmatrix} \end{array} \right\}$$

$$] / \left\{ \begin{array}{l} \begin{Bmatrix} [+syl] \\ [\neq grv] \end{Bmatrix} X _ \\ _ X \begin{Bmatrix} [+syl] \\ [\neq grv] \end{Bmatrix} \end{array} \right\}$$

in abbreviations is that in the domain possible, then the rule can be easily seen that the first vowel in a word are made to be necessarily the first vowel of the second part of 7.4" A) B) applies to bring all the vowels they follow or precede

the vowels.

Zimmer (1967) has presented several arguments against Lightner's use of an abstract root marker GRAVE for languages like Classical Mongolian, Finnish and Turkish (although at the end of his note he seems to retract that position). There is no need to repeat his discussion here. It seems to me, however, that there is one cogent argument against a treatment like that of Lightner's which has not been put forward. Rule 7.3 looks like a very straightforward and simple rule but its generality is spurious. Note that the feature GRAVE is a completely ad hoc feature which has nothing to do inherently with the phonological feature 'grave'. It bears no more relation to the phonological feature of gravity than would, say, the features NOUN or ANIMATE. Moreover, unlike the latter features it plays no role in the language outside of just this rule. If we consider that such ad hoc features are allowable there is nothing to prevent us from effecting the following 'economy' in a language like German or English. In German there is, of course, no constraint on the kinds of vowels (say, in terms of gravity) which can occur in a word or root. Nevertheless, a significant portion of the lexicon will consist of items which exhibit only grave or non-grave vowels. Suppose we set up the abstract markers HARMONIC and GRAVE. Now we can leave out the specification of the phonological feature of 'grave' for all items which are marked +HARMONIC and reintroduce these 'predictable' specifications by a rule very much like 7.3 (applying to words like *Makulatur, Uhu, Esel, Auto, Kuckuck, Popo, Vopo, Natur*, etc.: note that we can exploit various further 'generalizations': all monosyllables are predictably +HARMONIC: if a form consists of two syllables and is -HARMONIC, then the gravity of the second vowel can be predicted from that of the first, and so on).

7.2. One morpheme feature which is typically relevant to situations of vowel harmony is one which is not ad hoc like GRAVE but rather independently justified, namely the feature which distinguishes roots or stems from affixes. It seems that such a distinction often plays a role throughout a phonological system, especially in determining stress assignment and the like, but also in determining segments. Thus, in German, inflectional suffixes are built out of a very small subset of the segments of the language; moreover, the selection of the segments seems to exploit the maximal differentiations in the system: one stop /t/, one spirant /s/, one liquid /r/, one vowel /ə/, one nasal /n/ (with

minor exceptions). Further, it seems likely that we can define this distinction in a quite natural way in terms of the machinery of a grammar: by and large, lexical elements will be -AFFIX, everything else +AFFIX. That is to say, it is not necessary to mark elements for this feature (as it is for GRAVE), since it is predictable in a language-independent way.

Zimmer adduces Igbo as an example of a language in which both suffixes and prefixes harmonize.⁸ In such languages one can give a straightforward rule corresponding to the statement: the tenseness of the vowel in an affix is determined by the tenseness of the vowel of the root. Zimmer takes such situations as precisely those in which we would use Lightner's solution by use of a morpheme feature like TENSE, but with the feature AFFIX it is not necessary to use any such ad hoc device:

$$\text{Rule 7.5} \quad [+syl] \Rightarrow [\approx tns] / \left[\begin{array}{c} +syl \\ \approx tns \\ -AFFIX \end{array} \right] X$$

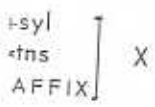
Note that the adoption of the various conventions used here--the neighborhood convention for after and before (in that order), the expansion of rules with 'X' to apply first to the longest domain--and the principle that rules must be stated in the most general possible way lead us to a decision that it must be the first vowel of a stem or root that is distinctively marked for the feature in question: graveness in Finnish, Turkish, Mongolian, tenseness in Igbo, Ijo (Williamson 1965). We know of languages where this is the correct decision, namely those in which the rules for

8-There seem to be a number of such languages in West Africa. Jakobson, Fant, Halle (1951:59-60) also mention Bari and Maasai--incidentally the reference given (p. 61) to Tucker and Mpaayei 1955 is wrong: p. 260 is a page in the glossary, apparently what is meant is 240 but see the entry in the index under 'vowel harmony' for a number of cases where affixes determine the quality of vowels in the root. I suspect that the system is of the kind considered above for Fogy.

determining vowels of stem value for vowels within there are no independent last vowel to be distinctively redundant. In such languages where the choice of vowels leads to incorrectness, in which there was (and only) harmonizing prefix and last vowel as distinctively marked for situations like view that (at least in the majority of cases) is predominantly progressive (when one vowel is marked, the other is not, as in Nez Perce, Aoki: 1965). I take this as being a reality of the proposed system.

9-The arguments here do not show that a logical rule can be used to effect a change in morphemes and to effect a change in the framework have made several unpublished treatments (Lightner 1965). Without a logical rule can be used to decide which morpheme for the feature in question forces us to favor progressive within morphemes. It is difficult to be used to support this independence (predominance of progressive again (cf. fn. 4, end) the involved.

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determining vowels of suffixes can also be used to determine the
 value for vowels within the root.⁹ We know of languages where
 there are no independent grounds for choosing the first or the
 last vowel to be distinctively specified for some feature elsewhere
 redundant. In such languages, there is no reason to follow our
 conventions, but there is likewise no reason not to. I know of no
 languages where the choice forced on us by the conventions sug-
 gested leads to incorrect results. Such a language would be one,
 say, in which there was vowel harmony within the root and also
 (and only) harmonizing prefixes which would lead us to set up the
 last vowel as distinctive. The use of the neighborhood conven-
 tion for situations like vowel harmony, in short, expresses the
 view that (at least in situations like vowel-harmony) the direc-
 tion is predominantly progressive, possibly progressive and re-
 gressive (when one value is dominant like in Fagny or, apparent-
 ly, Nez Perce, Aoki: 1966: or when lexical elements determine
 affix elements as in Igbo, Ijo, etc.) but never purely regressive.
 I take this as being strong evidence in favor of the linguistic
 reality of the proposed convention.

9-The arguments here depend in part on the assumption that a phono-
 logical rule can be used both to fill in redundant specifications within
 morphemes and to effect alternations in affixes and the like. In fact, all
 linguists that I know of who have dealt with vowel-harmony in a genera-
 tive framework have made this assumption (Lees 1961; McCawley in
 several unpublished treatments of Finnish: Harms 1966b; Zimmer 1967:
 Lightner 1965). Without this assumption no morphophonemic evidence
 can be used to decide whether to mark the first or last segment of a mor-
 pheme for the feature in question. The adoption of the notation still
 forces us to favor progressive assimilations over regressive ones even
 within morphemes. It is difficult to see what synchronic evidence could
 be used to support this idea. It may be possible to use historical evi-
 dence (predominance of progressive assimilations?), although it seems
 again (cf. fn. 4, end) that something more than a purely formal device is
 involved.

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