PROBLEMS AND PERSPECTIVES IN THE DESCRIPTION OF VOWEL HARMONY

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1. Introduction. Among the fairly large stock of terms inherited by modern linguists from the (by now often dim) tradition of phonetic research in the nineteenth century, "Vowel Harmony" is notable both for the apparent distinctiveness of the phenomenon to which it refers, and for its typological utility in classifying languages. As exemplified in languages such as Turkish and Hungarian, the dependencies between vowels in adjacent syllables to which we give this name form one of the standard examples of a phonological process. Hardly any elementary text in linguistics, structuralist, generativist or otherwise in its orientation, fails to illustrate the notion of phonological (or morphophonemic) rule with a case of vowel harmony. There is also an extended specialist literature on the topic, dealing both with general problems and with the analysis of specific languages. Despite this general feeling that vowel harmony is a well-understood category of phonological process, there is less of a consensus among phonologists than meets the eye as to just what the characteristics are that set vowel harmony apart from other types of rule.
As is often the case with traditional terms, we have a good idea of certain central cases which we would call vowel harmony systems, but much less of an idea of how we would go about defining the class other than extensively. Thus, vowel harmony is something that Turkish has, that Hungarian and Mongolian, as well as Finnish, also have; we have probably heard that some (which?) African languages have a form of it, and maybe some American Indian languages, of which Nen Perce is probably the most notorious (at least for readers of the Sound Pattern of English). It is clear that it consists of a systematic relation between vowel qualities in successive syllables of a word; but it is unlikely that many would be willing to call any such systematic relation 'vowel harmony'. We can thus raise the question of how we might define vowel harmony in precise (but general) terms, and of how we might distinguish it systematically from related processes.

2. Definitions of Vowel Harmony. Aside from concerns of philological precision in interpreting the work of traditional phoneticians, the principal reason for attempting to define such a notion is the feeling that it might tell us something: that 'Vowel Harmony' represents a cluster of consistent properties that go together, such that if we were to find certain critical ones in a new language, we could expect to find the other, consequential, ones as well. Further, when a set of properties go together in this way, we can suggest that an adequate theory of phonological structure ought to be constructed so as to have this clustering fall out as a consequence of general principles. The descriptive system provided by the theory, that is, ought to be such that the only way to describe a system with the criterial properties will have the others as consequences. Isolating such regular connections among p

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connections among phenomena, then, is a fundamental task involved in the construction of phonological theories. When we look at potential definitions, we will thus be concerned both with the way in which a proposal captures our intuitions about the basic properties of our 'central' cases, and with the extent to which it identifies features that are regularly found in association with each other.

2.1. Metaphony? Vowel Harmony is sometimes used loosely as synonymous with the general term 'metaphony', a dependence of the quality of a vowel on that of a neighboring syllable. This usage is obviously far from our central group of cases: an instance of (vowel) dissimilation should surely not be comprehended by the term. In Wolelian, for example (cf. Schu, 1975), /a/ is replaced by /ɛ/ before a low vowel (/a/ or /ɔ/), resulting in an alternation such as that between [mɛɛmɑə] 'moon' and [mɛɛmala] 'moon of'. The root here is /mərɔmə/: in the first form, the final /a/ is devoiced and shifted to [ɛ], while in the second devoicing affects the (final) /ɛ/. The first /a/ is then dissimilated in the first form; in the second form, dissimilation of the second /a/ eliminates the environment for dissimilation of the first. In any event, the first and second vowels in these examples show a dependence of quality on neighboring syllables, but obviously not vowel harmony in any significant sense.

2.2. Vowel assimilation? We might suggest then that only assimilatory influences count as vowel harmony: certainly the 'classical' harmony systems are assimilatory in character. It is not hard to see that this definition would still be too inclusive, however. Modern Uighur, for example (cf. Anderson, 1974:62ff and references there)
is subject to a rule raising and fronting /a/ or /o/ to [e] in initial unstressed syllables when the following syllable contains /i/: thus, /æ+i+ø+mæq/ becomes elinnq 'to be taken'. This process is certainly an assimilatory dependence of vowel quality on that of neighboring syllables, but while this is a Turkic language, and Turkic languages contain vowel harmony rules, this isn't one of them. It is rather an instance of the distinct category of Umlaut rules, and if we were to include all such under our definition, we would not have captured the essence of the notion of vowel harmony.

2.3. Progressive vocalic assimilation? One obvious difference between the Uighur umlaut rule and the 'classical' vowel harmony cases is that, while the latter typically involve the dependence of suffix vowels on the vowels at the beginning of the word, an umlaut rule typically operates from suffixes and affects earlier vowels in the word. We might suggest then that vowel harmony is definable as progressive (left-to-right, perseverative) assimilation of vowel quality. This suggestion, too, can be shown to be inadequate, however: it is both too comprehensive and too exclusive to capture the canonical notion of vowel harmony. On the one hand, consider the facts of the phonology of Chamorro (cf. Topping, 1973). In this language, when a word whose first vowel is [+back] is preceded by a particle containing a front vowel, the vowel is fronted:

(1) a. hulat 'tongue', i hulat 'the tongue'
   b. fagon 'stove', i fagon 'the stove'
   c. tahi 'man', i tahi 'the man'
   d. tigo 'to know', in tigo 'we (excl.) know'
      en tigo 'you (pl.) know'
   e. hulo 'up', i hilo 'in the direction up'

This is probably harmonic: not the fact that indeed Topping reported the fact that (as well as the fact that) on stems, rather than reasonable to treat umlaut, insofar as it was. Simply as vocalic assimilation.

On the other hand, excluded by the systems found in other languages (Turkish, etc.) by some determinant (almost) between (almost) the Uralic and Al signifiant phenomenon of vowel ha.

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This is probably closer to the notion of what 'vowel harmony' ought to be like than our previous examples, and indeed Topping refers to the process as vowel harmony, but the fact that it can affect only one vowel at a time (as well as the fact that it is an influence of affixes on stems, rather than the other way around) makes it more reasonable to treat it as a (progressive) variant of umlaut, insofar as these two processes are to be distinguished. Simply saying that vowel harmony is a progressive vocalic assimilation is too loose a definition, then.

On the other hand, some vowel harmony systems would be excluded by this definition. As we will see below, the systems found in African, American Indian, and some other languages differ from the Finnish, Hungarian, Turkish, etc. type (in part) in being bi-directional: the harmonic effect spreads outward in both directions from some determinant vowel. This correlates with a difference between (almost) exclusively suffixing languages, as in the Uralic and Altaic cases, and languages that allow significant prefixing as well as suffixing. The phenomenon of vowel harmony, then, is probably best not restricted to progressive assimilations.

2.4. Distant vocalic assimilation? We noted above that one of the difficulties with the definitions suggested thus far is that they admit of cases like the Chamorro one, in which only one vowel can be affected by the operation of the rule (despite the presence of other vowels in the word). We might suggest, therefore, that the essential nature of vowel harmony involves action at a distance: spreading its effects over an extended domain, rather than only a single syllable. Again, however, we can see that this is not all of the story. A process like Icelandic μ-Umlaut (cf. Anderson, 1974 and references
there), which replaces /a/ by /ʊ/ if the following syllable contains /u/, would certainly not be called 'vowel harmony'; and yet, due to the effects of another rule in the language (a rule of vowel reduction, turning unstressed /ʊ/ into /u/), this rule's effects can spread to an extended domain. Underlying /banʊn+um/ becomes, by umlaut, /banʊn+un/; reduction converts this to /banun+un/; and then umlaut can apply again to derive surface bonunum 'bananas (dat. pl.).' Such spreading of the effects of umlaut does not, presumably, qualify it as a 'vowel harmony' system. A similar example is furnished by the umlaut rule in Takelma (cf. Sapir, 1922). This replaces non-stem /a/ by /i/ when the following suffix contains /i/, provided the intervening consonants are all voiced. Such a rule can derive [ikumixininink] 'he will fix it for him' from underlying /ikumanarinink/ by repeated application, but still seems unlike the core sense of 'vowel harmony'. Basically, any rule whose output includes segments that can also serve to condition its operation can, if allowed to reapply, have effects across an extended domain; but while this may be part of the notion of vowel harmony, it is surely not a sufficient criterion.

2.5. A cluster of properties? There does not seem, from the above survey, to be any single, simple property that precisely characterizes vowel harmony systems. The most serious treatments of this question to date, therefore, have assumed that this class of processes is defined by the intersection of several criteria. Clements (1977a), following in part Ullman (1973), presents a set of five properties: a) phonetic motivatedness; b) root control; c) bidirectionality; d) unboundedness; and e) nonoptional. These (as well as others, perhaps) are supposed to be characteristics of all vowel harmony systems, and as

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Clements notes, if this is the case it is important that phonological theory be constructed in such a way as to make the conjunction of these properties a natural consequence of general principles. Clements argues further that a particular view of phonological structure, that of "Autosegmental Phonology", has this desirable result; we will examine that view below in section 3, but at this point it is worthwhile to examine the extent to which the properties cited constitute necessary and sufficient conditions for vowel harmony systems.

2.5.1: Phonetic Motivatedness. The substance of this condition is the requirement that vowel harmony processes stipulate requirements of identity with respect to features that have independent phonetic motivation and validity. Thus, harmony systems typically operate in terms of the features [\textit{back}], [\textit{round}], [\textit{thigh}], and some feature(s) of tenseness, tongue-root position, or the like. A classification of harmony systems on the basis of the features involved is, in fact, a possibility which we will assume implicitly in section 3 below.

Despite the fact that most harmony systems operate in terms of phonetically well-motivated features, however, there are others in which this basis is absent, but which we would probably want to call vowel harmony nonetheless. An obvious example is the harmony system in Nez Perce: here the two harmonic sets are \{i, u, a\} and \{i, o, a\}; and no phonetic basis is apparent. Indeed, it is hard to see how any phonetically motivated feature could be found to separate harmonic sets in any case where the same vowel belongs to both.

Harmony in Nez Perce and similar systems, though, differs in other ways as well from the 'classical' model, and we might want to restrict the claim of phonetic
motivatedness to systems of the Uralic and Altaic type. Even here, however, it is easy to see that historical change can destroy the phonetic basis of a harmony system. For example, in Burjat Mongolian, the original diphthongs /aj/ and /oij/ have become [æː] and [ɔː], respectively. Since the nuclei of these original diphthongs were back vowels, they behaved harmonically like other back vowels; and this behavior has persisted despite their shift to (phonetic) front vowels. The set of harmonic back vowels in modern Burjat thus consists of the phonetic back vowels plus æː, ɔː; while the harmonic front vowels are the phonetic ones with the exception of these two. Binnick's paper in this volume (Binnick, 1980) gives further discussion of these and related facts, as well as more detailed references. While the historical basis of this non-phonetic character of the harmony system is clear, this does not change the fact that, from a synchronic point of view, such harmony systems do not have the property of phonetic motivatedness.

Indeed, a particularly dramatic example of this type is furnished by Khorchin Mongol (cf. Poppe, 1965). In this language, a number of changes have taken place over time:

(2) a. *ə > å, *o > ø (central vowels)
   b. *u > u, *u > ø, *ø > ɔ
   c. *o > ɔ, *æ > ɔ /C/ ̄
   d. *i > ɪ

As a result of these changes, the harmonic sets of Khorchin are those in (3):

(3) a. "front" vowels: å, ɔ, u, ü, ɪ;
   b. "back" vowels: æ, ɔ, ø, ɔ;
   c. "neutral" vowels: i

It is difficult to imagine a system with less 'phonetic motivatedness', though again a historical motivation in
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terms of a well-motivated, phonetically coherent system is apparent. We must conclude, however, that synchronic vowel harmony systems are not, in the general case, restricted to those displaying such a phonetic basis; and thus that this is not a necessary condition.

2.5.2. Root Control. This principle refers to the fact that vowel harmony systems operate generally in terms of the effects of root vowels on affixes, rather than the other way around. Clements notes, however, that there is a well defined and frequently encountered type in which this is not the case. Vowel harmony in the Sahaptian languages (including Nez Perce), Luorewalian (including Chukchee), Diola Fogny, the Kalenjin languages, and others is based on a division between 'dominant' and 'recessive' vowels. The principle is that if a word contains a single instance of a 'dominant' vowel, all vowels must be (shifted into) the dominant set, regardless of whether the 'dominant' vowel is in the stem or in an affix. Only if all of the formative of which a word is composed have basic 'recessive' vowels can the surface form have vowels from this set. In these systems, stems do not generally have a privileged position (though in some cases, such as Igbo, they may be the only elements with basic vowels from the 'dominant' set, and thus the principle of root control may be adhered to). Root-control is thus not a necessary condition for vowel harmony; though we can note that there are apparently no systems in which suffixes exclusively control harmony. Vowel assimilations controlled only by suffixes seem to be limited to Umlaut rules.

2.5.3. Bidirectionality. We noted above in section 2.3 that in many vowel harmony systems (especially those of the 'dominant/recessive' type), harmonic influence spreads out in both directions from a determinant vowel.
Furthermore, in systems of the Uralic and Altaic type, where harmony seems to operate exclusively progressively (left-to-right), we might ascribe this to the accident that the initial vowel is the determinant of harmony (in line with an original position of stress, perhaps; cf. Binnick, this volume), and that these languages are (almost) exclusively suffixing. Such a system could be said to be potentially bidirectional, that is, but simply to lack any material to the left of the determining vowel to which the harmony could apply.

This line of explanation for the progressive harmony shown by Turkic, Mongolian, etc. languages, however, is probably not adequate. It is true that the most basic cases of vowel harmonic alternations in these languages do not present the possibility of bi-directional application; thus, the Finnish alternation displayed by *kumartamatt* 'without bowing' vs. *ymmärämätt* 'without understanding (it)' is produced by a rule which presumably spreads its effects from the root vowel; since this is initial, it would not be possible to observe an effect in the regressive (right-to-left) direction. In many harmony systems, however, there are exceptional or non-alternating affixes; and since these can appear in post-initial syllables, they could potentially give rise to opportunities for regressive harmony. Yet the case apparently is, that suffixes such as the celebrated Turkish */lycr+/, marking progressive and displaying an invariant rounded vowel, do not cause regressive rounding, despite the generally exceptionless character of Turkish rounding harmony - even in dialects without the process of 'palatal-umlaut' unrounding. This rule is, as argued by Zimmer (1967), exclusively a progressive assimilation.

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exceptions to the most straightforward form of this rule. As detailed by Johnson (1980) in this volume, the process of palatal umlaut may in several languages require that vowels preceding /y/ (sometimes other consonants as well) be front. When we examine a form like Kirghiz kéliägymin
'I don't make', therefore, we can note that a) the (umlauted, and thus) front vowel of the second syllable causes the final vowel to be front by harmony; but b) it does not cause the first vowel to front. The harmonic effects of this vowel thus operate progressively, but not regressively; and we can therefore see that the rule is not even potentially bidirectional. We must conclude that bidirectionality is not, in fact, a necessary condition for vowel harmony rules.

2.5.4. Unboundedness. In section 2.4 above, we discussed the fact that vowel harmony processes typically affect substantial stretches of a word (or 'domains'), rather than being limited (in principle) to a single vowel. Of course, the existence of exceptions such as those created by palatal umlaut, or lexically invariant vowels, which delimit the scope of a particular harmonic domain imposes a kind of restriction on the degree of unboundedness displayed by the process. This is still quite consistent with the conception of harmony as spreading as far as it can, rather than being strictly local. On the other hand, we saw above that there are other sorts of vocalic assimilations which should probably not be called vowel harmony, but which display similarly non-local effects. Unboundedness, therefore, is probably a necessary but not sufficient condition for a rule of vocalic assimilation to be considered 'vowel harmony'.

2.5.5. Non-optionality. Obviously, many rules in a grammar (including rules of vowel quality assimilation such
as Umlaut and others) are non-optional, and there is no
to question of this being a sufficient criterion for vowel
harmony processes. On the other hand, vowel harmony is
not in general the sort of thing that shows up in rapid
speech or other stylistically governed phenomena. It is
possible that this impression is due to the general lack
of serious documentation of such features for most lan-
guages: it would be interesting to know if, in languages
that have lost vowel harmony such as the mongolian cases
discussed by Binnick (1980), there was a stage at which
for at least some speakers the application of the rule was
optional or controlled by speech style. Nonetheless, in
the absence of any evidence for such a stage (and we should
note that mere orthographic fluctuation probably would not
count as serious evidence by itself), it is apparently
the case that vowel harmony, where found, is an obligatory
process.

One possible counterexample to this claim, however,
depends on the analysis of vowel harmony adopted for
Hungarian. As discussed abundantly by Vago and by Ringen
(in their contributions to this volume and elsewhere),
certain words in Hungarian have two optional vowel-harmonic
variants: e.g., for Ágnes we can have either Ágnesnek
or Ágnecek. It is hard to see a way in which these could
be treated without saying that somewhere in the operation
of the vowel-harmony process there is an optional rule
- in fact, both Vago and Ringen (while differing substan-
tially on the details) propose that an optional subpart of
the vowel harmony schema is involved. Clements (1977b),
on the other hand, posits an optional rule disassociating
a feature from the second vowel: this has the effect that
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but the evidence at present seems to favor such a claim.

We must conclude, therefore, that while Clements'
criteria point up important characteristics shared by
most vowel harmony systems, they still do not furnish the
required basis for a set of necessary and sufficient cri-
teria for differentiating vowel harmony from other types
of metaphor. We might further note, indeed, that any
theoretical principles which had the property of requiring
these properties to be co-present in a linguistic system
would actually be disconfirmed by (the full range of)
extant vowel harmony systems.

3. The Mechanisms of Vowel Harmony. Although our
efforts to define vowel harmony rigorously in terms of
properties or the rule(s) involved were not ultimately
successful, there is another and potentially more interest-
ing line to take on the problem. It is sometimes suggest-
ed in the literature that the distinctive feature of
vowel harmony is not so much the effect it achieves, but
rather the mechanism by which it operates: that is, that
other sorts of vocalic assimilation are strictly local
processes, applying one step at a time (even if, by
reapplication, this ultimately results in application
across an extended domain), but that vowel harmony involves
a simultaneous association of a unitary harmony property
with an entire domain. One instance of such a treatment
is Lyons' (1962) discussion in terms of prosodic analysis;
another with essentially the same property is Lightner's
(1965) treatment of harmony in terms of 'root markers'.
Yet another version of this sort of analysis is provided
by Clements' (1977a,b,c) 'autosegmental' account, which we
will discuss below. This issue of the mechanism by which
vowel harmony achieves its effect is potentially of some
importance to the question of definition we address here: if vowel harmony could be shown to operate by means of a fundamentally different principle than other vocalic assimilations, that principle might itself be the necessary and sufficient criterion we seek.

3.1. Types of assimilatory change. To set the stage for a consideration of vowel harmony in this regard, we can begin by distinguishing three quite different sorts of process. Each seems to involve a distinct mechanism, and each is well attested as the appropriate treatment for some domain of linguistic phenomena.

3.1.1. Assimilatory changes sennu strictu. Clearly, some rules have the property of simply altering the value of some feature(s) of a segment, under conditions which are established by the copresence in its environment of some relevant influence. A dissimilation is a clear instance of this: the new feature values assigned by the rule may be motivated by a neighboring segment, but they cannot be identified with the content of that segment. In some instances, assimilations can plausibly be said to have this character. Thus, in Icelandic k-umlaut, the vowel /a/ acquires certain features if the following vowel is /a/. The point to note is that it does not become /u/ (unless, of course, some other rule operates on it later): the environmental influence is thus not transferred, but rather serves to motivate an assimilatory shift in the composition of the affected vowel itself. This is the classical model for the operation of all rules in a generative phonology: its distinctness, as well as the probability that it is not (as previously maintained) the only mechanism by which phonological effects are manifested, will perhaps be clearer in light of the contrast presented by other types of change to be discussed below.

3.1.2. Contrast to the class of processes in languages of Afr: example, a sequent replacing the high consonant is voiced (perhaps all: cf. such a rising tone of low plus high nucleus: the fact low tone is thus not the relevance key to the nature of the form will be formulated as an appropriate posit if would be unexplained, change, however: element, but rather over more than the known (but little 1978) correlation can be invoked as a rule. Such a something of a factor be argued for the cf. Anderson, 19

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3.1.2. Changes involving feature spreading. In contrast to the classical model of change in feature value, we can consider the appropriate mechanism for the description of processes such as the spreading of tone in various languages of Africa (cf. Schuh, 1978). In Nupe, for example, a sequence of low tone plus high tone is altered, replacing the high with a rising tone, if the intervening consonant is voiced. Now for a variety of examples (perhaps all; cf. Anderson, 1978) it can be argued that such a rising tone ought to be represented as a sequence of low plus high realized on a single vowel or syllable nucleus: the fact that this change takes place after a low tone is thus indicative of its assimilatory character. But the relevance of the intervening consonant provides a key to the nature of the change. A traditional rule might well be formulated to insert a low tone element in the appropriate position; but the relevance of the consonant would be unexplained. There is another way to view this change, however: not as the addition of a new low tone element, but rather as the extension of the domain of original low tone of the first syllable, so that it extends over more than its original scope and persists into the beginning of the next syllable. On that view, the well known (but little understood: cf. Hombert, 1978; Anderson, 1978) correlation between voiced obstruents and low tone can be invoked as more than an arbitrary complication of the rule. Such an analysis of tone spreading is by now something of a commonplace; and a similar account can also be argued for the treatment of nasal spreading phenomena (cf. Anderson, 1976).

Essentially, then, we recognize a distinction between rules that add, insert, delete or permute feature specifications (the classical mode of operation of phonological
rules) and those that simply alter (by expanding or contracting) their domain. The study of such rules is still in its infancy, but there is every reason to believe that they will have quite different formal properties from the first variety, and thus that the classification of a phenomenon as one or the other is a matter of potential import for its integration into the rest of the description of a language.

3.1.3. Rules of 'prosody' assignment. Again, the primary source for the study of this formal type is the phonology of tone. Many languages appear to display the following type of tonal behavior: some category, such as a particular combination of tense/aspect within a verbal conjugation, is associated with a constant tonal pattern: e.g., high-low. This pattern is then realized on the segmental material of the relevant verb, without essential regard to the number of syllables available. If the verb has two syllables, that is, they will be assigned one tone each (high, then low); if there is only a single syllable, however, the entire contour will appear on that syllable, as a falling tone: while if there are more than two, the first will be high and all succeeding syllables low. Such systems are abundantly documented in tone languages all over the world.

The essential nature of this operation consists in the fact that the tonal pattern is essentially independent of the segmental material, and the correspondence between them is only established by the operation of a rule. This is in contrast to the tone-spreading case: there, the tone is (originally) associated with a particular segment or syllable, and this domain is systematically altered by the spreading rule. Here, however, the tonal pattern has no intrinsic connection with any particular syllable, independently of analysis of vowel especially clear abstract root mar it (by convention root. The intrinsic the segments, how whole. The process of this prosodic segments, then, is a feature specific process by which changed, added, d

Analyses of three types of ch from the literature interesting demon vowel harmony is character in these: it seems clear that metaphor can be first, or 'classi' this would lie in character of either process. These p

3.2. An arg analysis of vowel would take the fo: (disregarding for would be distinct: while other root unmarked or marked rule, having locat
independently of the assignment rule. Lightner's (1965) analysis of vowel harmony displays this sort of treatment especially clearly. Lightner proposes to represent an abstract root marker [i:GRAVE] with roots, and associate it (by convention) with the independent segments of the root. The intrinsic connection of the marker is not with the segments, however, but rather with the root as a whole. The process by which a single element or pattern of this prosodic sort is associated with a sequence of segments, then, is distinct both from the process by which a feature specification may alter its domain and from the process by which feature specifications are directly changed, added, deleted, etc.

Analyses of vowel harmony as (in essence) any of the three types of change distinguished here can be cited from the literature. For our purposes, however, the most interesting demonstration would consist in showing that vowel harmony is an assimilation which has a different character in these terms than other sorts of metaphony. It seems clear that many, if not most, other sorts of metaphony can be adequately treated as instances of the first, or 'classical' type - and thus the best hope of this would lie in showing that vowel harmony has the formal character of either a spreading or a prosodic assignment process. These possibilities will be examined below.

3.2. An argument against 'spreading' analysis. An analysis of vowel harmony in terms of a 'spreading' rule would take the following form. Some vowel(s) in the root (disregarding for the moment non-root-controlled systems) would be distinctively marked for the harmonizing feature, while other root vowels and affix vowels would either be unmarked or marked in some irrelevant way. The harmony rule, having located the determining vowel, would then
extend the scope of its specification so as to include all of the other material within the relevant domain; typically, either up to word boundaries or until a harmonically invariant, exceptional vowel is encountered. As a result, the single original feature specification is now relevant to the entire span encompassed by the harmony.

We can note immediately one consequence of such an analysis: it entails that nowhere within a harmonic domain should we find an instance of a segment that must be specified with a contradictory value of the feature that is involved in the harmony. If such a feature is found, of course, then it could not be the case that the harmonic determinative feature took the entire domain as its scope. If we had reason to believe that harmonic processes frequently allowed the appearance of such 'counter-harmonic' features within a domain, we would therefore have reason to reject the 'spreading' treatment of vowel harmony.

Counterevidence of this sort seems to be available, in the fact that vowel harmony rules frequently allow for the appearance of 'neutral' vowels. These are simply the vowels which can intervene between the determinant of a harmonic domain and some of the vowels affected. Now of course if such neutral vowels were never significantly specified for the features in terms of which harmony operates, this fact would cause no difficulties for the analysis; but this is not generally the case. In Finnish, for instance, the two harmony sets are ä, ö, y (=u) and a, ą, u; the harmony operates in terms of the feature [back]. The vowels i, e are neutral; thus, puhelin 'telephone' contains a back vowel and two neutral vowels, and is thus harmonically back: cf. partitive puhelinta. Note that in this word two neutral vowels intervene between the harmonic determinative (u) and the end of its domain (u). Both of these vowels are in fact specified for the harmonic feature: they occur within the entire span encompassed by the harmony.

Under certain conditions, assimilation of vowels can occur within a harmonic domain, and such a process will be documented from vowels, and suggested generally available.

That could itself focus is excluded stronger, as well as the environment in which the neutral vowels appear: the most plausible front quality of the neutral vowel is taken as a determinant for the harmonic determinative, but not for Ha.
harmonic feature: they are [-back] vowels. Since they occur within a [+back] domain, however, we cannot consider that a single instance of the feature [+back] takes this entire domain as its scope. Such examples can be documented from most vowel harmony systems with neutral vowels, and suggest that a 'spreading' analysis is not generally available for such languages.

Under certain highly restrictive assumptions about the application of rules, in fact, it might be possible to extend this argument so as to bring it to bear against assimilation analyses as well. It has been suggested (cf. Howard, 1972; Jensen, 1974) that constraints should be imposed on the material that can intervene between the 'focus' (roughly, the affected segment) and the 'determinant' (roughly, the significant part of the environment which allows the rule to apply) of a rule. Howard's "crossover constraint" and Jensen's "relevancy condition" both suggest that only 'irrelevant' material can intervene. For Howard, this means only material that could itself undergo the rule (i.e., another potential focus) is excluded; Jensen's condition is somewhat stronger, as well as more complex, but would exclude the appearance of another potential determinant within the environment in the case of vowel harmony rules. Now we can note that in Finnish, it is arguably the case that the neutral vowels serve sometimes as determinants of harmony: all-neutral vowel words, except those with certain derivational suffixes (cf. Riparsky, 1973), generally take front vowel affixes, and as Riparsky notes, the most plausible account of this is to say that the front quality of the neutral vowels themselves serves as determinant for harmony, if there are no non-neutral vowels available. Jensen notes the difficulty presented by this example for his condition, and suggests some
alternative accounts for vowel harmony in Finnish; but in the absence of positive evidence against the incorporation of Kiparsky's rather natural observation into the rule, we must conclude that Finnish vowel harmony is not subject to his condition.

There are at least two possible reactions to this fact. 1) We might conclude that Jensen's condition is simply incorrect. This would be an unfortunate consequence, however, since it expresses at least part of a quite natural insight about the operation of phonological rules: that phonologically conditioned processes (as opposed distinctly to morphologically conditioned ones: cf. Anderson, 1979) are generally 'local' in character. 2) Alternatively, we might conclude that Jensen's constraint is applicable to certain types of rules and not to others. We have discussed elsewhere (Anderson, 1979) facts that show it is not applicable to morphologically conditioned rules, which is not particularly surprising. On the other hand, the argument given at the beginning of this section is based on the apparent inevitability of this constraint (or one similar for all relevant purposes as far as vowel harmony is concerned) being applicable to processes of the sort described as 'spreading' rules. Jensen's examples include some such as the dissimilation of aspiration in Sanskrit and Greek by 'Grassmann's Law' and Navajo strident assimilation, rules which must apparently be described as classical assimilations rather than as spreading or prosody-assignment rules. If we conclude that the relevancy condition is generally applicable to such assimilations, the facts of Finnish vowel harmony might be taken to show that vowel harmony is actually a rule of a different type. We would therefore seem to have settled on the third rule-type suggested above, a rule of pre-elimination. We will argue against such an approach.
n Finnish: but not the incorporation into the harmony is not
tions to this condition is unattainable constitute part of a phonological process (as ditioned ones: in character. Jensen's consist rules and not to arson, 1979) morphologically surprising, the beginning of the ability of relevant purposes of applicable to ing' rules. dissimilation assmann's Law' which must appa- rions rather. If we generally applic- innish vowel harmony isuld therefore suggested above, a rule of prosody-assignment, by process of elimination. We will see below, however, that the case against such an account is strong enough to show that the real moral of the Finnish facts is simply that the relevancy condition is in need of further refinement.

3.3. Further arguments concerning the nature of vowel harmony rules. If we disallow the 'spreading rule' account, which seems strongly disconfirmed by the existence of neutral vowels, we are left with a choice between 'classical' assimilation and prosody-assignment as possible types for the mechanism of vowel harmony. As Clements (1977a,b,c) has presented by far the most explicit and well worked out account of this latter sort, it is his treatment to which we will oppose the classical one below. In the following sections, we will treat separately each of the different sorts of vowel harmony that are generally encountered.

3.3.1. The description of labial harmony. The best-known example of this sort is undoubtedly found in Turkish. Here the generalization as usually stated is the following: a vowel after the initial syllable is [+round] if and only if it is a) also [+high]; and b) preceded by a [+round] vowel in the syllable immediately before. Vowels in the initial syllable can be freely [+round] regardless of height. This process extends its applicability as far as possible across the word: it can thus be described quite straightforwardly as an assimilatory rule such as (4):

\[
(4). \quad \frac{[+\text{high}] + [+\text{round}]}{[-\text{round}]} C_0
\]

This rule assumes that other vowels ([+high] vowels after the initial syllable, etc.) are specified as [-round]
unless lexically (i.e., idiosyncratically) [+round]. Rule 4 applies progressively to its own output; since it feeds itself to the right, no special assumptions about directionality of reapplication are necessary.

We can now ask how these facts would be treated by a rule of prosody-assignment. Such a rule would associate a prosody (or 'autosegment'), either [+round] or [-round], with some element of segmental structure, and then invoke a convention of association to align this with the full range of vowels in the word. In the simplest case, we could associate this directly with the root as a whole:

\[ (+\text{round}) \quad \text{association} \quad (+\text{round}) \]
\[ /\text{sam}^{-}\text{in}+\text{I}+\text{mI}/ \quad /\text{sam}^{-}\text{in}+\text{I}+\text{mI}/ \]
\[ =/\text{comunumu}/ \]

Labial harmony in comunumu 'is it his loaf?'

The autosegment [+round] is thus associated with each vowel of the word. When one of the vowels is [-high], however, harmony must not associate [+round] with it, or with any subsequent vowel: thus, comunlavinnis 'your loaves' shows harmony stopping at the vowel of the plural suffix /'Ar/. In an autosegmental treatment, this could be accomodated by saying that all [-high] vowels after the first syllable are directly associated with [+round] autosegments; the operation of labial harmony in this form is thus as shown in (6):

\[ (+\text{round}) \quad [-\text{round}] \quad (+\text{round}) \quad [-\text{round}] \]
\[ /\text{sam}^{-}\text{in}+\text{I}+\text{mI}/ \quad /\text{sam}^{-}\text{in}+\text{I}+\text{mI}/ \]
\[ =/\text{comunlarin}/ \]

The [+round] autosegment attached to the root vowel is thus associated with the two vowels of the root, but not to the vowel of /'Ar/, since this latter is already associated with a [-round] autosegment. This [-round] autosegment is the it is only this au them, due to the p that association l

An initial pr of how we know th be associated with both representation in and we must have a association that i

\( (7) \quad a. \quad (+\text{round}) \quad /\text{sA}+\text{mI}+\text{I} \quad \text{=} \quad \text{comunla} \)

In this case, the the following: "u over bound autoseg [+round] is not be priority over the

In regular ca gives essentially treatment. As usu cases within a bar between alternative of the type hamul 'chamberpot', etc. 'labial attraction word is a, the sec nantism includes a [+round]. Presuma associate a [+rou an autosegment can vowel harmony:
Vowel Harmony

An association can be associated with such a vowel, such as the second vowel plus or minus the first vowel.

Consider the following: if the second vowel is a front vowel, the first vowel is a back vowel, and the final vowel is also a back vowel, the association is made.

In this case, the association is made by the theory:

\[
\text{association} = \begin{cases} 
\text{front} & \text{if [round]} \\
\text{back} & \text{if [round]} 
\end{cases}
\]

Thus, the vowel is associated with the second vowel.

In the following case, the association is made by the theory:

\[
\text{association} = \begin{cases} 
\text{front} & \text{if [round]} \\
\text{back} & \text{if [round]} 
\end{cases}
\]

This is true because the rule applies here.
(8) \[ \text{[-round] [+round] association, [-round] [+round]} \]
\[ /\text{havr}^{+}\text{ênas}/ \]
\[ /\text{havr}^{+}\text{ênas}/ \]

The representation in (8) shows the operation of harmony/association in the formation of the word *havrəunəs* 'your (pl) chamberpot'.

The problem arises when we add a further suffix, containing a non-high vowel, such as */-da/ 'too, also'. Here we get the word *havrəunəsda* 'your chamberpot too'.

The point to note is that the two harmonizing vowels of the possessive suffix */-ənə* harmonize with the final vowel of the root, rather than with the following non-round vowel of */-da*. If we assume the representation of this form (after the operation of labial attraction) is as shown in (9a), there does not appear to be any principled way to derive (9b) rather than the incorrect (9c) or (9d):

(9) a. [-round] [+round] [-round] b. [-round] [+round] [-round]
\[ /\text{havr}^{+}\text{ênas}^{+}\text{da}/ \]
\[ /\text{havr}^{+}\text{ênas}^{+}\text{da}/ \]
\[ /\text{havrəunəsda}/ \]
\[ /\text{havrəunəsda}/ \]

c. [-round] [+round] [-round] d. [-round] [+round] [-round]
\[ /\text{havr}^{+}\text{ênas}^{+}\text{da}/ \]
\[ /\text{havr}^{+}\text{ênas}^{+}\text{da}/ \]
\[ /\text{havrəunəsda}/ \]
\[ /\text{havrəunəsda}/ \]

Since it would appear that the autosegments [+round] of the second syllable and [-round] of the final syllable appear to be equally associated, there is no way of associating the intervening material with one rather than with the other. Attempts to correct this situation by allowing the rule of association to apply bidirectionally and then correcting some of the incorrect associations produced thereby would appear to run up against considerable difficulties, since Turkish contains a large number of forms with vowels that are exceptional with respect to harmony. On the account of this, production systems due to harmony, such as (9c) or (9d) such a correction rule produced associations for such examples of lexicon would be considered to be an irregularity, marks the progressive which never associates the source of any precedent.

The generalization that facts is that in this principle, of course, becomes (9b), and not the major motivation treatment of harmony (notes) the bidirectional as an essential concept. This is to the autosegmental preserving at least presentations, but doing the basic claims of a positive argument in be derived from the Turkish, and some pow
DESCRIPTION OF VOWEL HARMONY

On the autosegmental account, these presumably have lexically associated autosegments; these associations must remain after and take precedence over the regular association due to harmony. But once a representation such as (9c) or (9d) has been formed, it is hard to see how such a correction rule would be able to distinguish rule-produced associations, which might be subject to correction, from lexical ones, which must not be altered. These examples could be multiplied without limit by the consideration of such lexically exceptional forms, in addition to those due to labial attraction. There are also suffixes whose behavior with respect to labial harmony is irregular: notably, the element /-Igor/ which marks the progressive and which contains an invariant /o/ which never associates to its left, regardless of the source of any preceding autosegments.

The generalization which is apparent from the Turkish facts is that in this language, at least, labial harmony propagates only to the right, never to the left. That principle, of course, will predict that (9a) can only become (9b), and not either (9c) or (9d). It removes one of the major motivations for an autosegmental or prosodic treatment of harmony here, however, since (as Clements notes) the bidirectional nature of harmony is captured as an essential consequence of the basic principles of this theory. This is not to deny that an account similar to the autosegmental one can probably be constructed, preserving at least some of the properties of these representations, but doing so would involve the evacuation of the basic claims of the theory. There is certainly no positive argument in favor of an autosegmental account to be derived from the facts of at least labial harmony in Turkish, and some potentially significant problems suggest

harmony. On the autosegmental account, these presumably have lexically associated autosegments; these associations must remain after and take precedence over the regular association due to harmony. But once a representation such as (9c) or (9d) has been formed, it is hard to see how such a correction rule would be able to distinguish rule-produced associations, which might be subject to correction, from lexical ones, which must not be altered. These examples could be multiplied without limit by the consideration of such lexically exceptional forms, in addition to those due to labial attraction. There are also suffixes whose behavior with respect to labial harmony is irregular: notably, the element /-Igor/ which marks the progressive and which contains an invariant /o/ which never associates to its left, regardless of the source of any preceding autosegments.

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that such an account is contra-indicated.

There is at least one case of labial harmony, indeed from which a somewhat stronger argument against a 'prosodic' treatment of labial harmony can be obtained. Khalkha Mongolian has essentially the following vowel system:

(10)  ĩ  ū  e  ō  o
       [+back] [+front]

Labial harmony in this language affects mid vowels: the vowel /e/ is replaced by /o/ or /õ/ (depending on backness harmony), if the preceding non-neutral vowel of the word is /o/ or /õ/. For the purposes of this rule, the vowels /e/ and /õ/ are neutral: these same vowels are also neutral with respect to backness harmony in Khalkha. As a result, a suffix such as /-ār/ has alternants [-sær], [-sær], [-sær]:

(11) a. garār 'by hand'
b. tereger 'by car'
c. mođor 'by stick'
d. oõžõr 'by foot'
e. sũrser 'by axe'

In form (11a), we see that even though ū is [+round], it does not cause rounding, since it is a [+high] vowel.

The role of neutral vowels can be seen in forms such as morino og 'from the horse' (cf. dũxegess 'from the younger brother') or dũx-ũd 'by forties'. Here we find the vowel /e/ intervening between the rounded vowel that causes harmony and the vowel that undergoes harmony: note that vowels other than /e/ and /õ/ in this position block harmony. Now the problem is how harmony is to be propagated from the first round vowel to the suffix. Assume the basic representation

(12)  [+round]

/dũx+ũd/

In order for roundness to be associated with the vowels to its right:

(13)  [+round]

/dũx+ũd/

Observe that it is required to be associated with the intervening or in cross (another basic character)

(14)  [+round]

/dũx/ Representation (14)

In his treatise discusses another feature. In that is first spreading the domain, and then its specification the backness.

The operation of the: 'mitosis' of the or: non-crossing character.

(15)a.  [+back]

/kũðr+I+nəl/

The rule introducing can be stated quite -round] vowels in s also [+low]. Though
The basic representation looks like that below:

(12) [+round]
    \[\text{a}+\text{ee}\] /

In order for roundness to propagate to the suffix, the autosegmental account requires that it be associated with the vowels to its right by convention.

(13) [+round]
    \[\text{a}+\text{ee}\] /

Observe that it is not possible for the [+round] autosegment to be associated only with the suffix vowel, and not with the intervening i; this is because the i must itself be specified as [-round], and association lines must not cross (another basic principle of the theory):

(14) [+round] [-round]
    \[\text{a}+\text{ee}\] /

Representation (14) thus is ill-formed.

In his treatment of Hungarian, Clements (1977b) discusses another instance of vowels neutral to a harmonic feature. In that instance, the proposed analysis involves first spreading the harmonic feature across the entire domain, and then inserting new autosegments to correctly specify the backness of the intervening neutral vowels. The operation of this latter process causes a sort of 'mitosis' of the original autosegments to preserve the non-crossing character of association lines:

    \[\text{kia}+\text{a}+\text{n+}\] \[\text{kia}+\text{e}+\text{n+}\] \[\text{kia}+\text{a}+\text{n+}\]

The rule introducing [-back], deriving (15c) from (15b), can be stated quite generally, since there are no [+back, -round] vowels in surface forms in Hungarian that are not also [+low]. Though the 'mitosis convention'
(not Clements' term) seems a bit unusual, this provides an adequate account of the Hungarian facts.

Such an account is not available for the Khalkha facts discussed above, however. This is because ı, a neutral vowel, would become (by operation of labial harmony) the high front rounded vowel ü but Khalkha phonology clearly cannot contain a rule analogous to the Hungarian neutralization process, since ü is an independently occurring vowel in Khalkha, and must not in general undergo unrounding. Representation (13) above must be converted into (16), that is, but this cannot be accomplished by means of a rule ı > ı, analogous to the Hungarian process.

\[ (16) \quad [\text{+round}] [\text{-round}] [\text{+round}] \]

It is possible that some rule could be formulated to avoid this difficulty on an ad hoc basis: one might say, for example, that ü is replaced by ı precisely when the autosegment [round] to which it is bound also binds mid vowels on both sides of the affected vowel. Note that it is not just the sequence ö-ü-ö which is prohibited — this is a perfectly possible though exceptional sequence — but rather exactly instances of this sequence derived by the vowel harmony process. It does not seem possible to give an account of this fact which is consistent with the unitary generalization that the vowel /i/ is a non-alternating, neutral vowel: this vowel does not change shape, and is transparent to all harmony rules. The ad hoc rule restoring ı when it has been mistakenly (but necessarily) altered misses this property altogether.

This difficulty does not arise, of course, on the assumption that Khalkha labial harmony is formulated as a 'classical' assimilatory rule. Such a rule can include
this provides the Khalkha because i, a of labial but Khalkha nalogous to the is an indepen- ust not in on (l3) above this cannot be alogous to the

formulated to avoid might say, for y when the auto- o binds mid l. Note that it prohibited - this l sequence - but i derived by the possible to give mt with the i is a non-does not change rules. The ad takenly (but 'altogether. course, on the t formulated as a role can include

optional neutral vowels to be skipped over in its environ- ment, and thus does not have to produce incorrect derivations. While it is seldom possible to demonstrate that some set of facts cannot at all be handled within a given theory - most self-respecting theories can accomo- date a wide variety of facts, with a bit of stretching at the seams - the contrast provided here provides about as good an argument as one usually finds. The conclusion that follows is that, at least for the typical cases of harmony involving the feature [+round], vowel harmony should not be treated as a prosodic assignment rule, as suggested by the theory of autosegmental phonology, but as a classical assimilation.

3.3.2. The description of palatal harmony. Vowel harmony systems based on the feature [+back], as illustrat- ed in languages such as Finnish, are generally taken to be the canonical type of such processes. It is rather interest- ing to note, therefore, that this sort of harmony is appar- ently not attested anywhere outside of the Uralic and Altaic language families. While the existence of a relationship between these two groups is anything but uncontroversial - a major argument in favor of such a connection is precisely the parallel vowel harmony systems - it may well be the case that all of these cases of palatal harmony in fact go back to a common source. In that case, it would be dangerous to draw firm conclusions from the study of these rules, since what appears to be a valid generalization about vowel harmony might turn out to be merely accident and due to common inheritance.

Even if the Uralic and Altaic systems do not derive from a common ancestor, the structural patterns of the two families are sufficiently parallel that some of the typological parameters we might wish to examine are simply
not available. Both groups are primarily if not exclusively suffixing, for example. Since root vowels control harmony, it is quite difficult therefore to determine whether the process is bidirectional or not. Exceptional stems and affixes, however, indicate that it is not bidirectional in Turkish. Consider the form binadakiler 'the ones in the building' for example. The stem is bin 'building'; since this stem violates backness harmony internally, the feature [+back] is presumably associated with its final vowel. The following suffix /a/ 'locative' harmonizes with this [+back] vowel. This is followed by the 'relative' suffix /k{/, which is usually invariant with respect to backness harmony (though under some circumstances it harmonizes optionally); the following plural suffix /lur/ harmonizes with this. In each case, harmony is exclusively progressive; note in particular that the locative suffix, coming between two conflicting invariant vowels, harmonizes only with the vowel to its left. In Turkish, then, as in those other languages of the Uralic and Altaic families for which evidence is available, there is a prima facie case for an exclusively progressive (as opposed to bidirectional) rule of palatal harmony.

In considering the rule of labial harmony in the preceding section, we discussed an argument against a prosodic-assignment rule of the type posited in the theory of autosegmental phonology. This argument took the following form: the assignment of harmonic features by such a rule must associate a single feature with an integral harmonic domain. Such a domain may contain neutral vowels; the neutral vowels in question may take surface values inconsistent with the harmonic value of the domain in which they occur. This effect must be produced by a rule which adjusts neutral vowels to their surface value when they a When a neutral v only by the harm cannot be formul non-neutral vowel it is necessar t domains, but a ri t's would incorre Thus, the procod festly which does assimilatory type

We may now in connection wit any instances tiated in the ful but Finnish provi this type (cf. Co sition of the compregently ignored with a particular voeals i and e, k are treated as ne klorofyll 'chlori back vowel ending marttyrion 'mart back vowels, with front y later in functions as a ne assign the feature

17) [+] /mrj/ If left unaltered *[mnttavrjus].
value when they appear in a domain of the opposite value. When a neutral vowel differs from a non-neutral vowel only by the harmonizing feature, however, such a rule cannot be formulated, since it would incorrectly adjust non-neutral vowels within such a domain. Thus, in Khalkha, it is necessary to include i within [+round] harmonic domains, but a rule systematically unrounding these rounded i's would incorrectly apply to genuine instances of i. Thus, the prosodic treatment encounters a serious difficulty which does not arise for a rule of the classical assimilatory type.

We may now ask whether a similar argument is available in connection with palatal harmony rules. We do not know of any instances in which this sort of behavior is instantiated in the fully productive part of a harmony system, but Finnish provides at least a marginal example of exactly this type (cf. Campbell, 1980, in this volume for a discussion of the complexities of Finnish vowel harmony that are frequently ignored). In foreign loans - especially those with a particularly 'learned' character - not only the vowels i and e, but also y (=ü) and occasionally even o are treated as neutral vowels. Thus, martyyri 'martyr', klorofylli 'chlorophyll', voplyymi 'book', and others take back vowel endings (e.g., martyyreja, partitive plural; martyyrjuus 'martyrdom', etc.) by virtue of their initial back vowels, without regard to the fact that they contain front y later in the word. For a word in which y thus functions as a neutral vowel, the harmony process must assign the feature [+back] without regard to its presence:

\[ \text{[+back]} \]
\[
/\text{martyrjuus}/
\]

If left unaltered, however, this representation would yield *[martujuus]*. A rule of absolute neutralization can
properly change all instances of /ɨ/ (from /i/ in [+back] domains) to [ɪ], but a corresponding rule for incorrect instances of /u/ in such forms would incorrectly apply to genuine instances of /u/. There is no systematic way to distinguish between representation (17) and that given below for the form partuer̥a 'barber (partitive plural)'.

(18) [+back]
/partuer̥a/ → /partu̥er̥a/.

The rule correcting */martturius/ to */marttiyrius/ apparently also change */parture̥a/ to */partuyre̥a/. This shows that neutral vowels cannot actually be integral parts of harmonic domains with respect to [ɪ̥bḁk] in Finnish, but must rather be skipped over, much as consonants are disregarded in assigning harmonic features. This, in turn, shows that a classical assimilatory treatment is to be preferred for at least some instances of palatal harmony to a prosodic rule of the autosegmental type. Taken together with the evidence above for the unitary directionality of palatal harmony, this suggests that such rules, like those of labial harmony, are in general better treated by a rule of conventional type than by an autosegmental account.

3.3.3. 'Tongue root' and related harmony systems.

In addition to labial ([round]) and palatal ([ɪ̥bḁk]) harmony, most typological studies (e.g., Jakobson, 1942; Zimmer, 1967; Aoki, 1968; Ulan, 1973) distinguish a third type: 'horizontal' harmony. The phonetic opposition involved is variously described as height or tenseness. Typically, the vowels [ɛ, ɪ, ø, ɜ, u] are opposed to [e, o, i, u] as the two harmony sets involved. More recent interpretations of these systems (e.g., Stewart, 1967; Halle & Stevens, 1969; Hall et al., 1974; Lindau, 1978) treat them as based on a feature of advancement.
om /i/ in [+back] for incorrect correctly apply to systematic way to and that given (vs. retraction) of the tongue root ([+ATR]). We will not be concerned to differentiate the various manifestations of this parameter phonetically (but cf. section 3.3.3.2 below), and thus will treat these systems as a homogeneous class. In those terms, this harmony type is far and away the most widespread among the languages of the world: it is found at least in Niger-Congo languages, Nilo-Saharan and Afro-Asiatic (Somali and Tangale) in Africa; Tibetan, most of the Paleo-Siberian languages, and arguably elsewhere as well.

3.3.3.1. Development of [±ATR] harmony. In at least two instances, we can see the development of such systems. Hooper (1976) discusses the development of some dialects of Spanish which lead to a [±ATR] vowel harmony system in the dialect of Grenada. Roughly, the development is as follows. In a wide range of Spanish dialects, vowels in closed syllables are 'lax' ([−ATR]), while vowels in open syllables are 'tense' ([+ATR]). Further, in some dialects, final s has weakened to h or disappeared altogether. In a subset of dialects showing both developments, final syllables originally closed by -s retain their 'lax' quality despite the fact that they have become open through the loss of this segment. As final -s is the usual marker of noun plurals and some other productive categories in Spanish, these dialects have transferred the marking of such distinctions to vowel tenseness alone. Further, in the dialect of Grenada, the tense or lax quality of a final vowel has given rise to a vowel harmony rule, by which all of the vowels of the word become [+ATR] in agreement with the final syllable. In this quite plausible development, we can see perhaps the source of such harmony in other languages as well.
Another example is furnished by vowel harmony in Maltese. As described by Puech (1978a, 1978b), this language has evolved a set of vowel harmony processes from the loss of original pharyngeal consonants. Apparently, these consonants transferred their influence on pharyngeal width to adjacent vowels (as is indeed well attested in contemporary Arabic dialects). With the loss of pharyngealization in the consonants themselves, this secondary vowel feature was spread to vowels in neighboring syllables. The system has been extensively restructured, and appears in a variety of different dialect forms based on the independently motivated features of backness and rounding; but its origin in a feature of pharyngeal width is not difficult to reconstruct. While pharyngealization is not the same as the feature [+ATR], the two are interrelated, and we thus include this case together with the 'horizontal' harmony systems. These latter also tend to undergo re-interpretation in terms of other features, as we discuss in the next section.

3.3.3.2. Restructuring in [±ATR] harmony systems.

By no means all of the languages of the 'horizontal' harmony type display a common phonetic basis. The Nilotic languages discussed by Jacobson (1980) in this volume, for example, seem to have reinterpreted the harmonic feature in terms of voice quality and other distinctions rather than just tongue root position. More extensive restructuring is also quite possible, however. In particular, as the traditional term 'horizontal' harmony suggests, this feature is closely tied up with the height dimension in vowels, as well as with backness. The pairs [e, e] and [o, o], for example, found characteristically in these systems, are often said to differ in vowel height as well as 'tenseness'. Further, in languages such as Somali, the vowels of the [±ATR] front than those of the [±ATR].

These facts a development of som the [±ATR] type. Chukchee, and Kory 'close' and 'open' and [e, e, o] in Jak [i] and [ø], respectively be seen as at least in their Zhukova, 1972) it correspondent of [open] corresponds system with sets [phonetically natur form of [e]]. In 'close' and 'open' again, this is quiet in African [±ATR] low vowels first. systems have an ov by the two sets, at least purely pt.

It would seem a celebrated system related language the same history. A + the reconstruction sets are [i, e, o] 1968; Rigsby & Sil for we assume that thi with an added part.
DESCRIPTION OF VOWEL HARMONY

Vowels of the [-ATR] harmony set are systematically more front than those of the [-ATR] set.

These facts appear to account for the subsequent development of some systems that are superficially not of the [ATR] type. The Paleo-Siberian languages Gilyak, Chukchee, and Koryak distinguish two harmonic sets of 'close' and 'open' vowels (cf. Jakobson, 1952): [i,e,u] and [a,o] in Jakobson's transcription. Kanchadal adds [Y] and [I], respectively, to these sets, which can plausibly be seen as based on tongue root position features, at least in their origin. Now in Modern Koryak (cf. Zhukova, 1972) it is apparently the case that the 'close' correspondent of [a] has merged phonetically with the 'open' correspondent of [I] as [e]: the result is a new system with sets [i,e,u] and [a,o], arising through the phonetically natural raising and fronting of the [-ATR] form of [a]. In other forms of Koryak, however, the 'close' and 'open' forms of /a/ have merged as simply [a]; again, this is quite natural, given the observed tendency in African [ATR] systems to neutralize the distinction in low vowels first. In both cases the resulting harmony systems have an overlap in the form of one vowel shared by the two sets, and so there is in fact no phonetic (or at least purely phonetic) dimension separating the two.

It would seem reasonable to suggest that the celebrated system of Nux Parce (and Palouse Sahaptin, a related language of the Sahaptian group) has much the same history. A great deal of energy has been devoted to the reconstruction of this system, in which the harmony sets are [i,e,o] and [u] (cf. Aoki, 1966; Jacobsen, 1968; Rigby & Silverstein, 1969; and Zwicky, 1971). If we assume that this was originally a three vowel system with an added parameter of tongue root position, we can
see an evolution similar to the Paleo-Siberian one. We will see in the next section a further parallel between this system and other [+ATR] cases. The original harmony sets, on this view, might have been [+ATR] [i, a, u] and [-ATR] [i, e, o]. We assume that the relatively front position of the [+ATR] vowel [i] is parallel to the fronting seen in Somali. Assume now that the dimension of tongue root position is neutralized for the non-low front vowels: these thus merge as [i]. Lindau (1975) has argued independently that tongue-root distinctions are neutralized more easily for the front vowels than for the back vowels, so this development is not arbitrary. Once it has taken place, however, the tongue root oppositions found in the other vowels are phonetically isolated, and we can expect them to be reinterpreted in terms of other features. The interpretation of [o] as [-high] [o], and of [a] as [-baak] [a] both seem straightforward, yielding the modern system. In the other dialects of Sahaptin, however, (Umatilla and Yakima), the opposition of tongue root position was simply neutralized everywhere, yielding a three vowel system [i, a, u]. In these dialects, the original system is preserved only in the fact that in words originally containing [+ATR] vowels, velars are palatalized before /i, a/. This is not unexpected, on our account which assumes that the [+ATR] vowels were originally more front than the [-ATR] counterparts.

We can thus suggest that the set of harmony systems based on [+ATR] - at least originally - is even greater than appears immediately, and that in fact the only harmony systems that we count as true "vowel harmony" besides the labial and palatal harmony cases are in origin of this type. We should also repeat here the remark made above in section 2.5.1, that where mergers have resulted in a single vowel's being serious problems that of autosegment parameter is ass...
The description of tongue root harmony.

Tongue-root harmony systems have sometimes been taken to constitute the best cases for a 'prosodic' treatment (cf. Zimmer, 1967; Clements, 1977c) due to their generally bidirectional character. Since languages such as Igbo, Ewe, Kalenjin, and the others generally discussed under this heading typically have both prefixes and suffixes, and since the material which harmonizes can include vowels on both sides of the element determining the harmony, a rule of traditional directional type seems inappropriate. Since bidirectionality is an essential feature of prosodic approaches (including that of autosegmental phonology), these seem particularly well-motivated for such languages. We will see below, however, that a rule of classical assimilatory type is not really at a disadvantage in these cases, and that in fact there is some reason to believe that such a rule provides a better account after all.

We should first distinguish two subcases of these harmony systems. On the one hand, we find languages such as Igbo and Akan which display root control. Each root, that is, is characteristically composed either of [+ATR] or of [-ATR] vowels, and both prefixes and suffixes vary accordingly. On the other hand, we find languages such as Diola Fongny and Kalenjin which display asymmetric harmony of the 'dominant/recessive' type. One class of vowels is dominant and the other recessive, in the sense that whenever a word contains a single instance of a dominant vowel, all of the other vowels of the word are replaced by their dominant counterparts (unless basically dominant, of
Dominant vowels that thus condition harmony may appear freely in both stems and affixes. Superficially, at least, the mechanisms of these two systems are quite distinct.

Let us first consider the treatment of systems of the asymmetric type. It is an interesting fact that all such systems appear to involve the same categorization of vowels: in all cases, it is the [+ATR] vowels that are 'dominant', and the [-ATR] vowels that are recessive. This observation also extends to the dominant/recessive harmony systems of the Palec-Siberian and Sahaptian languages discussed in the preceding section, if our historical account of those systems is accepted. We could therefore imagine the following treatment of these languages. Assume that 'recessive' morphemes all have [-ATR] vowels, and dominant ones [+ATR] vowels, as phonetically motivated (ignoring here the added complications that may result from restructuring). Then we need only say that the feature [+ATR] spreads in both directions. This could of course be accomplished by means of a prosodic rule, on the assumption that only dominant morphemes are specified, with a [+ATR] autosegment which is by convention associated with all (unassociated) vowels, and that vowels which remain unassociated are assigned [-ATR]. It could equally be accomplished by means of a mirror-image rule of assimilation (of the type motivated in Anderson, 1974) such as that below:

\[(19) \text{[+syll]} \ast \text{[+ATR]} \Rightarrow \text{[C]} \ast \text{[ATR]}\]

Such a rule, allowed to reapply to its own output, will have the effect of spreading the feature [+ATR] across the word in both directions from a single instance (if necessary) of an underlyingly dominant ([+ATR]) vowel.
Once we have observed this, however, the characterization of the root-controlled systems is quite straightforward. All that we need to assume is that, in those languages, only roots can contain [+ATR] vowels; affixes are restricted to containing only [-ATR] vowels. The vowel harmony rule, however, is exactly the same: rule (19) will perform just the same function, bidirectionally, in these cases as in the asymmetric examples. A prosodic account of the autosegmental variety can also be constructed, of course: again, it would be based on the limitation of [+ATR] autosegments to root morphemes alone. We should note here that this account, based on rule (19), is essentially the same as that given of the difference between Igbo and Diola Pouny by Ringen (1975): the conclusion that bidirectional processes of this sort can be handled adequately by a classical assimilation rule is thus not a new one. But in that case, the claimed advantage for prosodic approaches disappears.

When we consider harmony processes, in fact, we can see that prosodic approaches are at a minor disadvantage. It is a striking but apparent fact that, in all attested cases of tongue-root harmony systems, the only exceptional formatives that are encountered are of the same type: they contain vowels which are invariably recessive ([−ATR]), and thus do not undergo harmony. They further have the effect of limiting the domain of the harmony rule, so that a dominant vowel on one side of such an element cannot affect a recessive vowel on the other side of it. There do not, however, appear to be instances of vowels that are exceptional in being invariably dominant, but similarly delimiting the scope of harmony.

Now observe that, on the account of bidirectional harmony based on a rule like (19), the limitation on possible types of exceptional element is a necessary one.
If all of these harmony systems are basically of an asymmetric character, that is, the only way of designating a morpheme as exceptional is to mark it as not undergoing rule (19). A morpheme containing [-ATR] vowels which cannot undergo rule (19), of course, will also stop the propagation of harmony, since this depends on the mechanism of successively assimilating adjacent vowels. Notice that, in this system, there would be no natural way to describe a morpheme which was of the dominant class but which stopped the propagation of harmony: the limitation on possible forms of exceptionality thus follows as a necessary consequence from the only available way of describing the harmony rule.

In an autosegmental account, however, this limitation does not have a similar systematic basis. An exceptional vowel on this view would be described by associating with it lexically an autosegment [-ATR]. There is no principled reason, however, why there should not also be some lexically associated [+ATR] vowels, which would characterize (in the same language) an exceptionality of exactly the same sort. Of course, one could state as a fact about the language that only [-ATR] can be lexically associated with particular vowels: indeed, one would have to do so. But this is in principle an ad hoc fact about each language so characterized. The apparent absence of tongue root harmony systems which are symmetric with respect to the distribution of exceptions, that is, does not follow as a matter of principle from the mechanism of vowel harmony on the assumptions of autosegmental phonology; but as we have seen, it does follow from the assumptions of the 'classical' account. On the latter view, the asymmetry of such systems is essential; on the former, it is accidental. In constructing a theory of phonology, then, the methodology section 2 should be classical sort to a.

The point can follow. If in Igbo containing exceptional given in (20a), why

(20) a. [−ATR] [+ATR] /
   \...v.v.v...v.v

b. [−ATR] [−ATR] /
   \...v.v.v...v.v

The absence of derivation the 'prosodic' view principled on the v: harmony. We are then as the basis of a tl

4. Conclusion

vowel harmony process; that neither a 'prosodic assignment', such as autosegmental phonology description of such palatal harmony, the dictionary of neutral \ harmonic features of:

This does not show, arbitrary 'prosodies' content, such as the Firthe or the theory structuralism, could facts. Such a theor of little interest, phonology is strongl
then, the methodological assumptions discussed above in section 2 should lead us to prefer a treatment of the classical sort to an autosegmental description.

The point can be illustrated diagrammatically as follows. If in Igbo, for example, we can find words containing exceptional affixes that take the derivation given in (20a), why are there no derivations like (20b)?

\[
(20) \text{a. } [-\text{ATR}] [-\text{ATR}] [-\text{ATR}] [-\text{ATR}] [-\text{ATR}] \rightarrow \ldots V.V.V...V.V.V...V.V.
\]

\[
(20) \text{b. } [-\text{ATR}] [-\text{ATR}] [-\text{ATR}] [-\text{ATR}] [-\text{ATR}] \rightarrow \ldots V.V.V...V.V.V...V.V.
\]

The absence of derivations such as (20b) is accidental on the 'prosodic' view underlying these representations, but principled on the view that rule (19) is the mechanism of harmony. We are thus led to prefer the latter description as the basis of a theory of vowel harmony.

4. Conclusions. A survey of the major types of vowel harmony process, then, has led us to the conclusion that neither a 'spreading' rule nor a process of 'prosody assignment', such as that suggested by the theory of autosegmental phonology, is appropriate in general to the description of such systems. In the cases of labial and palatal harmony, this followed from the essential contradiction of neutral vowels appearing within the domain of harmonic features opposite from their own intrinsic values. This does not show, of course, that a theory recognizing arbitrary 'prosodies' unrelated to particular phonetic content, such as that advocated by some followers of Firth or the theory of 'long components' in American structuralism, could not provide an account of these facts. Such a theory is sufficiently unconstrained to be of little interest, however. The theory of autosegmental phonology is strongly rooted in phonetic facts, however,
and thus limited in power: if this theory were in fact adequate to describe vowel harmony, this would be a result of considerable interest. Since it is not, however, we must reluctantly conclude that this is not an appropriate domain for its application.

In considering tongue-root harmony systems, however, we have also seen that the theory of autosegmental phonology is apparently not sufficiently limited to exclude some possible but non-occurring systems. Since the theory of classical assimilatory processes does exclude these cases, this is apparently the basis we should accept for the description of vowel harmony.

Notice now, however, that we have concluded that the formal mechanism of vowel harmony is not distinct from that underlying other sorts of metaphor (dissimilation, Umlaut, etc.). We have thus once more failed in the effort, initiated in section 2, to find necessary and sufficient conditions for vowel harmony systems (as opposed to other types of rule). If we had found that vowel harmony is produced by a rule of distinct type from that involved in other cases of metaphor, that is, we would have established a criterion of the sort we sought in section 2; but the results of section 3 suggest that in fact no such criterion is available.

The appropriate conclusion from this would appear to be that the similarities among vowel harmony systems in the languages of the world are of the 'family resemblance' type, rather than providing a delimiting definition of a theoretically significant process. There are common threads running through vowel harmony systems in various languages, that is, but no set of 'core properties' common to all and only systems of this type.
This is not actually unprecedented. The accidents of history have resulted in a number of theoretical constructs being given considerable attention in traditional phonetic accounts; but closer examination does not always confirm our expectations that the processes identified and named by our predecessors will correspond to significant theoretical types in a more nearly adequate view of general phonology. Another example of this sort is the category of 'compensatory lengthening': it is argued by deChene & Anderson (1979) that this category does not in fact correspond to a unitary mechanism in phonetics and phonology, but rather that such processes always arise from effects of other sorts. This account places interesting limitations on the circumstances under which 'compensatory lengthening' can arise, and is thus to be preferred on general grounds, despite the fact that it denies theoretical significance to one of the traditional categories of phonetic processes. A similar example is perhaps furnished by the status of 'downstep' tones (distinct, of course, from rules of downstep). For reasons connected with the history of the study of tone, these elements have appeared to have unique and typologically significant theoretical status; but a balanced reconsideration suggests (cf. Anderson, 1978) that they are simply instances of intermediate level tone elements of (slightly) restricted distribution.

Vowel harmony seems to be another example of the same general sort. When description of languages such as Turkish, Finnish, and Hungarian were first taken into account by general linguists (whose experience was usually limited otherwise to European languages of the Indo-European family), they seemed significantly different; and one obvious parameter of this difference was the existence
of vowel harmony rules. This construct thus came to
assume major dimensions for typological purposes, and it
is natural to expect that it will therefore be recon-
structed as a well-defined theoretical entity by sub-
sequent phonological theory. Upon examination, however,
it seems that this expectation fails, and we must be
ready to incorporate vowel harmony as an instance of a
more general rule type, that of metatheny processes
describable by rules of the ordinary sort. Literally,
then, this means that there is nothing special about
vowel harmony; but of course that needn't prevent us from
having a conference devoted to it.
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0. In this paper, the phenomenon of vowel harmony that I have called phonological spreading and in Formal Linguistics forthcoming). This paper was presented at the Fifth Annual Meeting of the Society for Linguistic Methodology and Philosophy and the J.R. Vergnaud, 1977 paper on formal devices and these languages.

1. The paper discusses the theory presented in Chapter 8 of The Structure of a Language. In standard phonology, inadequacies of the symbols for the modifications of phonological structure (in the sense of z. elements: a phonological system).