

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 ostensibly. 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 Nez 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 criterial 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

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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 Woleaian, for example (cf. Sohn, 1975), /a/ is replaced by /s/ before a low vowel (/a/ or /ɔ:/), resulting in an alternation such as that between [meramɛ] 'moon' and [maremalɛ] 'moon of'. The root here is /marama/; in the first form, the final /a/ is devoiced and shifted to [ɛ], while in the second devoicing affects the (final) /i/. 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. *Vocalic 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)



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 *u*-Umlaut (cf. Anderson, 1974 and references

there), which replaces /a/ by /ö/ 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 /ö/ into /u/), this rule's effects can spread to an extended domain. Underlying /*banan+um*/ becomes, by umlaut, /*banön+um*/; reduction converts this to /*banun+um*/; and then umlaut can apply again to derive surface *bönunum* '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 [*ikuminininink*] 'he will fix it for him' from underlying /*ikumanananink*/ 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 Ultan (1973), presents a set of five properties: a) phonetic motivatedness; b) root control; c) bidirectionality; d) unboundedness; and e) nonoptionality. 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 [*±back*], [*±round*], [*±high*], 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, ə*} 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 Buriat Mongolian, the original diphthongs /aj/ and /oj/ have become [æ:] and [ö:], 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 Buriat thus consists of the phonetic back vowels plus æ:, ö:, 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. \*e > ê , \*o > ô (central vowels)  
 b. \*ü > u , \*u > o , \*o > ɔ  
 c. \*o > ö , \*a > e / \_\_\_C<sub>0</sub>é  
 d. \*é > i

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

- (3) a. "front" vowels: ê, ô, u, ü, ô:  
 b. "back" vowels: a, ɔ, o, e, ö  
 c. "neutral" vowels: i

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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), Luorawetlan (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 formatives 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.

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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 *kumartamatta* 'without bowing' vs. *ymmärtämättä* '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 *+/Iyor+/,* 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 *kəlbäymin* '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 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 languages: 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 *Ágnesnak*. 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 substantially 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 the vowel harmony process *per se* is without exception. It remains to be seen whether such exceptionless behavior

is universally characteristic but the evidence at

We must conclude that the criteria point up important differences in the required basis for a theory of vowel harmony. We must therefore differentiate between the criteria for differentiating vowel harmony from other processes of metaphony. We must also note that the theoretical principles underlying these properties would actually be different from the extant vowel harmony

3. *The Mechanism*  
 efforts to define vowel harmony in terms of the properties of the rule. If these efforts are successful, there is a strong line to take on the mechanism of vowel harmony. As noted in the literature, the mechanism of vowel harmony is not the same as other sorts of vocal processes, applying a rule and reapplying it. This is a simultaneous association across an extended domain with an entire domain. This is Lyons' (1962) discussion of another with essentially the same mechanism. (1965) treatment of vowel harmony. Yet another version of the mechanism is discussed by Clements' (1977a), which will be discussed below. The mechanism of vowel harmony achieved

is universally characteristic of vowel harmony rules, 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 criteria for differentiating vowel harmony from other types of metaphony. 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 of the rule(s) involved were not ultimately successful, there is another and potentially more interesting line to take on the problem. It is sometimes suggested 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 sensu 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 *u*-Umlaut, the vowel /a/ acquires certain features if the following vowel is /u/. 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.

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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

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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,

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3.2. *An argument for analysis of vowel* would take the form (disregarding for would be distinct: while other root is unmarked or marked rule, having local

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 [ $\pm$ 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* ( $=\{ü\}$ ) and *a, o, 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 *puhelin*. Note that in this word two neutral vowels intervene between the harmonic determinative (*u*) and the end of its domain (*a*). Both of these vowels are in fact specified for the

harmonic feature: they occur within consider that a *si* takes this entire be documented from vowels, and suggest generally available

Under certain the application of to extend this arg assimilation analy (cf. Howard, 1972; be imposed on the the 'focus' (rough 'determinant' (rou environment which Howard's "crossove condition" both su can intervene. Fo that could itself focus) is excluded stronger, as well appearance of anot environment in the can note that in F the neutral vowels harmony: all-neut certain derivation generally take fro the most plausible front quality of tl determinant for ha vowels available. by this example fo

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. Kiparsky, 1973), generally take front vowel affixes, and as Kiparsky 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 phonological elimination. We would argue against such an account on the real moral of the relevancy condition.

3.3. Further developments of the vowel harmony rules account, which seem to be the consequence of neutral vowel harmony 'classical' assimilations. Possible types for the account are given by Clements (1977a,b,c). The account is explicit and well known. It is his treatment of the account one below. In the account separately each of the account that are generally

3.3.1. The account known example of the account Turkish. Here the account the following: a vowel [±round] if and only if b) preceded by a [±round] immediately before. Vowel freely [±round] requires extends its application word: it can thus as an assimilatory

(4). [±syllable] [±high]

This rule assumes that the initial syllable

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):

$$(4). \begin{matrix} +\text{syll} \\ +\text{high} \end{matrix} + [+round] / \begin{matrix} +\text{syll} \\ +\text{round} \end{matrix} C_0 \text{ ---}$$

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:

$$(5) \begin{array}{ccc} [+round] & \text{association} & [+round] \\ /sAmIn+i+mI/ & & /sAmIn+i+mI/ \\ & & (= [somunumu]) \end{array}$$

Labial harmony in *somunumu* '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, *somunlariniz* 'your loaves' shows harmony stopping at the vowel of the plural suffix /lAr/. In an autosegmental treatment, this could be accommodated 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):

$$(6) \begin{array}{ccc} [+round] & [-round] & \\ /sAmIn+lAr+iInIz/ & \longrightarrow & /sAmIn+lAr+iInIz/ \\ & & (+round) \quad (-round) \\ & & (= [somunlariniz]) \end{array}$$

The [+round] autosegment attached to the root vowel is thus associated with the two vowels of the root, but not to the vowel of /lAr/, since this latter is already associated with a [-round] autosegment. This [-round]

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$$(7) \text{ a. } \begin{array}{c} [+round] \\ /sAmIn+lA \\ = somunla \end{array}$$

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

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autosegment is then associated with the following vowels;  
it is only this autosegment that can be associated with  
them, due to the principle (a major part of the theory)  
that association lines cannot cross.

An initial problem encountered here is the question  
of how we know that the second vowel of this form should  
be associated with [+round], rather than with [-round].  
Both representations in (7) below are well-formed, that is,  
and we must have a way of choosing the direction of  
association that is to prevail:

- (7) a.    [+round]    [-round]    b.    [+round]    [-round]  
          / sAmɪn+lAr+ɪnɪz/            / sAmɪn+lAr+ɪnɪz/  
          = somunlarɪnɪz                = \*somɪnlarɪnɪz

In this case, the principle suggested by the theory is  
the following: "unbound autosegments [...] take priority  
over bound autosegments." (Clements, 1977a). Thus, since  
[+round] is not bound to any particular segment, it takes  
priority over the already bound [-round].

In regular cases, then, the autosegmental theory  
gives essentially the same results as the assimilatory  
treatment. As usual, however, the examination of irregular  
cases within a harmony system turns up more differences  
between alternative possible formulations. Consider words  
of the type *hamul* 'patient', *maymun* 'monkey', *havruz*  
'chamberpot', etc. These forms exemplify the rule of  
'labial attraction', by which, if the first vowel of the  
word is *a*, the second [+high], and the intervening conso-  
nantism includes at least one labial, the second vowel is  
[+round]. Presumably, the effect of this rule is to  
associate a [+round] autosegment with such a vowel. Such  
an autosegment can be associated with later material by  
vowel harmony:



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 */-Iyor/* 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

und] [+round]  
 $\swarrow$   $\searrow$   
 hAvrɨs+ɨnɨs/

tion of harmony/  
 hAvrusunus 'your

ther suffix,  
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 representation of  
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 incorrect (9c) or

i] [+round] [-round]  
 $\swarrow$   $\searrow$   
 hAvrɨs+ɨnɨs+dA/  
 hAvrusunusda  
 i] [+round] [-round]  
 $\swarrow$   $\searrow$   
 hAvrɨs+ɨnɨs+dA/  
 hAvrusɨnɨsda

nts [+round] of  
 final syllable  
 s no way of  
 h one rather than  
 s situation by  
 y bidirectionally  
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 against consider-  
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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)	i	ü	u	
	e	ö	ə	o
			a	
				[-back] [+back]

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

- (11) a. *garaar* 'by hand'  
 b. *tergeer* 'by car'  
 c. *modoor* 'by stick'  
 d. *xölööör* 'by foot'  
 e. *sümeer* 'by axe'

In form (11e), we see that even though u 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 *morinoos* 'from the horse' (cf. *dүүgees* 'from the younger brother') or *dööči-ööd* 'by forties'. Here we find the vowel i intervening between the rounded vowel that causes harmony and the vowel that undergoes harmony: note that vowels other than i and ə 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 representa

- (12) [+round]  
 /dEƏI-EEd/

In order for roundne  
 autosegmental accoun  
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- (13) [+round]  
 /dEƏI-EEd/

Observe that it is r  
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- (14) [+round]  
 \* /dEƏ

Representation (14)

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- (15)a. [+back] >  
 /klÁr+I+nÁl/

The rule introduc  
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 -round] vowels in s  
 also [+Low]. Thoug

the basic representation looks like that below:

(12)  $\begin{array}{c} [+round] \\ /d\acute{e}\acute{c}i-EEd/ \end{array}$

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)  $\begin{array}{c} [+round] \\ /d\acute{e}\acute{c}i-EEd/ \end{array}$

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)  $\begin{array}{c} [+round] \quad [-round] \\ * \\ /d\acute{e}\acute{c}i-EEd/ \end{array}$

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:

(15) a.  $\begin{array}{c} [+back] \\ /kl\acute{a}r+i+n\acute{a}l/ \end{array}$  > b.  $\begin{array}{c} [+back] \\ /kl\acute{a}r+\acute{e}+n\acute{a}l/ \end{array}$  > c.  $\begin{array}{c} [+back] \quad [-back] \quad [+back] \\ /kl\acute{a}r+i+n\acute{a}l/ \end{array}$

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 *i*, 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  $\ddot{u} > i$ , analogous to the Hungarian process.

(16) [+round] [-round] [+round]  
 $\swarrow \quad \searrow$   
 /dE*ü*I-EE*d*/

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 *i* 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 *i* 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

optional neutral vowels, and thus does not require special provisions. While it is possible to give some set of facts consistent with a given theory - most languages date a wide variety of neutralizations - the con- sideration of the seams - the con- sideration of a good argument as to why the neutralization that follows is the result of a harmony involving the neutral vowel should not be treated as a classical assimilatory rule suggested by the theory as a classical assimilatory rule.

3.3.2. *The de-voicing of vowels*  
 The de-voicing of vowels in harmony systems based on languages such as English is the canonical type. In noting that there are many recently not attested languages in the family. The difference between these two cases is a major argument in favor of the parallel vowel harmony case that all of them go back to a common source. It is dangerous to draw conclusions from these rules, since what is known about vowel harmony is limited and due to common sense.

Even if the Uralic languages are from a common ancestor, the two families are still distinct typological parameters.

optional neutral vowels to be skipped over in its environment, 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 accommodate 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 illustrated in languages such as Finnish, are generally taken to be the canonical type of such processes. It is rather interesting to note, therefore, that this sort of harmony is apparently 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

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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 *bina* 'building'; since this stem violates backness harmony internally, the feature [+back] is presumably associated with its final vowel. The following suffix /dA/ 'locative' harmonizes with this [+back] vowel. This is followed by the 'relative' suffix /ki/, which is usually invariant with respect to backness harmony (though under some circumstances it harmonizes optionally); the following plural suffix /lar/ 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 are neutral. When a neutral vowel is only by the harmonic value of the non-neutral vowel in its domain, but a rule which would incorporate this prosodic difficulty which does not assimilate to the type

We may now see in connection with any instances of this type but Finnish provides this type (cf. Caution of the complement frequently ignored with a particular vowels *i* and *e*, *i* are treated as neutral *klorofylli* 'chlorophyll' back vowel ending *marttyyrin* 'martyr' back vowels, with front *y* later in functions as a neutral assign the feature

(17)  $\begin{matrix} [+ \\ /m\text{A}rtt \end{matrix}$

If left unaltered  
\*[*marttuurius*].

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 *ü*. 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* (= [y]) and occasionally even *ö* are treated as neutral vowels. Thus, *marttyyri* 'martyr', *klorofylli* 'chlorophyl', *volyymi* 'book', and others take back vowel endings (e.g., *marttyyreja*, partitive plural; *marttyyrius* '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:

(17) 
$$\begin{array}{c} [+back] \\ \swarrow \quad \searrow \\ /m\text{Ar}t\text{t}U\text{U}r\text{i}+U\text{s}/ \end{array}$$

If left unaltered, however, this representation would yield \*[*marttuurius*]. A rule of absolute neutralization can

properly change all instances of /ɛ/ (from /i/ in [+back] domains) to [i], 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 *partureja* 'barber (partitive plural)':

$$(18) \quad \begin{array}{c} [+back] \\ \swarrow \quad \searrow \\ /pArtUre+j+A/ \end{array}$$

The rule correcting \*/*marttuurius*/ to [*marttyyrius*] would apparently also change /*partureja*/ to \*[*partyreja*]. This shows that neutral vowels cannot actually be integral parts of harmonic domains with respect to [±back] 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 ([±back]) harmony, most typological studies (e.g., Jakobson, 1942; Zimmer, 1967; Aoki, 1968; Ultan, 1973) distinguish a third type: 'horizontal' harmony. The phonetic opposition involved is variously described as height or tenseness. Typically, the vowels [ɛ, ɔ, ɪ, ɒ] 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

(vs. retraction) of *t* not be concerned to cations of this para 3.3.3.2 below), and t homogeneous class. far and away the mos the world: it is fo Nilo-Saharan and Afr Africa; Tibetan, mos and arguably elsewe

3.3.3.1. *Devel* two instances, we ca Hooper (1976) discus of Spanish which lea the dialect of Grena follows. In a wide closed syllables are syllables are 'tense final *s* has weakened subset of dialects *s* syllables originally quality despite the the loss of this seq of noun plurals and Spanish, these diale such distinctions to the dialect of Grena final vowel has giv which all of the vo agreement with the development, we can in other languages

(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 now 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,ɛ] and [o,ɔ], 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

These facts are a development of some the [±ATR] type. Chukchee, and Koryak 'close' and 'open' and [e,a,o] in Jakut [ü] and [ö], respectively be seen as back at least in their (Zhukova, 1972) it is correspondent of [i] 'open' corresponds to the system with sets [i] phonetically natural form of [a]. In the 'close' and 'open' again, this is quite in African [±ATR] low vowels first. systems have an overlap by the two sets, at least purely phonetically

It would seem that the celebrated system of related languages of the same history. As for the reconstruction of sets are [i,a,o] and [e,ɛ] (1968; Rigsby & Silman) we assume that this with an added parameter

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 Paleosiberian languages Gilyak, Chukchee, and Koryak distinguish two harmonic sets of 'close' and 'open' vowels (cf. Jakobson, 1952): [i, e, u] and [ɛ, a, o] in Jakobson's transcription. Kamchadal adds [ü] and [ö], 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 [ɛ, 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 Nez Perce (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, a, o] and [i, e, u] (cf. Aoki, 1966; Jacobsen, 1968; Rigsby & 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 [ $\pm$ ATR] cases. The original harmony sets, on this view, might have been [+ATR] [i, a, u] and [-ATR] [ɪ, ə, ɔ]. We assume that the relatively front position of the [+ATR] vowel [a] 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 [ɔ] as [-high] [o], and of [a] as [-back] [ə] 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 [ $\pm$ 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 be serious problems that of autosegmental parameter is assumed

### 3.3.3.3. *TR*

Tongue-root harmony constitute the basic bidirectional change (cf. Zimmer, 1967 Ewe, Kalenjin, and this heading typically and since the material on both sides of rule of tradition Since bidirectional approaches (including these seem particularly We will see below assimilatory type cases, and that is that such a rule is

We should find harmony systems. as Igbo and Akan that is, is characteristic of [-ATR] vowels accordingly. On Diola Fогny and K of the 'dominant/dominant and the c ever a word contains vowel, all of the their dominant cov

single vowel's belonging to both harmony sets, potentially serious problems are posed for a theoretical position like that of autosegmental phonology where a unitary phonetic parameter is assumed to control the harmonic distinction.

### 3.3.3.3. *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 Fogany 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

course). 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 Paleo-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) [+syll] → [+ATR]  $\% \text{ \_\_\_ } C_0$  [+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 categorization of the root forward. All that languages, only root are restricted to vowel harmony rule (19) will perform in these cases as account of the aut constructed, of co limitation of [+AT We should note here is essentially the between Igbo and D conclusion that bidir handled adequately thus not a new one tage for prosodic

When we consider that prosodic It is a striking cases of tongue-re formatives that ar they contain vowel ([-ATR]), and thus have the effect of so that a dominant cannot affect a re There do not, how that are exception similarly delimit

Now observe harmony based on possible types of

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 these 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 Fogny 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 invariantly 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 invariantly 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.

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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 methodological section 2 should be in a classical sort to a

The point can be made as follows. If in Igb. there is a morpheme containing exceptions to the rule given in (20a), why

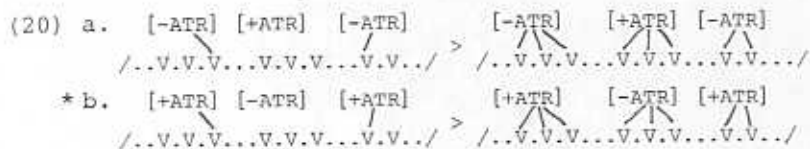
- (20) a. [-ATR] [+ATR]  
 /...V.V.V...V.V  
 \* b. [+ATR] [-ATR]  
 /...V.V.V...V.V

The absence of derivational harmony on the 'prosodic' view is not principled on the view of vowel harmony. We are thus left with the fact as the basis of a theory.

4. *Conclusions*  
 The theory of vowel harmony processes that neither a 'spread' nor an 'assignment', such as the autosegmental phonological description of such processes as palatal harmony, the neutralization of harmonic features of vowels. This does not show, however, that an arbitrary 'prosodic' content, such as the theory of Firth or the theory of structuralism, could account for such facts. Such a theory of little interest, however, in phonology is strongly

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)?



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 metaphony (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 metaphony, 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.

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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 *downdrift*). 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 reconstructed as a well-defined theoretical entity by subsequent 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 metaphony 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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A FORM

0. In this paper I discuss the vowel harmony that has been proposed (in the *preparation of phonological theory* coming) and in *Formal Phonology* (forthcoming). This paper was given at the Fifth International Conference on Phonology and Phonetics Methodology and Phonetics, Philadelphia, J.R. Vergnaud, 1977. I discuss the formal devices used in these papers.

1. The papers in this volume depart from the theoretical framework of Chapter 8 of *The Structure of Standard Phonology*. In this chapter of exposition, I show the inadequacies of the standard phonological theory and justify a revision of the theory. The modifications have been made in the phonological statement (in the sense of Zwicky) and the elements: a phonological statement is *nonlinear* (in the sense of Zwicky).