

The Autosegmental Treatment of Vowel Harmony

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Zusammenfassung: Eine Theorie der Vokalharmonie muß nicht nur beobachtungsadäquat sein, sondern muß auch im Stande sein, von Sprache zu Sprache wiederkehrende gleichbleibende Eigenschaften der Vokalharmonie zu erklären. Es wird gezeigt, daß verschiedene dieser Eigenschaften aus der Struktur einer autosegmentalen Theorie der Vokalharmonie abgeleitet werden können. In der autosegmentalen Phonologie besteht die phonologische Repräsentation nicht ausschließlich aus linearen Folgen von Merkmalbündeln (Phonemen); vielmehr können bestimmten Merkmalen Domänen zugewiesen werden, die kürzer oder (wie bei der Vokalharmonie) länger als das traditionelle Segment sind. Sätze werden daher gleichzeitig durch mehrere Strukturebenen repräsentiert, von denen jede aus einer Folge von 'Autosegmenten' (phonetischen Merkmalen oder Merkmalbündeln) besteht. Die Autosegmente verwandter Ebenen sind zueinander durch eine Wohlgeformtheitsbedingung in Beziehung gesetzt. Bei der Beschreibung von Vokalharmonie wird das die harmonische Klassenzugehörigkeit eines Wortes bestimmende Merkmal auf einer eigenen autosegmentalen Ebene repräsentiert. Die Art und Weise, wie sich dieses Merkmal über das Wort ausbreitet, wird von der Wohlgeformtheitsbedingung geregelt. Diese Theorie wird auf verschiedene Typen von scheinbar irregulärer Vokalharmonie angewendet: 'opake' Vokale, disharmonische Wurzeln und Schnellsprechregeln, die bewirken, daß sich ein Merkmal (wie z. B. Nasalität) über Nachbarsegmente hinweg ausbreitet.

1. In going about the task of constructing a phonological theory one tries to keep in mind a number of general principles which play a role in theory evaluation, of which two are of particular interest here. The first of these may appear so obvious as to require no mention: a valid theory must provide a framework within which the data can be correctly described; it must allow the investigator, adhering to its terms, to "account for the facts". This requirement, although certainly uncontroversial, has proven in the case of vowel harmony to be an extremely difficult one to satisfy. Theories of vowel harmony within existing generative frameworks have almost without exception been quickly falsified. In many cases, this has resulted from the reluctance of the investigator to consider sufficiently complex sets of data. There are many conceivable theoretical frameworks that might allow us to formulate the simple observation that all vowels in a word agree with respect to a certain phonetic feature category; what is difficult to do is to provide a well-motivated account of the many types of irregular and apparently exceptional behavior one encounters when one looks at vowel harmony systems in sufficient detail.

If this initial condition is satisfied, a new problem arises. This is the fact that within generative systems there are in principle many formalisms that can yield descriptively correct results. It is not sufficient, therefore, to show that we have a theory that "works". We must also be able to show that it is the most highly valued among the sets of descriptively adequate alternatives. To accomplish this we place the more stringent requirement on the theory that it allows the recurrent and invariable characteristics of the data to be deduced from the set of basic theoretical assumptions. Thus all else being equal, the more highly valued of two alternative theories will be the one which allows us to predict which

properties are always characteristic of the data and which properties are never characteristic of the data. Even though this condition may never be entirely satisfied, it will usually allow us to rank various proposed theories along a gradient of relative acceptability. To the extent that a theory of vowel harmony meets this condition, then, it can be considered to characterize the class of possible vowel harmony systems.

The latter of these two evaluatory principles, applied to the study of vowel harmony, requires us to determine which features of vowel harmony are "universal" in the sense that they regularly recur across historically unrelated languages, and to devise a theory that is compatible with systems exhibiting just this range of features, and no others. The investigation of a selection of vowel harmony systems in a wide number of language families suggests at least the properties which are listed below; this list follows in essential respects the conclusions reached by Ultan in research conducted for the Stanford Language Universals Project (Ultan (1973)):

- (i) **phonetic motivatedness.** As Professor Rédei has already pointed out at this conference, vowel harmony systems can be typologized according to the phonetic features which serve as their basis. These features will, I believe, prove to be defined by most or all of the following feature categories: back, high, round, advanced tongue root, constricted pharynx, nasal.
- (ii) **root control.** In most known systems, vowel harmony in suffixes is determined by the harmonic category of the root, rather than vice-versa. There are, however, a number of languages (such as Nez Perce and Kalenjin) in which certain affixes (or perhaps grammatical categories) may condition the shift of the root category, a shift which A. N. Tucker has termed "stem ablaut".
- (iii) **bidirectionality.** A fairly large number of languages with vowel harmony are of a morphological type which makes use of both prefixing and suffixing in word formation. In most of these languages (which include Akan and Igbo) vowel harmony is bidirectional in effect, in the sense that both prefixes and suffixes are subject to harmony.
- (iv) **unboundedness.** Vowel harmony processes are never observed to be subject to an arbitrarily-imposed limitation on the number of syllables affected, but apply over as many syllables as are contained in their domain (the domain of vowel harmony is usually the word, that is, the stem with its dependent affixes and clitics). In other words, vowel harmony is a process that spreads over a given domain without regard to the number of syllables contained in that domain; no vowel harmony process (as these are defined here) "counts" syllables. In this respect vowel harmony must be distinguished from purely local rules of metaphony or unclaut, which apply only one syllable to the left or right.
- (v) **nonoptionality.** There is no known case of a (root-controlled) vowel harmony process which applies optionally. This remarkable, but generally unnoticed, fact distinguishes vowel harmony from many other types of common phonetic processes, such as (local) assimilation.

2. Let us consider the general structure of a theory which attempts to satisfy the two requirements mentioned above. This theory is an extension of the autosegmental theory of phonology developed by John Goldsmith at M. I. T., for the initial purpose of treating problems in the analysis of tone and intonation. Autosegmental phonology takes its point

of departure from the observation that certain phonetic features (such as those characterizing tonemes) behave with relative independence with respect to others. Unlike standard versions of generative phonology, it permits such features and feature clusters to be assigned to separate, concurrent levels or "tiers" in phonological representations:



In these examples, "L", "M", and "H" are abbreviations for the feature complexes which characterize low, mid, and high tone respectively. The features and feature complexes assigned to each level (which for convenience we might term "autosegments") will not generally correspond in one-to-one fashion with the autosegments assigned to other tiers, as we can see from the representations in (1) and (2). In (1) I have represented a three-syllabled word bearing a single unit of tone, and in (2) I have shown the representation of a word bearing a final rising tone, which is analyzed into successive mid and high components. The relationship of association which binds autosegments on related tiers is indicated in such diagrams by the solid lines joining them. Such representations are phonetically well-formed in the sense that they describe unique patterns of coarticulation: any autosegment is coarticulated with any autosegment to which it is bound by an association line.

If such a view of phonological representation is to be formally coherent it must provide an exact specification of the set of well-formed representations, both underlying and derived. For this purpose Goldsmith has proposed a general condition on derivations termed the Well-formedness Condition; in Goldsmith (1976a) it is given as follows:

(3) Well-formedness Condition (tone)

- (a) All vowels are associated with at least one tone; all tones are associated with at least one vowel
- (b) Association lines do not cross

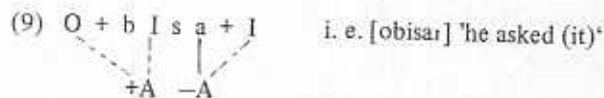
It can easily be seen that the representations of (1) and (2) meet this condition.

The Well-formedness Condition can be extended to the description of vowel harmony with no essential modification. Let us use the term "harmony feature" to designate the features that serve as the basis of any given vowel harmony system. The Well-formedness Condition for vowel harmony can then be stated as follows:

(4) Well-formedness Condition (vowel harmony)

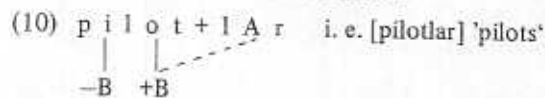
- (a) All vowels are associated with at least one harmony feature; all harmony features are associated with at least one vowel
- (b) Association lines do not cross

The Well-formedness Condition functions throughout the course of derivations, correcting ill-formed representations that may arise as a result of rule application. To see how it applies in the description of vowel harmony we may examine a concrete example from the Asante dialect of the Akan (Twi-Fante) language, a West African language whose vowel harmony system, based on the feature category of tongue root advancing, was first described in detail by Stewart (1967). The regular root *fiti* 'to puncture, to prick' belongs to the category of root-advanced or [+ATR] forms. We shall therefore assign it the representation given below:



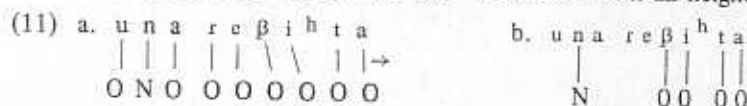
We can easily see that examples of this sort cannot be treated in an insightful way within the framework of most earlier generative treatments of vowel harmony (cf. Lightner (1965)). Such theories were unable to account for the fact that a root may contain two (or more) harmonic domains, each belonging to a different harmonic category. The autosegmental approach has no difficulty in handling such a fact; roots like *bisa* (which are frequent in the language) are treated as belonging, in effect, to two successive harmonic categories, which determine the harmonic behavior of prefixes and suffixes, respectively.

From this analysis it is easy to see how we might treat disharmonic roots (that is, roots which do not conform to vowel harmony internally). All vowels in such roots may be treated as opaque.³ Thus, consider the representation of the Turkish loan root *pilot* 'pilot' which is exceptional with respect to both backness ("velar") and rounding ("labial") harmony. The important generalization concerning such roots is that it is the final vowel that controls the harmonic behavior of suffixes. This fact follows as a formal consequence of the structure of our theory, since only one association can be entered by the terms of the Well-formedness Condition:

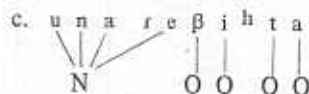


The alternative possibility, an association between the initial harmony autosegment "-B" and the suffix vowel, would of course constitute a violation of the condition that no lines may cross.

As a final illustration of the way the autosegmental approach allows a natural treatment of irregular harmonic phenomena we may examine a fast speech rule of nasal spread found in several languages, which causes the distension of the nasality feature across neighboring strings of vowels or sonorants until the first obstruent is reached. (Some languages, such as Igbo and Ewe, have a similar, but obligatory rule.) My example is drawn from a form of Castilian Spanish spoken in southern Spain. Consider, for example, the pronunciation of such a form as *una revista* [una rɛβi^hta] 'a review' which in fast speech may become [ūnā rɛβi^hta]. This may be attributed to the operation of an optional rule which has the effect of deleting the feature "oral" associated with all neighboring sonorants:



We postulate, on the basis of a certain amount of evidence that cannot be considered in detail here, that reassociation proceeds outward in all such cases from the autosegment which was the conditioning element of the rule. As a result, the Well-formedness Condition yields the following, unique output form:



Within this treatment, fast speech rules such as nasal spread are viewed as rules which simplify representations through the deletion of features; this allows a natural characterization of fast speech rules as rules that "obliterate distinctions". Features subject to such deletion are characteristically those which are nondistinctive or redundant in the segments concerned; in Spanish, for instance, nasality is nondistinctive in sonorant continuants.

Without going into detail we can see that this general approach can be extended to the treatment of so-called "asymmetric" vowel harmony systems (Aoki (1968)) such as those of Nyangamarda, Nez Perce, Diola-Fogny, Kalenjin, Somali, and many Bantu languages. These are languages in which root or affix vowels which must be lexically assigned to one harmonic category A shift to Category B in the presence of certain forms which are invariably of category B. Such harmony would result from a feature-deleting rule of the type exemplified by nasal spread in Spanish, except that such rules are obligatory.

Time prohibits discussion of further important aspects of the analysis of vowel harmony, such as the treatment of (transparent) neutral vowels and of the blocking effect of certain consonants. These topics are discussed in a fuller study of vowel harmony now in preparation (Clements, to appear).

3. We have asked of a theory of vowel harmony that it provide an explanation for the recurrent, invariant properties of vowel harmony systems such as those proposed at the outset. Let us now review the way in which the autosegmental treatment accounts for these.

First, in regard to the principle of phonetic motivatedness, we see that this is a necessary consequence of the fact that autosegmental representations are given in terms of phonetic features, rather than (for instance) in terms of diacritic features or Firthian prosodies. Within this framework, therefore, it would be extremely difficult to describe a vowel harmony system based on a phonetically arbitrary vowel classification.

The further, recurrent properties of vowel harmony also follow from the structure of the theory. The principle of root control is the consequence of the assignment of vowel harmony autosegments to roots, but not in general to affixes (cf. example 7). It is postulated within this system that roots are always assigned harmony autosegments; thus, the root category will always spread to the neighboring (nonopaque) affixes. In order to express harmony phenomena controlled by elements other than roots, as in the case of nasal spread or of asymmetrical harmony systems, we postulate the application of language-specific deletion rules. It will be observed that this treatment allows the deduction that the non-optionality condition can only be broken in harmony systems of the latter types; in fact, Spanish nasal spread can itself be regarded as an asymmetrical, optional vowel harmony system.

Finally, the characteristics of bidirectionality, non-optionality, and unboundedness follow from the form of the Well-formedness Condition. Harmony systems (symmetrical systems) which do not display these characteristics are simply inexpressible within the vocabulary of autosegmental phonology.

4. At the outset we mentioned two criteria that play a fundamental role in theory evaluation. These will not themselves, however, prove sufficient to justify the choice of one theory over another in all cases. Let us consider the hypothetical case of a pair of theories both of which are adequate at the observational level, and both of which allow identical sets of deductions to be drawn about the characteristics of the data. Such theories will not necessarily be notational variants; they may differ in important respects in

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terms of their formal structure. Thus, of two theories, one may rely crucially upon the use of ad hoc entities, notations, or processes whose only motivation lies in the description of the data under consideration, while the second employs a set of theoretical categories which is consistent with, and (at least in part) deducible from the fundamental assumptions of the general theory of which it forms a component. In such a case we find justification for the choice of the latter theory in the fact that it relies upon concepts which themselves play a crucial role in the explanation of larger, independent, domains of investigation.

In this respect, it is important to remember that the autosegmental theory of vowel harmony is only one aspect of a general theory of phonological structure which has so far been devised and justified on the basis of entirely independent areas of phonology. We have not been able to review the nature of this evidence here; a summary and further discussion of the formal structure of autosegmental phonology with references to other research can be found in a recent article by Goldsmith appearing in *Linguistic Analysis* (Goldsmith (1976a)) and in his dissertation (Goldsmith (1976b)). It should be emphasized that autosegmental phonology, a theory which differs in many important ways from standard, linear views of phonology, is a theory still in the process of development whose consequences for many further areas of research still remain to be explored. Its potential as an alternative view of phonological structure can be seen in the extent to which it has so far managed to provide simple and elegant solutions to a number of the traditional puzzles and problems presented by prosodic phonology.

(Earlier versions of this talk were given at the M. I. T. Workshop on Formal Problems in Phonology and at the University of Salzburg, in June, 1975. I would like to thank John Goldsmith and Morris Halle for extensive discussion of the issues treated here.)

Discussion (summary)

Autosegmental phonology could be regarded, in part, as an attempt to construct a formal theory capable of expressing some of the insights about prosodic structure which Z. Harris and J. R. Firth shared.

The extension of autosegmental phonology to vowel harmony suggests the possibility of parallels between tone and vowel harmony. We find a phenomenon similar to floating tones in the displacement of certain vowel features from deleted vowels onto neighboring segments. Such processes have been described for Modern Greek in a paper given by the Drachmans at the Salzburg meeting⁴ in August, as well as for Mongolian by Poppe in his *Mongolian Language Handbook*, and are probably much more widespread. Within autosegmental phonology we can regard such vowel features as being "set afloat" by the (incomplete) deletion of a vowel; they would subsequently re-associate to the neighboring segment under the Well-formedness Condition.

We must distinguish between vowel harmony proper, as illustrated in the Akan and Turkish examples, and the vowel harmony processes that are brought into play by the application of a rule, as in the Spanish nasal spread example. Whether processes of the latter type are bidirectional or unidirectional depends on whether

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