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The phonetic and phonological basis of the Simplex Feature Hypothesis*

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Introduction

Recent years have shown an increased interest in simplex or single-valued features; for an early statement, cf. Sanders (1972). On one view, a single-valued feature system represents the logical end point of what is called Radical Underspecification (Kiparsky 1982; Archangeli 1984; 1988). The central goal is to express the idea that the two poles of logically binary oppositions do not play the same role in the phonology. Radical underspecification theory expresses this by using binary features, while stating that only one value may be specified in the underlying representations; the other value, often called the default value, is added during or at the end of the derivation. In a single-valued approach a stronger claim is made. The default value is eliminated as a phonological entity altogether, so that the feature is single-valued at all stages of the phonological derivation. The single-valued theory that I will defend is also stronger than current underspecification theories in another way. I claim that it is always the same value of a feature which represents the marked phonological property. In underspecification approaches the possibility is allowed that either of the two values is marked.

In this article I will propose a particular single-valued feature system for vowels, which differs from other current single-valued systems, although it shares fundamental insights with some of them. Phonological and phonetic justification will be provided for this approach. I will suggest how the system can be put to use in the analysis of vowel harmony processes and conclude with a brief discussion of potential arguments against a single-valued system.

1 Single-valued features for vowels

My proposal can be seen as a development of Dependency Phonology (DP, cf. Anderson & Ewen 1987) and Government-based Phonology (GP, cf. Kaye, Lowenstamm & Vergnaud 1985) and much work related to these approaches (e.g. Schane 1984; Goldsmith 1985; Rennison 1987). For a somewhat critical discussion of these approaches I refer to den Dikken & van der Hulst (1988).

A study of typological surveys of phonological systems, e.g. that of Maddieson (1984), reveals that the overwhelming majority of vowel systems is triangular in shape; i.e., in general, there are more oppositions amongst high vowels than amongst low vowels, so that languages having two low vowels differing only in the front-back dimension, and not in length, are very rare. A feature system like that of SPE, however, treats the vowel space as rectangular, as in (1):

(1)

	[−back]	[+back]	
[+high]	/i/	/u/	[−low]
[−high]	/e/	/o/	[−low]
[−high]	/æ/	/ɔ/	[+low]

On the basis of typological considerations, then, we would rather like to have a feature system which characterizes vowel systems as triangular (cf. Fischer-Jørgensen 1984a,b and Basbøll 1984 for a discussion on these matters). We can do this, following DP and GP, by assuming a different feature system which takes the three points of the vowel triangle as basic. This gives us three features, which will be represented in terms of the letters |i|, |u| and |a| between vertical strokes. A simple three vowel system consisting of [i], [u] and [a], can now be represented in the following way:

(2) /i/ |i| /u/ |u|

/a/ |a|

Not all vowel systems are of the form in (2), however. Vowel systems may include, for example, mid vowels, front rounded, back unrounded, central vowels, advanced vs. retracted vowels, etc. Within the present approach, and again I share this with DP and GP, most additional vowels are represented by combinations of the three features. For example, mid front vowels can be represented as a combination of the feature |i| and |a|.

But vowel systems can contain more than one mid front vowel. Assuming that we want to characterize both as combinations of |i| and |a|, we then need some way of stating the difference. This is where the dependency or government relation comes in. A characteristic of the present approach, also shared with both DP and GP, is that the features which make up the content of segments are organized in terms of an asymmetrical relation indicating, in intuitive terms, which of them represents the most salient property of the segment in question. Hence, given that we have two features |i| and |a|, there are two possible feature structures:

(3) a. [e] b. [ɛ]

```
(3)   a.  [e]     b.  [ɛ]
          i           a     (governor)
          |           |
          a           i     (dependent)
```

Using representations as in (3) raises the question how we interpret them phonetically and how we actually can tell that combining |i| and |a| gives us an [e]-like sound rather than a voiceless lateral velar fricative. This is where the phonetic interpretation of the features becomes relevant.

In my approach the status of each feature as either *governor* or *dependent* is reflected by a distinct phonetic interpretation, corresponding to what would be a separate phonological feature in feature systems which do not make use of the government-dependency (henceforth GD) relation. The interpretation I propose for |u| is the following:

```
(4) Interpretation of |u|:  Governor:    Velar constriction
                                                 |
                            Dependent:       Rounding
```

These two aspects of |u| correspond to different articulatory gestures which naturally go together in the sense that lip-rounding *enhances* the acoustic effect of velar constriction (cf. Stevens et al. 1987). It is, therefore, far from arbitrary to give formal expression to the intimate relation between roundness and backness in the way proposed here. I would like to go further and state that in any theory of features it must be accounted for that the features [velar] or [back] and [labial] or [round] are intimately related.

What I propose here reflects the same idea which has guided our choice for single-valued features, viz. the idea that markedness considerations should be expressed directly in the phonological formalism. The use of single-valued features represents an attempt to express directly the notion of marked value, as stated earlier. However, markedness not only involves the 'context-free' phenomenon that one value of every feature is marked, it also involves 'context-dependent' phenomena such as the fact that backness and roundness tend to come together. The present proposal, then, represents an attempt to build the latter type of markedness into the phonological formalism.

For the features |i| and |a| I suggest the following dual status:

(5) Interpretation of |i|:
G: Palatal constriction
|
D: Advanced tongue root

(6) Interpretation of |a|:
G: Pharyngeal constriction
|
D: Openness

Can we justify the grouping of properties in these cases, too? We know that palatal constriction arises from advancing the tongue root, as clearly indicated in the studies of Wood (1982). It is therefore not arbitrary to suggest that the [Advanced tongue root] is closely linked to the [Palatal constriction]. Similarly, it is also clear that a-type vowels are produced with a jaw opening which is wider than that for u-type vowels, in addition to the fact that the former have a pharyngeal constriction, showing that jaw opening and pharyngeal constriction tend to co-occur as well.

The use of |i|, |u| and |a| instead of the SPE features, with their interpretation as linguistically relevant constriction locations, ties in rather well with findings and proposals regarding vowel systems, presented in Wood (1982), who shows in some detail that the traditional tongue arch model in which vowels are characterized according to the location of the highest point of the tongue simply cannot be maintained in the light of X-ray recordings of actual vowel production.

Let us look at some further aspects of the model. Consider the representations in (7) of simple three or five vowel systems:

(7)

/i/	/u/	/a/		/i/	/e/	/u/	/o/	/a/
i	u	a		i	i	u	u	a
					|		|	
					a		a	

I will adopt a universal default rule which assigns a dependent feature identical to the governor, unless the absence thereof is distinctive in the system. In this way I account for the fact that, for example, a back vowel is naturally rounded:

```
(8) Universal default rule:    f   →   f
                                       |
                                       f
```

Furthermore, I assume that the phonetic interpretation of features is *absolute*, in the sense of *non-gradual*. From this it follows that a single feature can occur at most twice in the representation of a single segment, once as governor and once as a dependent. This means that for any pair of two features we can generate 8 feature structures; take |i| and |a| as an example:

```
(9)   i    i    i    i    a    a    a    a
      |         |    |    |    |         |
      i        a,i   a    i   a,i        a
```

These representations characterize a spectrum of vocalic segments, which are phonetically adjacent, using a term from Ladefoged & Maddieson (1986).

I also assume that the phonological representation of a particular phonetic segment is, in part at least, *system-dependent*. For example, the way in which a vowel [e] is represented in a given system will depend on its phonological behaviour and on which phonetically adjacent distinctive segments are present in the system. Thus, I will allow an e-type vowel to be represented in terms of either of the three structures in (10):

```
(10)   a.  i        b.  i        c.  i
                        |            |
                       a,i           a
```

Shortly, I will show that this flexibility, although perhaps suspect at first sight, is actually necessary.

To conclude this sketch of the model, let me make some comparative remarks. In this feature system, there is no need for an independent feature [ATR], since ATR is identified with the feature |i| in dependent position. I emphasize this, because both DP and GP have a separate feature [ATR]. Also, DP and GP use a fifth feature or element, which plays an essential role in the characterization of central and back unrounded vowels. In the present proposal we characterize central and back unrounded without the use of extra features. Consider the following representations:

(11)	a.	/ɯ/	/u/	b.	/i/	/ɨ/
		u	u		i	i
			|			|
			u			i

I assume here that the presence vs. the absence of a dependent feature expresses a phonemic distinction. Given the phonetic interpretation of our features, (11a) represents the distinction between a back unrounded and a back rounded vowel. The feature specifications in (11b) represent a distinction between an advanced high front vowel and its non-advanced or slightly less fronted counterpart. It seems to me that these are the kinds of distinctions we need for systems having central or back unrounded vowels.

One could object to the representations in (11), saying that rounded back vowels are formally more complex than their unrounded counterparts, whereas they are less marked typologically. One should not fail to notice, however, that it is the presence of the back unrounded vowel in a system which causes this complexity. If such a vowel is lacking, /u/ is simply represented in terms of a governor |u| without |u| as dependent feature. It is not clear that 'system-complexity' should be reflected in the representation of the sounds which happen only to occur in more complex systems. To be explicit: I will reject this correlation. Insofar as feature structures in isolation represent complexity, this is phonetic complexity rather than typological complexity. The latter type of complexity can be derived from looking at the vowel system as a whole.

2 Harmony systems

Having set out the basic ingredients of my proposal, I will briefly indicate what implications it has for the analysis of vowel harmony processes. My claim is that long-distance harmony processes typically involve the spreading of features in dependent positions. This gives us three types of vowel harmony, involving |i|, |u| or |a|.

2.1 |i| systems

Since the operator feature |i| represents ATR, it seems as if we cannot make a distinction, at the phonological level, between ATR-harmony, common in many African languages, and palatal harmony, as for example in Finnish and Hungarian. Indeed, I want to suggest that the two types of systems are closely linked, in that both involve the spreading of |i|. There are two reasons which justify this claim. Firstly, it has been shown that there can be a diachronic development from one into the other (for example by Svantesson 1985 with reference to Mongolian), suggesting that the two are close phonetically, and, secondly, to my knowledge no language has both palatal and ATR-harmony, which suggests that the two are phonologically identical. I will assume therefore that the two in fact do not differ and that both involve the spreading of |i|. The difference between ATR-harmony and palatal harmony arises from slightly different phonetic implementations, possibly due to overall properties of the phonological system. (A potential problem here involves Koromfe, discussed in Rennison 1987, which seems to involve both palatal and ATR harmony; I refer to van der Hulst 1988 for a discussion of this case.)

A rather complex vowel system with [ATR] harmony, that of Kpokolo (a Kru language, discussed in Kaye et al. 1985), comes out as follows in the present feature system:

(12)	/i/	/e/	/ɨ/	/ə/	/u/	/o/		/ɩ/	/ɛ/	/ᵻ/	/a/	/ɜ/	/ʊ/	/ɔ/
	i	i	u	u	u	u		i	i	u	a	u	u	u
	|	|	|	|	|	|			|			|	|	|
	i	a,i	i	a,i	u,i	a,i,u			a			a	u	a,u

The advanced counterpart of /a/ in Kpokolo is /ə/, which is also the regular counterpart of /ɜ/. Apparently, then, the result of harmonizing /a/ has to be merged with the harmonic congener of /ɜ/. I will assume that in Kpokolo |a| cannot govern |i|. When |i| spreads to |a|, |a| is demoted to dependent status and |u| acts as a default governor:

(13)	a		•		u
	|	=	|	=	|
	i		a,i		a,i

An additional fact about Kpokolo is that rounded vowels alternate with central vowels. Given our featural representation, this involves the presence or absence of dependent |u|.

2.2 |i| *and* |u| *systems*

Various systems, especially in the Altaic family, have both palatal (or ATR) harmony and labial harmony. In Turkish labial harmony is limited to high vowel targets. Due to the fact that, at least for high vowels, two harmonies operate together, we get a four-way alternation: /i, y, ɨ, u/ (Clements & Sezer 1982). If these four vowels are to differ only in their dependent features we must represent the vowel system as follows:

(14)

/i/	/y/	/ɨ/	/u/	/e/	/ö/	/a/	/o/
i	i	i	i	a	a	a	a
|	|		|	|	|		|
i	i,u		u	i	i,u		u

Thus for a system of this type it is unnecessary to have |u| as a governor. I will assume that this is a parameter of the grammar. To be more specific, I will assume that a system can have all three features as governors, only |i| and |a| or only |a|. The last-mentioned option might be useful in characterizing so-called one-vowel systems, as for example found in the Northwest Caucasian languages (cf. Halle 1970).

I will furthermore assume that the precise phonetic interpretation of governors depends on the presence of other governors. Hence, in the case at hand, the interpretation of |i| switches from 'palatal constriction' to 'tongue-body constriction'. A result of this is that the characterization of many vowel systems becomes ambiguous. As it stands, we crucially need |u| only in systems having central vowels such as that of Kpokolo. In all other cases, we have to rely on phonological considerations to decide whether |u| plays a role or not.

Another Turkic language, Kirghiz, also has both palatal and rounding harmony. In certain contexts, however, rounding harmony is limited to front vowels only. This phenomenon, which appears to occur in other Turkic languages as well, has been referred to by Steriade (1981) as parasitic harmony (cf. also Cole & Trigo 1988; Mester 1988). The idea is that rounding harmony takes a free ride, as it were, on the palatal harmony. The 'group' behaviour of |i| and |u| cannot be expressed in the present model. Let us assume that |u| can be dependent on |i|, even though |i| itself is dependent on |a| or |i|:

(15)

```
|a|
 |
|i|
 |
|u|
```

(In van der Hulst 1988, I assume that |i| and |u| are dominated by a node which is labelled |y|.) For Kirghiz then we will assume the following representation of the vowel system:

```
(16)  /i/  /y/      /ɨ/  /u/      /e/  /ö/      /a/  /o/
       i    i        i    i        a    a        a    a
       |    |             |        |    |             |
       i    i             u        i    i             u
            |                           |
            u                           u
```

That rounding harmony can take place in front words, where it does not on vowel sequences of the same height in back words, follows from the fact that the spreading of |i| must entail spreading of |u|, if |u| is present.

In addition Kirghiz does have an independent rule of |u|-spreading, but the point is that this rule does not cover all combinations of vowels of different height. 'Parasitic' status of some features represents a parametrized choice, since in Turkish, for example, |i| can spread without causing parasitic rounding harmony.

We have now discussed cases of both |i|-spreading and |a|-spreading. To complete the picture, let us look at one case which involves |a|-spreading.

2.3 |a|*-spreading*

The harmony systems of Nez Percé, Chukchee and Middle Korean, which have been referred to as 'diagonal' and which have been analysed in terms of [−ATR] spreading, can be understood in terms of |a|-spreading. Consider the well-known case of Nez Percé (Hall & Hall 1980):

```
(17)  /i/  /æ/  /a/  /o/  /u/
       i    a    a    u    u
                 |    |
                 a    a
```

Here /u/ alternates with /o/, and /æ/ with /a/. Given the representation in (17) both alternations involve the absence versus the presence of |a|. A similar analysis is offered in Anderson & Durand (1988).

3 Problems

In this section I will discuss a number of cases which could be considered problematical for the single-valued feature system proposed here. Problems can be of two types. Firstly, we sometimes encounter the apparent necessity of referring to the 'wrong' value of a particular feature, either because both values are necessary or because the other value is considered to play the role of the default value. Secondly, the problem might instead, or in addition, relate to the particular choice of features. I mainly restrict myself here to discussing two cases of the former type.

3.1 The wrong value as a blocker: the case of Kalenjin

Sometimes vowels fail to undergo a spreading even though their feature composition would not exclude a fusion with the spreading feature. A well-known case in which we run into this problem involves ATR-harmony in Kalenjin, as discussed in Hall et al. (1974). The problem raised by this case is discussed in Dresher (1985) and in Ringen (1988). We want to prevent certain low vowels from undergoing ATR-harmony while in general low vowels have an ATR-congener. In binary systems we can handle cases of this type by assigning a negative specification to the vowels at issue:

(18)
```
[-ATR]
  |
  V
```

In a single-valued approach, we are forced to invoke a negative condition, which is formally distinct from a phonological feature. I therefore suggest that we allow such negative conditions and I claim that such a move is supported by similar proposals made in work on feature structures within the framework of unification grammar. It has been suggested in Karttunen (1986) that we make a distinction between specifying a feature with a value and imposing a condition saying that a particular feature does not have (and may not get) a particular value. 'A negative constraint attached to some structure A limits the class of structures that can be unified with A. It is not part of the content of A itself' (Karttunen 1986: 27). I suspect that a translation of autosegmental spreading into the unification formalism will reveal that negative conditions give us just the power we need here, but I leave this for future research.

3.2 The wrong value as a spreader: the case of Yoruba

We have discussed a case of |a|-harmony. Hall & Hall have suggested that Nez Percé involves the spreading of [−ATR], which would be totally impossible in this model. Recently another case of alleged [−ATR] harmony has been revealed. Archangeli & Pulleyblank (1988) suggest that vowel harmony in Yoruba involves leftward spreading of [−ATR] and as such their analysis raises a problem for the single-feature framework assumed in much recent work including my own. Yoruba has a seven-vowel system:

(19)

/i/		/u/
/e/		/o/
/ɛ/		/ɔ/
	/a/	

A high mid vowel and low mid vowel cannot co-occur, but in addition /e/ and /o/ do not occur to the left of /a/. Archangeli & Pulleyblank claim that the data can only be straightforwardly analysed if [−ATR] spreads from right to left, [+ATR] being the default value. I cannot give their argumentation here. Let us simply assume that they are correct in pointing out that [+ATR] cannot be the spreading value. I claim that the Yoruba harmony system can be analysed in terms of |a|-spreading, but, in order to do that, I must represent the vowels in the following way:

(20)

/i/	/u/	/e/	/o/	/ɛ/	/ɔ/	/a/
i	u	i	u	i	u	a
|	|			|	|	
i	i			a	a	

The most remarkable aspect of this representation is presumably the fact that high mid vowels are represented as [−ATR] high vowels, rather than as [+ATR] mid vowels. It will be clear that a featural analysis as in (20) permits a different view on the spreading process. Segments which, in Archangeli & Pulleyblank's analysis, cause [−ATR]-spread constitute a natural class here in being |a|-specified.

4 Conclusions

In this article I have presented the outlines of a system of single-valued features for vowels. Essential to the proposal is that features can be combined asymmetrically, and that their phonetic interpretation is sensitive to this relation. I have shown that this specific proposal leads to a straightforward analysis of a wide variety of harmony systems.

A claim which cannot be dealt with here is that our approach, due on the one hand to the particular choice of features and, on the other hand, to their strict single-valuedness, compares favourably to approaches using binary features and radical underspecification in that it reduces the number of possible phonological grammars, thus explaining phenomena which would otherwise be coincidental.

Finally, in the last section we have looked at two cases which appear, at first sight at least, to be problematical for the feature system proposed here. For these cases it has been shown that there is in fact an analysis consistent with our model.

Obviously there are many details to be spelled out and even more problems to be solved. Despite that, I believe the approach to be interesting and worthwhile pursuing.

Note

* The ideas expressed here first appeared in van der Hulst (1987). Further developments of the model are found in van der Hulst (1988; 1989; 1990) and Smith & van der Hulst (1990). This article must be seen within this 'historical perspective', i.e. as a bridge between van der Hulst (1987) and van der Hulst (1988, mainly sect. 1 and 2). In van der Hulst (1989) and subsequent papers the point that led to diagram (14) in the present paper is developed further in that it is proposed to organize the three components in a fixed hierarchical structure.

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