THE DUAL INTERPRETATION OF [i], [u], [a] AND [u]

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0. Introduction

In this paper I will propose a feature system for vowels. The system shares fundamental insights with the systems of Dependency Phonology and Charm Phonology, which will be discussed in section 1. In section 2, I will provide phonological and phonetic justification to support my proposal and, in section 3, I will apply the system to a variety of "test cases", mainly involving harmony processes.

1. Background

In this section I will briefly discuss two approaches to vowel features, that of Dependency Phonology (e.g. Anderson & Levin 1987) and that of Charm Phonology (e.g. Kaye et al. 1985). I do not intend to give a detailed overview. My purpose here is to make clear that my own proposal can be seen as a natural development of certain aspects of these approaches.

Dependency Phonology (DP) has four basic SINGLE-VALUED FEATURES:

(1)  [i], [u], [a], [a]

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The features are: [Front] represented as [i], [Round] represented as [u], [Low] represented as [a] and [Central] represented as [a]. DP also has [Advanced tongue root] (henceforth [ATR]) to deal with harmony systems involving this feature, but it is not integrated into the system. I will represent it here as [a]. In this system, then, the vowel system in (2a) is represented as in (2b):

(2)  a. /i/ /u/  b. ([i]) ([u])
     /a/

A vowel which is high, front and uncrowded is quite simply and exhaustively represented in terms of the feature "set" ([i]). More complicated vowel systems involve segments whose feature specifications are more complex. For example: a mid front unrounded vowel /e/ is represented as ([i], [a]), a front high rounded vowel /y/ is represented as ([i], [u]), etc.:

(3)  a. /i/ /y/ /u/  b. ([i],[u]) ([i],[u])
     /e/ /ɛ/ /u/     ([i],[ɛ]) ([i],[u])

The centrality component, which was absent in early versions of DP (e.g. Anderson & Jones 1974), plays a role in the analysis of vowel systems having a series of central vowels:

(4)  a. /i/ /i/ /u/  b. ([i]) ([a]) ([u])
     /ɛ/ /ɛ/ /u/     ([i],[a]) ([a]) ([u])

Another aspect of the DP system is the fact that DEPENDENCY RELATIONS are used to express various vowel heights, e.g.:

(5)  /i/ /ɛ/ /ɛ/ /a/
     i i a a
     a i

In the case of /ɛ/, this notation expresses that [i] "governs" [a], or, alternatively, that [a] is "dependent on" [i]:

(6)  i governor/head
     a dependent

A final remark about the DP system, which I will come back to below, is that at least one proponent of this system, Lass (1984), has proposed to "split up" [u] into [u] ([Round]) and [u] ([Back] or [Velar]).

The second approach to be discussed here is "Charm
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Phonology" (CP), as proposed in Kaye et al. (1985). In the CP system the phonological primes are called ELEMENTS. Elements are not simply single-valued features; they are defined in terms of fully specified feature matrices and interpreted as "pronounceable" units:

\[
\begin{array}{cccccccc}
|u| & |i| & |a| & |æ| & |u|
\end{array}
\]

The binary features are not phonological primitives. They play a role, as we will see below, in the "fusion calculus", but for the phonology the elements are the primitives, rather than the features. Here I will disregard the difference between the interpretation of primitives as "features" (the CP position) or as notation.

In CP every element except |a| has precisely one HOT FEATURE (intuitively representing its most salient property), capitalized in (7), but there is no element for which |low| is the hot feature. Elements characterize segments either on their own or when fused. Kaye et al. provide a fusion calculus, which says that in a fusion one element, the OPERATOR, carries over its hot feature to another element, the HEAD:

\[
\begin{array}{cccccccc}
|-round| & -round & -round & -round & -round \\
+back & -back & +back & +back & +back \\
+high & -high & +high & +high & +high \\
-attr & -attr & -attr & -attr & -attr \\
\end{array}
\]

Notice that an element functioning as an operator represents a subset of the properties which are represented by the same element functioning as a head. For example, the roundness aspect of |u| is "isolated" when |u| has the status of operator. In that case only |u|'s hot feature ([-round]) is of importance for the result of fusion. Notice that the "extracting out" of roundness bears some resemblance to Lass's suggestion to split up [u].

As in CP, the fusion operation is asymmetric. Reversing operator and head leads to another vowel:

\[
\begin{array}{cccccccc}
|i|, |a| \to & -round & -back & +low & -attr
\end{array}
\]

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An aspect of CP which I want to draw attention to is that the element |i| has special properties: it does not reside on an autosegmental line. In normal cases it cannot be the head or the only element exhaustively characterizing a vowel.

The preceding brief overview shows not only that DP and CP share the use of dependency relations between the phonological primitives, but also that the sets of the primitives are also highly similar. But we noted some developments and discrepancies. Early versions of DP started out using three components (|i|, |u| and |æ|), while CP added a later addition. A further expansion of the feature set occurs in Anderson & Even (1987), where [æ] is added. In two important respects, CP represents a modification of the DP system, firstly, in assigning a special status to |i| and, secondly, in differentiating (implicitly) between operator and head properties of elements. In the next section it will become clear that these developments and modifications in some sense "prefuse" my own proposal, which will involve a "return" to the position that we need no features other than |i|, |u| and |æ|.

2. The proposal

The essence of my proposal is to give a substantive interpretation to the formal status of features. I propose that the status of the three features as either HEAD or OPERATOR is reflected by a dual phonetic interpretation. As in DP and CP, I assume that a feature can be either a head (or governor) or an operator (or dependent) and, as in CP, I take it that the two functions are associated with different phonetic aspects of the feature:

\[
\begin{array}{cccccccc}
\text{(10) Interpretation of } |u| \\
\text{Head: Velar constriction} \\
\text{Operator: Rounding}
\end{array}
\]

The two aspects of |u|, velar (head) and rounding (operator), correspond to different articulatory gestures which naturally go together in the sense that liprounding 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 want to suggest now further that the features |i| and |æ| have a similar dual status. An important consequence of this move is that we can dispense with the feature |i|. A second innovation will be that a feature can occur both as head and as operator in the interpretation of a single vowel. A move which enables |æ| to dispense with the feature |æ|, as we will see below. In (11), I suggest the dual interpretation of both |i| and |æ|:
mean as a substitute for it. Cf. van der Hulst (1988) for a discussion of the feature [Tense]. Logically the three features as heads define seven "locations" (cf. 5), which is clearly to much. Wood however is not concerned with the generative capacity of the feature system. He represents u-type vowels as palato-velar, suggesting (translated into our system) that the feature [u] alone does not define a stable constriction location. Also, he represents /e/ type vowels as [-palatal, +open], suggesting that [l, a] is superfluous as a constriction location (if "constriction" is the right word to use here).

There are two possible ways of reducing the number of combinations of head features. We could say that head features simply do not combine, or that only [l, e] and [u, a] do not combine. Here I will take the stronger position and make no use of multiple-headed representations. In Even & van der Hulst (1988) it is further proposed that the three head features are hierarchically arranged as in (13):

(13)  

Tongue-body constriction     Pharyngeal constriction

<p>| | |</p>
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It is argued there that the impossibility of combining [u] and [l] would follow straightforwardly if we regard them as VALUES of the feature [y] ("tongue body constriction"). In addition, the fact that [a] can combine with [y], rather than with [l] or [u], possibly relates to the fact that the former are at the same hierarchical level. Cf. Even & van der Hulst (1988) and van der Hulst (1986) for further discussion of this matter.

Having outlined the essence of the current proposal, I will discuss a number of issues involving the relation between operators and heads, without striving for completeness and leaving many issues "in the air".

In simple three or five-vowel systems, most Operator specifications are redundant (cf. 14). I will assume that head features redundantly have themselves as operators, unless the absence of an operator is distinctive within the system. (15) represents a general redundancy statement expressing this (from now on I will indicate head status of a feature with capitals, and operator status with lower case):

(15)  

/1/ /u/ /a/  /1/ /e/ /u/ /o/ /a/  

I   U   A  I   I   U   U   A  

/1/ /a/  /1/ /a/  

I   a  a
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(15) OPERATOR REDUCTION (OR)

\[
\begin{array}{ccc}
  & U & A \\
 I & u & a \\
 A & i & u
\end{array}
\]

Above, I showed how we dispense with the feature [i]. In feature plays a crucial role in the characterization of central dispense with this feature in the following way. Nothing stops us from the presence vs. the absence of an operator to express a phonemic distinction. Consider the following representations:

(16) a. /a/ /u/ b. /i/ /u/ 

\[
\begin{array}{ccc}
  & U & A \\
 I & u & a \\
 a & i & u
\end{array}
\]

(16a) represents the distinction between a back unrounded and a representation of an advanced high front more centralized high front unrounded and a clearly front and interpret a sound of [i]. Whether or not the latter depends on the centrality one attaches to the fact that no central unrounded vowels. This is not the point at issue here, without further component such as the centrality component used in DP.

Intuitively, this proposal says that something specified with [U] (a head) and nothing else is rounded (by virtue of 15), there is a vowel which is minimally different in having [U] as an because the vowel /a/ is LESS marked but formally MORE complex notice that it is the presence of /a/ in a system which causes be reflected in the representation of the sounds whose presence presupposes the presence of certain other sounds.

Let us now investigate the consequences of allowing free combinations between sets of head features and sets of operator are allowed in DP and CP, and we allow one feature to occur combinations of two heads (roughly corresponding to the DP notion of me not disturbingly great:

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(17) I I I I I A A A A

\[
\begin{array}{cc}
  & A \\
 a & i
\end{array}
\]

As we will see in section 3.3., some systems use a fairly large number of distinctions. In van der Hulst and Smith (1987b), we showed that various Eru languages offer quite severe problems for standard feature systems anyway, precisely in this "region" of the vowel space. Now consider the possible modes of combining [i] and [u]:

(18) I I I I U U U U

\[
\begin{array}{ccc}
  & u & i \\
 u & i & u
\end{array}
\]

A system such as that of Kpokolo (Kaye et al. 1985) has six of the eight possibilities in (18), lacking the third and fourth representation; cf. (21) below.

Future research may lead to other formal or substantial universal constraints on possible vowel feature structures. I refer to van der Hulst (1968) for further discussion of the formal basis of the feature system. For now I leave this matter rest and proceed with a discussion of the analysis of some vowel harmony systems.

3. Harmony systems

In this section I intend to illustrate the most important characteristics of the feature system proposed here by offering analyses of a number of well-known harmony systems. I do not claim that these schematic analyses are complete, but limitations of space prevent me going into details. For a more elaborate discussion I refer to van der Hulst (1968), where I also discuss the merits of this approach to harmony systems as compared to other current approaches.

3.1. Advanced tongue root and Palatal harmony

Since the operator specification [i] represents ATR, it seems as if we cannot make a distinction at the phonological level between ATR-sprreading and palatal harmony, as for example in Finnish and Hungarian, on the assumption that only operator features spread. Indeed, I want to suggest that the two types of systems are closely linked, in that both involve the spreading of [i]. This is precisely what we want. First, it has been claimed that there can be a diachronic development from one into the other (cf. Svantesson 1985 and section 3.2.), which suggests the two are closely related, and, secondly, no language has both palatal and ATR-harmony, which suggests that the two are
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phonologically identical. I will assume therefore that the two do not in fact differ and that both involve the spreading of [i]. Take Finnish:

(19) /i/ /y/ /u/ /e/ /o/ /a/  
    I U U I U U A A  
    | | | | | | | 
    a, a, a, a

As is well known, the vowels /i/ and /a/ are transparent. In fact that [back] can spread "through" these vowels without affecting them. Clearly, in this approach, only [back], i.e., [i], can spread. A spreading [i] can spread across /i/ or /a/ because these vowels will end up having this property anyway. In other words there is no Feature Cooccurrence Constraint (FCC) blocking vowels acquiring [i] by a redundancy rule. It comes as no surprise that they fail to trigger harmony.

A ten-vowel ATR-system then is characterized as follows:

(20) /i/ /u/ /e/ /o/ /a/ /I/ /U/ /E/ /O/ /A/  
    I U U I U U A A  
    | | | | | | | 
    a, a, a, a, a

A more complex system, that of Kpokolo (discussed in Kaye et al. 1985), comes out as follows:

(21) a. /i/ /I/ /u/ /U/ /e/ /E/ /o/ /O/ /a/ /A/  
    b. /i/ /I/ /u/ /U/ /e/ /E/ /o/ /O/ /a/ /A/

The advanced counterpart of /a/ in Kpokolo is /A/. To handle this we would call for a rule changing [A] to [U] just in case [i] associates, which is not very elegant. The "logic" of the present system allows for an alternative: non-high central vowels can be represented in a different way, by opposing them to the low vowel instead of opposing them to the back vowel.

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(22) /i/ /I/ /u/ /U/ /e/ /e/ /o/ /O/ /a/ /A/  
    I U U U I I A A U U  
    | | | | | | | 
    i, i, u, a, i, a, i, a, a, i, a

In that case the reduction of the advanced low vowel to /a/ is simply brought about by Operator Reduction:

(23) /a/ /A/  
    A A A  
    | -> | -OR- >  
    a, a, i

Classical Mongolian has palatal harmony, which, according to Svanesson (1985), developed into ATR-harmony in Khalkha and Burul, but not in West Mongolian (cf. van der Hulst and Smith 1987a, 1988). In this approach this is entirely a matter of phonetic interpretation. However, it might be argued that the difference between the palatal or advanced tongue root interpretation of [i] corresponds to a difference in head features. We might assume that the difference between Classical Mongolian and Khalkha is that in the latter but not in the former [U] is active. Suppose then that we say that the shift from Classical Mongolian to Khalkha was brought about by introducing the head feature [U], which in turn might relate to the loss of the vowel /a/:

(24) Class. M. /i/ /y/ /y/ /u/ /e/ /e/ /o/ /a/ /o/  
    Y Y Y A A A  
    | | | | | | | 
    i, u, u, i, u, u

Khalkha /I/ /U/ /A/ /A/ /A/  

If this proposal is maintained then the representation of Finnish high vowels should be changed accordingly. Khalkha /I/ is transparent with respect to ATR-spreading. We account for this by in the usual way: /I/ does not get [I], but is not incompatible with it.

2.2. Palatal harmony and labial harmony

In Khalkha, we also have rounding harmony among the low vowels. High vowels, in particular the rounded vowels fail to trigger rounding harmony, but also block it. Given the representation in (24) high rounded vowels COULD NOT trigger harmony. The /I/ does not undergo, but nor does it interrupt the
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spreading of roundness. The behavior of the high vowels represents a notorious problem in vowel harmony theory. I shall not discuss it here (cf. fn. 5).

Let us now consider Turkish. We would like to say that we have two types of suffixes Y-specified and A-specified. This at least gives us a straightforward picture:

(25) /i/ /ì/ /u/ /ù/ /e/ /ë/ /a/ /á/
    Y Y Y A A A A
    u u u A A A A
We find a situation which is rather different from what was attested in Khalkha. [u] does NOT spread to A-specified vowels, but all [u]-specified vowels trigger rounding harmony. This time the target condition is that undergoers should be Y-specified. Quite expectedly, /a/ and /á/ are opaque with respect to rounding harmony.

Another type of reduced rounding harmony occurs in Uyghur and Hungarian (cf. Sezer & Wetzel 1987). Here I only discuss the suffixes: /a/, /a/ and /i/, /u/. The surface vowel system of Uyghur is as that of Finnish:

(26) /i/ /ì/ /u/ /ù/ /e/ /ë/ /a/ /á/
    Y Y Y A A A A
    u u u A A A A

The three-way alternating suffix can be handled by including in the underlying inventory a vowel specified as [I]/I/. A segment structure rule will fill in the operator [u] in case neither [I] of [I]/I/ alone, we must assume that the representation of /ì/ distinctivly involves the operator [I]. In order to prevent rounding harmony on low suffixes, there is a target condition as in Turkish undergoers must be [Y]-specified.

2.3. [A]-harmony

In van der Hulst & Dikken (1987), it is shown that the harmony systems of Nez Perce, Chukchee and Middle Korean can be understood in terms of [A]-spreading. Consider Nez Perce:

(27) a. /i/ /ì/ /u/ /ù/ b. /i/ /a/ /ú/ /ó/ /ù/ /ì/ /a/ /ú/
    /a/ /ì/ /ú/ /ù/ /ì/ /a/ /ù/ /ì/ /a/ /ù/ /ì/ /a/ /ù/
    [A] [A] [A] [A] [A]

Two remarks are in order. First, the representation of /a/ apparently makes use of the multiple head specification. However, what I mean to say here is that the dependency relation has not been specified. Spreading of /a/ forces a decision in favor of [A]-headness, otherwise the default option is to take [I] as the head. Second, the schwa is represented as "headless." Some schwas do not trigger harmony and are also transparent. These will be represented without the operator [a], which will, in that case, be added later on.

3. Conclusion

An idea which has guided much recent work in feature theory is that markedness considerations should be "built in" in the formalism for expressing phonological rules and representations. The use of underspecification or single-valued features represents an attempt to express directly the notion of marked value, introduced in Fraguan phonotheory. However, markedness not only involves the "context-free" phenomenon that in the case of a binary opposition one value is marked, but it also involves "context-dependent" phenomena such as the fact that backness and roundness or highness and ATR-ness go together in the unmarked case. The present proposal represents a natural extension of this research program since it is an attempt to build the latter type of markedness into the formalism.
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Notes

1. This paper offers the outline of a proposal which is discussed in more detail in van der Hulst (1988). I am grateful to the following colleagues who have discussed with me ideas which are central to the proposal: Marcel den Dikken, Colin Even, Teun Boekstavr, Iggy Roks, Norval Smith and Keith Snider.


3. Elements can furthermore be classified in terms of another property CHARM, but I will ignore that here. Cf. den Dikken and van der Hulst (1988) for a more detailed discussion.

4. There is a resemblance to Schane's (1984) Particle Phonology in that we allow a single feature to occur twice in the representation of a vowel, but also note that I am not allowing just any number of occurrences. It is limited to two, on principled grounds.

5. An attempt to deal systematically with the behaviour of invariant vowels in harmony systems is offered in van der Hulst and Smith (1986). In van der Hulst & Smith (1987a, 1988) special problems concerning rounding harmony in Mongolian and Tungusic are discussed. van der Hulst & den Dikken (1987) address similar problems in Nez Perce and Middle Korean. In van der Hulst (1988) show how the respective proposals can be integrated into the current approach.

6. As shown in Korn (1969) and Steriaide (1981) the Turkic language family offer a wide variety of different reduced rounding harmony systems. For discussion see van der Hulst (1988).

7. References regarding the languages discussed here can be found in van der Hulst & den Dikken (1987).

References


1. A three-dimensional model of tone

A number of recent studies have shown the need for a model of tone which is richer than that developed in early work on autosegmental phonology (e.g. Goldsmith 1976). Shown on the left in (1), the original model incorporates a single tonal tier containing a binary-valued tone feature, whose values are referred to as High and Low. In this paper I will argue for one particular alternative model, the one shown on the right in (1). This model incorporates not one but two tonal tiers, a move first suggested by Yip 1980; moreover, it connects those tiers to an intermediate level in the representation, the tier of tonal nodes. In line with the proposals of Clements 1985 for incorporating all phonological features in a single hierarchy, tonal nodes encode not only the connections holding between different tone features but also the correspondence between those tone features and the skeletal units on which they are phonetically realized.

(1) a. $x$ skeletal tier b. $x$ skeletal tier
   \[T\] tone tier $o$ tonal node tier
   \[TT\] tone tiers

Tone Feature Geometry
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