The segmental spine and the non-existence of [±ATR]

Harry van der Hulst
University of Leiden

0. INTRODUCTION

Assuming an approach to segmental structure in which there are only three atoms from which vowels are constructed, our first expectation is that there can only be three types of vowel harmony. In this paper I will address the question as to whether there are three types of harmony systems corresponding to the segmental atoms |a|, |i| and |u|, familiar from a large body of work on vocalic structure (e.g. Anderson & Ewen 1987; Kaye, Lowenstamm & Vergnaud 1985; Goldsmith 1985, 1987; Rennison 1986, 1987; van der Hulst 1988a, 1988b; 1989, van der Hulst & Smith 1985; Schane 1984, 1987). I will show that the correlation holds. Furthermore, I will argue against a fourth primitive like a centrality component (as adopted in Anderson & Ewen 1987), or a 'cold vowel' (as adopted in Kaye, Lowenstamm & Vergnaud 1985). Instead I will introduce a structural component, the *segmental spine*. With respect to the feature [±ATR], two issues will be addressed: a) whether we need an independent primitive for [(+)ATR] as distinct from [–back] (or [front]) (as argued by Anderson & Ewen 1987, and Kaye, Lowenstamm & Vergnaud 1985) and b) whether we need to say that something like [–ATR]-harmony exists. The answer will be negative in both cases.

1. THE MODEL

In a number of papers I have adopted the view that vowels are constructed in terms of the following three *components*:

(1) *Components for vowels*
|a|, |i|, |u|

(Cf. van der Hulst 1988a, 1988b, 1989). Components are either present or absent, which expresses the claim that all vowel properties are privative in nature. When these components enter into combinations, the resulting units are characterized as *binary*, *headed* constituents, an idea taken from Dependency Phonology (Anderson & Ewen 1987):

(2) | \
a i (read: |a| governs |i|, or: |i| is dependent on |a|)

The phonetic interpretations of the components are independent of each other, i.e. components never should represent two values of a single phonetic parameter. The interpretation is, however, sensitive to the status of the component as either head or dependent. The components |a| and |i| are associated with a *constriction locus*, as well as with a *modificatory* gesture which can be added to a vowel produced at either of the two constriction loci. |u| is not associated with a constriction locus, but only represents a modificatory property:

(3) *Phonetic interpretation of the components for vowels*

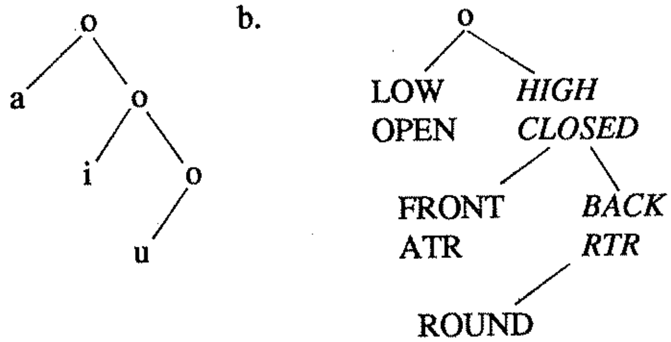
	LOCATIONAL PROPERTY	*MODIFICATORY PROPERTY*
|a|	pharyngeal constriction	OPEN (i.e. jaw opening)
|i|	palatal constriction	ATR
|u|	–	ROUND

(Henceforth, I will also use the terms LOW and FRONT instead of pharyngeal and palatal constriction, respectively.) In the interpretation of components in dependent role the locational property is suppressed. As heads, components represent both the locational and the modificatory property. Below it will hopefully become clear why all these 'decisions' regarding the phonetic interpretation are justified. It must be borne in mind, however, that phonologically speaking, these matters play no role. What does play a role is the fact that there are three primitives and a distinction between dependent and head status.

In van der Hulst (1988a) I propose that |u| has the locational property *velar constriction*. This was motivated with the fact that the properties of backness and roundness are closely linked and with the fact that our goal is to express such links directly in the basic structure of the phonological model rather than introducing arbitrary redundancy rules (such as [+BACK] → [+ROUND]). The relationship which exists between such phonetic properties as LOW and OPEN, or between FRONT and ATR is encoded by seeing these as phonetic implementations of the same phonological primitive. I now derive the relationship between ROUND and velar constriction (or BACK) differently. To make this point clear, it will be necessary to introduce a further elaboration of the model.

In van der Hulst & Smith (1987), Humbert (1988) and van der Hulst (1989) arguments are presented for placing the three components in a hierarchical structure (as in 4a), which I will refer to here as the *segmental skeleton*:

(4) a. b.



The path comprising the right branches in the segmental skeleton I will refer to as the *segmental spine*.

The tree in (4b) represents how the various nodes in the segmental skeleton are phonetically interpreted. Observe that a node on the spine receives a phonetic interpretation which is opposite to the interpretation of the component which occupies the sister-node; these phonetic labels are in italics. The spinal nodes, then, play a role in the phonetic interpretation. For example: any segment which contains the component |u| necessarily has the spinal nodes BACK and HIGH. This, among other things, encodes the relation between ROUND and BACK, and, less directly the relation between ROUND and HIGH. A grouping of binary vocalic features, reflecting the affinities between HIGH & ATR and between BACK & ROUND is also proposed in independent work by Odden (1989). Some of the motivation he gives is also relevant to the grouping proposed here.

The motivation for this geometry is, in part, of the kind which has been used to propose the feature structures in the Clements (1985), Sagey (1986) tradition. For example, the structure encodes the fact that |i| and |u| frequently behave as a group. The hierarchical arrangement offers a possibility to explain so called parasitic effects in vowel harmony, making available the generalization that agreement with respect to hierarchically higher components typically conditions harmony for lower components. Agreement in height (i.e. |a|) For example, frequently conditions ATR-harmony or labial harmony, and the presence of frontness may condition labial harmony. Such matters are discussed in van der Hulst (1989). The hierarchical organization also reflects general insights into the structure of vowel systems (i.e. the relation between the nature and the number of vowels in a particular system) and into the order of acquisition, topics which are currently more fully explored.

In van der Hulst (1989), I also make use of the possibility that segments are provided with nodes on the spine, which are either terminal themselves or which merely dominate a lower spinal node that is terminal:

```
(5)  a. i.    o    ii.         o     b. i.  o    ii.          o
             /|               /|           /|                /|
            a o        OPEN  HIGH         a o        OPEN   HIGH
                             CLOSED         |               CLOSED
                                            o                 |
                                                            BACK
                                                            RTR
```

As shown, such representations (containing *empty spinal nodes*) have an unambiguous (albeit broad in the case of (5a) phonetic interpretation. Implicitly, I assumed that empty spinal nodes cannot be dependents. If we say that the headship of spinal nodes is a default for segments which have no component in head position, we derive this point, because, after all, heads are obligatory while dependents are not.

A logical consequence of using empty spinal nodes is that vowels can also be represented in terms of the spine alone (the phonetic interpretation has been added in parentheses):

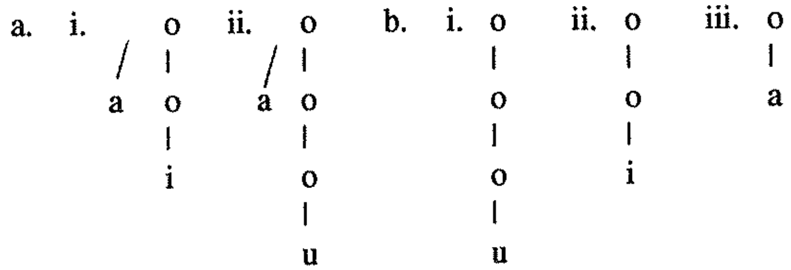
```
(6)  a. o             b. o             c. o
        |                |
        o (HI,CL)        o (HI,CL)
        |
        o (BA,RTR)
```

Phonologically (6a) represents a back unrounded high vowel, (6b) a non-advanced nonback high vowel. (6c) is an *empty vowel*, which has no phonetic interpretation at all. Representations such as in (6) indicate that the spine is an autonomous component different from |a|, |i|, and |u| in being purely structural.

Given that vowels with empty spinal nodes lack positive properties (in head position), it comes as no surprise that such vowels are highly likely to undergo spreading processes; they are in a clear sense *incomplete*. Such vowels are *marked* because they have no content. Since the positive properties (such as LOW, FRONT and ROUND) correspond to the *marked values* in binary feature systems, we end up with the paradox that vowels which are headed by spinal nodes are marked, while these spinal nodes correspond to the unmarked values in a binary notation. The paradox disappears when we realize that markedness results from lack of content. This view on markedness does not exclude that we compute markedness by looking at the number of components. The starting point for 'counting' is one, not zero, and what we value is deviations from one, not the number of components as such.

Although any incomplete vowel must be allowed to surface as a distinctive segment, we expect this only in the presence of vowels which differ minimally in possesing the component dominated by the lowest empty spinal node, i.e. the vowels in (5) and (6) presuppose the presence of those in (7):

(7)

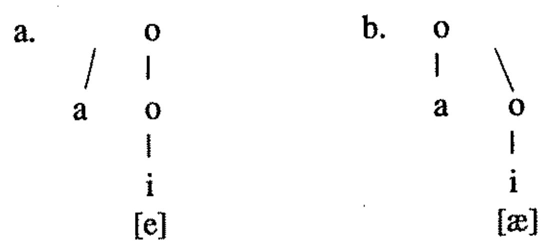


In the absence of such contrasts, we could still use the incomplete representations (for simplicity sake or to deal with alternations) on the understanding that an automatic default procedure would apply to make the incomplete representations complete by supplying the component under the lowest empty spinal node. The 'minimal' pairs which can be formed on the basis of (5), (6) and (7) characterize [E]-[e], [ʌ]-[o], [ɯ]-[u], [I]-i] and [ə]-[a], respectively.

Summarizing, we see that vowels are characterized in terms of components and a spine. The spine in a sense forms the vital part of the segment, since it does not presuppose the presence of components, while the reverse is not true. The spine combines a number of functions. Firstly, it imposes a hierarchical organization on the components which can be motivated in a number of ways (cf. above). Also it enables us to eliminate the extra components for ATR and centrality which are adopted in Dependency Phonology (Anderson & Ewen 1987) and the model of Kaye, Lowenstamm & Vergnaud (1985).

Of the many questions that remain to be answered, I want to mention here the problem of determining to what extent a certain relation holds between *dominance* and *dependency*. Are hierarchically higher components the most likely governors? Does the reverse hold? Or is there no relation? For example, consider the representations in (8):

(8)



Usually the presence of a low front vowel presupposes the presence of a mid or higher front vowel. This suggests that |a| is less likely to govern |i|, i.e. that (8b) is required just in case (8a) is also present. With respect to the relation between |i| and |u| it is suggested in van der Hulst (1989) that in this case the governing relation is set one way or the other for the whole system, and that the two possibilities are mutually exclusive, and furthermore that this makes the difference between so-called palatal harmony systems and ATR systems. Dependency Phonology makes no use of a difference in government direction between |i| and |u|, whereas Kaye, Lowenstamm & Vergnaud (1985) design their interpretation calculus in such a way that the direction makes no difference.

2. THREE TYPES OF VOWEL HARMONY

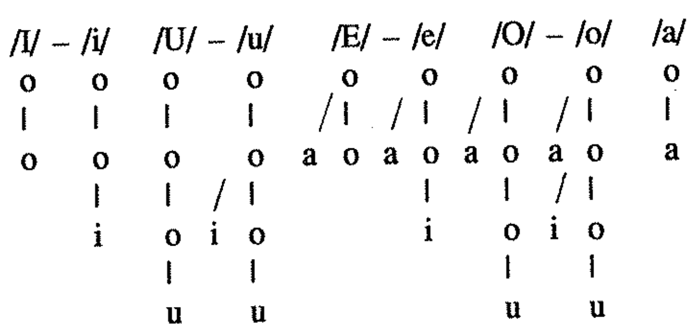
A survey of the literature on vowel harmony reveals four, rather than three major harmony types (a representative sample of each type is discussed in van der Hulst (1988b), where appropriate references can be found):

(9) a. [–ATR]-harmony (Nez Perce, Chukchee, Yoruba, ...) → |a|
b. [+ATR]-harmony (Kalenjin, Tunen, Akan, ...) → |i|
c. Palatal harmony (Finnish, Hungarian, ...) → |i|
d. Labial harmony (Turkish, Yawelmani, ...) → |u|

On the right I have indicated which components these harmony systems will be analyzed with in the proposed model. I will now briefly illustrate what such analyses look like, but I will not discuss |u|-systems here, probably the least controversial category. Rather I wish to concentrate on ATR-systems. The most surprising point, perhaps, is that I propose to represent both [+ATR]-harmony and palatal harmony in terms of |i|-spreading. I will discuss this point in section 2.1. Then I turn to a discussion of so-called [–ATR]-systems. Their existence, next to [+ATR]-systems, poses an interesting challenge to a model based on privative components. I will show that [–ATR]-systems involve |a|-spreading.

2.1 [+ATR] & palatal harmony

In van der Hulst (1988a) I proposed that the property [+ATR] can be expressed in terms of |i|. So called [+ATR] harmony systems, then, involve the spreading of |i|. Consider a typical nine-vowel system:

(10)


The first four pairs of vowels are involved in a [–ATR]/[+ATR] harmonic relation. In this system the vowel /a/ has no harmonic counterpart, as is often the case in ATR-systems, which we express by saying that |a| cannot govern /i/, a parametric choice (cf. above). If |a| was permitted to govern |i|, we would derive a ten vowel system containing, in addition to the vowels in (10), the vowel in (11):

```
(11)  a.  o              b.  o
          |  \               |      \
          a   o             LOW    CLOSED
              |             OPEN    |
              i                    FRONT
                                   ATR
```

The fact that a [+ATR] low vowel is necessarily phonetically higher than its [–ATR] counterpart is an automatic result of our phonetic interpretation calculus.

When |a| cannot govern |i|, it does not follow that low vowels cannot undergo harmony. In some harmony systems the [+ATR] counterpart of /a/ merges with another vowel, for example /e/. In such cases, then, the result of spreading |i| to |a| is transformed into a structure where |i|, rather than |a|, is the governor. The availability of such *repair rules* is apparently a matter of language-specific choice.

The similarity between [+ATR] and palatal systems can be seen in one other respect. Just as the setting of the parameter for |a|-|i| government leads to two types of [+ATR]-harmony systems (i.e. those with and those without a [+ATR] low vowel), so we can also derive two types of palatal harmony systems. As is well-known, Finnish differs from Hungarian in having a front counterpart to the low vowel /a/, whereas Hungarian has a mid counterpart. We can say, then, that in Finnish |a| can govern |i|, whereas this is not so in Hungarian. This does not mean that |i| cannot spread to |a|. We must assume that Hungarian has a repair rule switching headship if |i| spreads to |a|, making |i| the governor, which results in a mid vowel. As argued above, sometimes [+ATR] systems have a similar repair rule.

By claiming that we can analyze both [+ATR] systems and palatal systems in terms of |i|-spreading we make the clear prediction that no language can have both palatal harmony and [+ATR] harmony, and we furthermore claim that a diachronic development from one system to the other (a proposed scenario for the development of Classical Mongolian to Khalkha) is a change in phonetic realization of invariant phonological structure; cf. van der Hulst (1988b) for further discussion of this point.

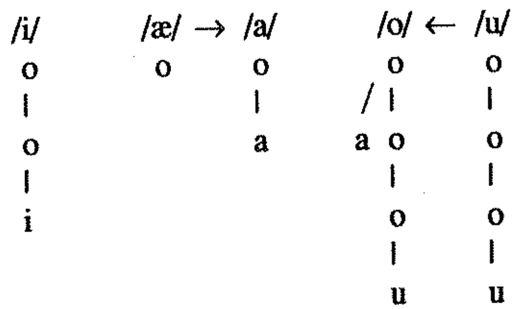
2.2 [−ATR]-harmony

In the phonological literature several cases have appeared in which it is claimed that vowel harmony involves the spreading of [−ATR]. I will show here that in many cases it is |a| which spreads. This is a welcome result for two reasons. Firstly, [−ATR] is a non-available entity in our model. Since [+ATR] (= |i|) *is* present, the presence of [−ATR] would undermine the claim that phonological atoms are privative. Secondly, given that |a| forms part of our model, we expect to find harmony systems involving this component. Let us consider a number of such cases, which are also discussed in van der Hulst (1988b). Here the analyses have been adjusted mildly by making use of the notation used in van der Hulst (1989).

Consider Nez Perce (Zwicky 1971, Hall & Hall 1980). Vowels that alternate within the harmonic system are indicated by arrows. Lowering is conditioned by the low vowels /a/ and /o/:

(12) /i/ /u/ → /o/
/æ/ → /a/

In our model we analyze this as follows:

(13)


The question of how to spell out the empty vowel remains to be answered. Anderson & Durand (1988), who present a similar analysis, suggest providing both |i| and |a|, which in fact is the first non-used option that comes to mind.

Middle Korean is highly similar, but has central vowels (Hayata 1975, Kim-Renaud 1986):

```
(14) /i/     /ʌ/ ← /i/   . /e/ → /a/    /o/ ← /u/
      o       o     o      o     o      o     o
      |      /|     |            |     /|     |
      o     a o     o            a    a o     o
      |                                 |     |
      i                                 o     o
                                        |     |
                                        u     u
```

As in Nez Perce, the vowels specified with |a| are both the triggers and the "output" of harmonic spreading of |a|.

Chukchee has the most complicated system of this type (Krause 1980, Kenstowicz 1983):

```
(15) /i/ →  [e] =  /e/ →  [æ]   /E/   /ə /   /O/  /a/  [o] ←  /u/
      o      o      o      o     o     o      o    o    o      o
      |     /|      |     /|    /|    /|     /|    |   /|      |
      o    a o      o    a o    o a   a o    o a   a  a o      o
      |      |                  |       |    |          |      |
      i      i                  i       o    o          o      o
                                             |          |      |
                                             u          u      u
```

Two remarks are in order. Firstly, note that harmony is not structure preserving, in the sense that the derived vowels, between square brackets, are different from all underlying vowels of Chukchee. Secondly, some schwas fail to be triggers. These will lack |a| underlyingly and acquire it by spreading or by a spell-out rule. As in the previous systems, both |i| and |a| are added to the incomplete vowel /e/, which collapses with the lowered product of /i/.

In Coeur d'Alene we also find |a|-harmony (Johnson 1975, Sloat 1980). The following is based on the analysis presented in Cole (1987), who uses standard SPE features. An interesting aspect of this harmony is that a leftward |a|-spread is triggered by guttural consonants; these consonants all contain the component |a| as argued in van der Hulst & Smith (forthc.). In Coeur d'Alene, we have to deal with the following alternations:

```
(16) /i/       /u/     /æ/     /o/     /a/
               |- - - - - - - - ->              (a)
                       |- - - - - - - - ->      (b)
     |- - - - - - - - - - ->                    (c)
     |- - - - - - - - - - - - - - - - - - ->    (d)
```

Progressive harmony is triggered by /a/ and /o/, the only two vowels having |a| underlyingly. If all alternations are seen in terms of |a|-spreading, we have a problem in cases (c) and (d), where both take the same vowel as input. To solve this I postulate a double underlying source for surface [i] (as Cole does, i.e. /i/ and /ɨ/). In addition we have two representations for both surface [a] and surface [æ], one underlying and one derived:

```
(17) /i/ →   [æ] =   /æ/ →   [a] =   /a/ ←   /ɨ/    /o/   /u/
      o       o       o       o       o       o      o     o
      |      /|               |      /|       |     /|     |
      o     a o               a     a o       o    a o     o
      |       |                                      |     |
      i       i                                      o     o
                                                     |     |
                                                     u     u
```

The underlying /a/ loses the empty spinal node and merges with the derived [a]. In the case of /ɨ/, |i| is added. The empty vowel is again spelled out as |a→i|.

A fuller discussion of '[–ATR]' would have to include vowel harmony in Yoruba, which has been claimed to involve [–ATR]-spreading (cf. van der Hulst 1988b for an alternative), and various other cases. The claim made here is that a close re-examination of all '[–ATR]' systems will show that the harmony involves some other independently motivated property (such as |a|, or perhaps 'tense'; cf. Smith and Van der Hulst, this vol.), or that we deal with the deletion of |i| ('[+ATR]') under very specific circumstances.

3. CONCLUSION

In this paper a proposal is made for allowing a 'structural component', the *segmental spine*, in the representation of phonological segments. Then I showed that the prediction made by using three positive 'content components' regarding types of vowel harmony systems is compatible with the harmony systems known from the literature. In particular, I argued that there is no distinction between [+ATR] and palatal harmony systems and that there are no systems which crucially require [–ATR]. In effect, I demonstrated that a separate component [ATR] does not exist.

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