Vowel Systems

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1. Introduction

It used to be a major area of concern for phonologists to rethink and reconsider the proper set of distinctive features needed to analyze the vowel and consonant systems of languages around the world. Since the changes and shake-ups in phonology of the 1970s, changes which shifted attention toward the geometrical structure of phonological representations, this concern has by and large been suspended.

That is most unfortunate, if for no other reason than that autosegmental analyses still rely heavily on the use of features, and unexamined assumptions about the inventory and nature of these features will almost inevitably affect the validity of the conclusions drawn from them. [1]

In recent years, the primary concern involving the nature of features has revolved around whether phonological features act in a strictly binary way within the lexical phonology, or whether only one value of each feature plays an active role at that point. Each individual argument that has been offered about this matter, however, inevitably makes certain assumptions about the proper set of features needed to describe vowels and consonants, and it is that which we ought to reconsider.

My purpose in this paper is to step back for a moment and rethink the proper treatment of some of the most basic kinds of vowel systems. The particular emphasis in this paper will be on the canonical five vowel system, as in (1), in part because it is the most common system, and the one from which most other vowel systems deviate in relatively minor ways. It is also simply a fruitful area for research of the sort that I propose undertaking.

1. Five vowel system

   i e a o u

2. Tradition

Tradition of quite long canonical five vowels is henceforth call "the i leaves no doubt that it is a vowel system Mid, and Low), and to Back), (though one tries years in this count the central vowel; America such vowels Back and no

Recent tradition also binary features, High (e,o) as "minus" [-] following chart:

<table>
<thead>
<tr>
<th></th>
<th>High</th>
<th>Low</th>
<th>Back</th>
<th>Round</th>
</tr>
</thead>
<tbody>
<tr>
<td>a e i o</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Round</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

This, I trust, is as of the reader's hand.

3. Problems

This treatment of unsatisfactory in severe to light a surprising theory: the lack of a right to answers to

1. Why do the vowels system, rather than feature specification?
2. Why should phonology binary features, High binary combinations phonological explana
3. Why do the distributional class these vowels are equivalent), and occurrence that other up in unstressed posi onl these three vo
2. Tradition

Tradition of quite long standing now informs us that the canonical five vowels system as in (1) -- which I shall henceforth call "the five vowel system", when context leaves no doubt that this is what is being referred to -- is a vowel system with three vowel heights (High, Mid, and Low), and two horizontal positions (Front and Back), (though one tradition, less heard from in recent years in this country, includes the vowel /a/ as a central vowel: Americans, following SPE, generally call such vowels Back and non-Round).

Recent tradition also analyzes vowel height using two binary features, High and Low, marking the mid vowels [e, o] as "minus" [-] for both features, giving us the following chart:

(2)

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>e</th>
<th>i</th>
<th>o</th>
<th>u</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Low</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Back</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Round</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

This, I trust, is as familiar to the reader as the back of the reader's hand.

3. Problems

This treatment of the five vowel system is unsatisfactory in several respects, respects which bring to light a surprising deficiency in current phonological theory: the lack of a theory of vowel systems. We have a right to answers to the following questions:

1. Why do the vowels in (2) form the most natural vowel system, rather than vowels defined by some other set of feature specifications?

2. Why should phonological theory be driven to use two binary features, High and Low, for which one of the four binary combinations is simply disallowed with no phonological explanation?

3. Why do the vowels [i, u, a] form a natural distributional class? In many linguistic traditions, these vowels are called "primary vowels" (or the equivalent), and these vowels have privileges of occurrence that other vowels do not: only they may show up in unstressed position, for example. In other cases, only these three vowels may be present underlyingly.
Why do these three vowels form the canonical three-vowel system?

4. Why do the vowels \{e, o\} form another natural class? As we shall see, these vowels trigger Height harmony in Bantu and other languages: why?

5. Why do /a/ + /i/ typically merge to form [e], and /a/ + /u/ to form [o]? Featural accounts give no hint or clue as to which features should be saved and which lost when two vowels "merge" (and such accounts provide no notion of "merger", either). The sequence /i/u/ most often fails to merge, other than to form the diphthong /ey/, though in some cases it merges to /u/.

The aim of this paper, and the work that it summarizes, is to provide a simple theoretical framework that provides straightforward answers to these questions. We may add a further desideratum for such a proposal: we would like it to depend on a minimal number of theoretical modifications and innovations. Finally, an extremely important condition must be added: we would like this undertaking, of the modification of our conception of vowel features, to be consistent with the effort to show that all assimilations are autosegmental in character, i.e., are all formally represented by the addition of association lines. This is a more difficult result to achieve at this point, but it is, at the very least, something that I take to be a desideratum for a theory of vowel representations.

Another point that may be borne in mind in evaluating this proposal is that it attempts to (and succeeds in) sharply reducing the number of features used in the lexical phonology for the vowel systems of most languages, thus making more plausible the notion that all features are autosegmentalized. This notion (originally suggested by several people, of whom the first was Morris Halle, over ten years ago) suffered a much larger degree of implausibility at the time due to the fact that so many features, many of them highly dependent on each other, would have to be placed on separate tiers (e.g., High on one tier, Low on another). This hypothesis -- one feature, one tier -- becomes more plausible under the current account, at least as far as vowel systems are concerned. Similar work has already made such a view for prosodic systems quite plausible.

The proposals offered here should be viewed in the light of parallel work being done currently by a number of linguists from very similar perspectives, especially Vergnaud, Kaye, and Lowenstein, Rennison, van der Hulst and Smith, and Schan References below).

4. A Proposal Regarding

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Having defined this these possibilities 1

(3) a. Prativ feature

\ [+F]  

V  

V  

The examples in (3) explicit: if we representations, the prativ feature distinction, and an to a ternary distinc true in practice (wh

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to form the diphthongs
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References below).

4. A Proposal Regarding Feature Specifications

The main framework that I will be using is autosegmental
phonology of a traditional sort, with the vocalic
features used in the lexical phonology placed on
separate tiers. In this there is no theoretical
innovation.

The first modification I wish to propose is that
features be allowed to be either equipollent or
private, in a way that is language-specific and even
feature-specific. The terms I borrow from Trubetzkoy,
but in this context they must be explained. A private
feature is one for which only one feature value (plus,
minus) is used and allowed in the distinctive,
lexical phonology. The position of underspecification
theory (within lexical phonology) is that all features
have this character. An equipollent feature is one for
which both feature values are used within the
distinctive, lexical phonology, as within most of the
work with the SPE generative tradition. The present
proposal differs, then, from both recent
underspecification theories and from the SPE tradition
in that the phonology must be allowed to use both
types of oppositions.

Having defined this distinction, let us observe what
these possibilities look like, as in (3).

(3) a. Privative feature b. Equipollent feature

$$\begin{array}{c}
{[+_F]} \\
V \\
{V}
\end{array}$$

$$\begin{array}{c}
{[+_F] [-_F]} \\
V \\
{V} \\
{V}
\end{array}$$

The examples in (3) make clear what has not been
explicit: if we set no further conditions on
representations, then in an autosegmental context, a
privative feature will give rise to a binary
distinction, and an equipollent feature will give rise
to a ternary distinction. This will not always prove
ture in practice (which is probably fortunate), as we
will see below, because we will suggest mechanisms that
put upper and lower limits on the number of association
lines linked to a particular skeletal position. That
however, is another matter, and a separate, distinct
proposal. In any event, the interpretation of the
ternary distinction suggested in (3b) is by no means

\[
\text{Which may exist! (cf. Innigus)}
\]
self-evident, and the examples below will suggest that
the formally unmarked case (the third case in \((3b)\)) will
sometimes be interpreted phonetically in a way
indistinguishable from one of the actually specified
values; this is the case for the feature [Round], in the
the five vowel system, where a vowel that is unmarked for
[Round] is not round, though it is still phonologically
distinct from a vowel that is phonologically marked [\{-Round\}]. In other cases, the unmarked value will be
phonetically interpreted as intermediate between the
\([-F]\) value and the \([+F]\) value. I would like to
emphasize that this law between the phonological
representation and its phonetic interpretation is not an
inherent weakness of the proposal; in my view recent
concretist views on phonological features -- that they
can, in effect, be largely inferred from phonetic detail
-- are based on a philosophy of phonological
representation that has certainly not been borne out by
current work in phonology: there seems now little reason
to think that the structure of phonological
representations directly reflects instrumentally
observable phonetic fact.

Before proceeding further, I would like to paraphrase
the suggestion made just above. Typically, vowel
systems will have between three and eight or nine
vowels. Given the assumptions reviewed so far, that
means that the vowel system will typically have two or
three contrastive vowel features, each on a separate
cotosegmental tier. If these features were the same
across all languages -- if there were only three vowel
features -- but each language could choose whether it
used each privatively or equipollently, we would be
faced mathematically with an inventory of nine types of
complete vowel systems using two features, and twelve
types of complete vowel systems using three features. I
mention this calculation for one simple reason: to
waylay the reaction which some readers may feel, the
reaction that says that by allowing the
privative/equipollent distinction to be feature
specific, we open the doors to astronomical numbers of
vowel systems, vast beyond measure. In fact, we get
only a very reasonable number, by no means any larger
than what we might expect to find in a typology of
distinct vowels systems.

We turn now to the canonical five vowel system. This
will be analyzed with one equipollent feature, [+Round];
and one privative feature, [Low], on separate tiers.
The combinations allowed are given in \((4)\), and the
vowels that these feature combinations represent are
given below.

\[
\begin{array}{c}
(4) & [\{-Round\}] & [\,+F,] \\
& \downarrow & \downarrow \\
v \\
/\i/ \\
\end{array}
\]

In such a system
teness, and by
no need to be re
phonology. The
added by the (pos
that is not pre
vowel language.

(5) Redundant From

The mid vowels \(\{e, i, u\}\) respect
\(/i/\) and \(/u/\) respec
representation.

This process of cat
associated with a
component of the
suggest a language
number of associat
from the various vo
two figures in pare
\((e.g., \,(0,2)\)\). We
it has all the vow
parameter. Initia
property of the \(1\)
peak, by each ske
we shall the max
main as outer para
ye things in a
example of thi
neutralization, typ
where the wide ran
down to a set of vi
vowels. In such e
effect arises fro
associations allo
low will suggest that the case in (3b) will typically in a way actually specified in a way that is unmarked for still phonologically marked [-Round] in the phonological system. The non-contrastive feature [+Round] will be added by the (post-lexical) rule (5) on a separate tier that is not present in the lexical phonology in a five vowel language.

In such a system, fronting is as predictable as tenseness, and by traditional reasoning, therefore, has no need to be represented in the distinctive lexical phonology. The non-contrastive feature [+Front] will be added by the (post-lexical) rule (5) on a separate tier that is not present in the lexical phonology in a five vowel language.

The mid vowels {a, o} are formal combinations of /a/ with /i/ and /u/ respectively, the kind of result that we demand as a boundary condition on our system of representation. The primary vowels {a, i, u} form a natural class in that they are singly-associated elements.

This process of counting the number of association lines associated with a skeletal V-slot is an important component of the definition of a vowel system. We suggest a language specifies the minimum and maximum number of associations permitted on a skeletal position from the various vowel feature tiers; we indicate these two figures in parentheses, as will be illustrated below (e.g., (0, 2)). We will call a vowel system complete if it has all the vowels permitted by the minimum-maximum parameter. Initially we may view this as being a property of the language which is inherited, so to speak, by each skeletal V-slot in that language; as we proceed, we shall see that there is reason to think of the maximum and minimum numbers set by the language as a whole as outer parameters within which the language may vary in a systematic way. The most striking example of this involves positions of vowel neutralization, typically found in unstressed positions, where the range of underlying vowels must narrow down to a set of vowels chosen from a smaller subset of vowels. In such cases, we will try to show that the effect arises from the fact that maximum number of associations allowed the skeletal position has
decreased.

Another point, one which is largely terminological but nonetheless of some interest: I shall define the schwa (and use the symbol ə) as the skeletal position associated with no vowel features. The term "schwa", of course, is widely and inconsistently used to variously refer to a vowel of a particular quality, or a vowel that cannot be stressed, or a vowel that tends to delete more than others, or yet some other sort of vowel. With this terminological move I mean to suggest that the constant factor in all this, and the intuition that lies behind the use of the term, is that there is a phonological common ground to these schwa vowels: that phonologically they are unassociated with vowel features. This point has already been made in slightly different terms, I hasten to add, by a number of other linguists using similar frameworks, such as by Anderson (1962).

One other assumption will be made in the material that follows: the value of a feature, if privative, is predictable, or put in a slightly clearer fashion, there is available a privative feature Low, but none called "High"; there is a privative feature Front, but none called "Back"; there is a privative feature Round, but none called "Unround".

With this in mind, we may review the set of vowel systems that this notation allows for.

I. One privative feature (let us suppose it is Low, for concreteness’ sake)

1. (0,1) 2 vowel system

   1. V V

   This may be heard as Low

II. One equipollent feature (Round, for concreteness’ sake)

2. (0,1) 3 vowel system

   [+round] [-round]

   V V V

3. (1,1) 2 vowel system

   [+round] [-round]

   V V

IV. One equipollent feature (Low)

5. (0,1) 3 vowel system

   [round]

   V V V

6. (1,2) 3 vowel system

   [round]

   V V

7. (0,2) 6 vowel system

   [+round] [-round]

   V V

8. (1,2) 5 vowel system

   [+round] [-round]

   V V

9. (1,1) 3 vowel system

   [+round] [-round]

   V V
III. Two privative features (Round, Low)

4. (0,2) 4 vowel system

```
<table>
<thead>
<tr>
<th>[round]</th>
<th>[round]</th>
</tr>
</thead>
<tbody>
<tr>
<td>u</td>
<td>a/o</td>
</tr>
<tr>
<td>v</td>
<td>v</td>
</tr>
<tr>
<td>[Low]</td>
<td>[Low]</td>
</tr>
</tbody>
</table>
```

5. (0,1) 3 vowel system

```
<table>
<thead>
<tr>
<th>[round]</th>
</tr>
</thead>
<tbody>
<tr>
<td>u</td>
</tr>
<tr>
<td>v</td>
</tr>
<tr>
<td>[Low]</td>
</tr>
</tbody>
</table>
```

6. (1,2) 3 vowel system

```
<table>
<thead>
<tr>
<th>[round]</th>
</tr>
</thead>
<tbody>
<tr>
<td>u</td>
</tr>
<tr>
<td>v</td>
</tr>
<tr>
<td>[Low]</td>
</tr>
</tbody>
</table>
```

IV. One equipollent feature (Round), one privative feature (Low)

7. (0,2) 6 vowel system

```
<table>
<thead>
<tr>
<th>[+round]</th>
<th>[-round]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[+round]</td>
<td>[-round]</td>
</tr>
<tr>
<td>v</td>
<td>v</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>
```

8. (1,2) 5 vowel system

```
<table>
<thead>
<tr>
<th>[+round]</th>
<th>[-round]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[+round]</td>
<td>[-round]</td>
</tr>
<tr>
<td>i</td>
<td>u</td>
</tr>
<tr>
<td>v</td>
<td>v</td>
</tr>
<tr>
<td>[Low]</td>
<td>[Low]</td>
</tr>
</tbody>
</table>
```

9. (1,1) 3 vowel system

```
<table>
<thead>
<tr>
<th>[+round]</th>
<th>[-round]</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>u</td>
</tr>
<tr>
<td>v</td>
<td>v</td>
</tr>
<tr>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>
```
V. Two equipollent features (Round, Low)

10. (0,2) 9 vowel system
   [+Round] [-Round] [+Round] [-Round]
   V V V V V V
   [+Low] [+Low] [+Low]

11. (1,2) 8 vowel system: same as #10, but without A (i.e., the featureless schwa)

12. (0,1) 5 vowel system
   [+Round] [-Round]
   V V V V V
   [+Low] [-Low] [-Low]

Using same interpretation as 10 above: i ı u

VI. Three Privative Features (Round, Front, Low)

13. (0,3) 8 vowel system i u i u (Tuvan)
    e o a o
    [Round] [Round] [Round] [Round]
    V V V V V V V V
    [Low] [Low] [Low] [Low]

14. (1,3) 7 vowel system: Same as 13 above, but without the ı (i.e., the schwa): Khalkha Mongolian

15. (0,2) 7 vowel system: i ı u a o

VII. One Equipollent F Features (Front, Low)

16. (0,1) 4 vowel syst

17. (1,1) 3 vowel syst

18. We will consider historically and str vowel system:

   Finnish, Hungarian
   [+Round] [-Round]
   V V

   Using same interpretation as 10 above: i ı u

In one version of the rule (3) applies, from the 7 or 8 vowel syste

   e ö o
   (a) a

5. The canonical 5 vow

The canonical 5 vowel system 8 above, also languages have these of the specific proper type of phonemnon example for concrete proclitics end in -a;
16. (0,1) 4 vowel system: \( i \quad u \)

17. (1,1) 3 vowel system: \( i \quad u \quad a \)

VII. One Equipollent Feature (Round) and Two Privative Features (Front, Low)

18. We will consider only one here, the one based historically and structurally on the canonical five vowel system:

Finnish, Hungarian

\[
\begin{array}{cccc}
  & +Round & -Round \\
\text{V} & V & V \\
\text{[Low]} & [Low] & [Low] \\
\end{array}
\]

\[
\begin{array}{cccc}
  & +Round & -Round \\
\text{V} & V & V \\
\text{[Front]} & [Front] & [Front] \\
\text{[Low]} & [Low] & [Low] \\
\end{array}
\]

In one version of this system, the Redundant Fronting rule (5) applies, fronting the [-Round] vowels, yielding the 7 or 8 vowel systems (Finnish, Hungarian):

\[
\begin{array}{cccc}
  & +Round & -Round \\
\text{i} & u & u \\
\text{e} & \text{e} & \text{o} \\
\text{(a)} & & a \\
\end{array}
\]

5. The canonical 5 vowel system: Bantu

The canonical 5 vowel system, I have suggested, is the system 8 above, also given in figure (4). Many Bantu languages have these five vowel systems, and show some of the specific properties of this system. One specific type of phenomenon can be seen in Zulu (to pick an example for concreteness' sake, again), where many proclitics end in -a; if the following morpheme begins
I shall include a long chapter on why people like us imply more phonemic facts (as Goldsmith [11985] did it) in the Flanagans.

Word base is less the importance of phonetic facts (as less basic) who serves phonetic facts for base, for example, merges with the Class 1 prefix umu to give nomu, just as it merges with the Class 2 prefix imi to form nemi.

I have elsewhere argued in some detail that Yaka, a less well-studied Bantu language, also shows the internal behavior of the System 8 proposed here. I will briefly point out the highlights this account, discussed in Goldsmith (1985). Yaka involves two vowel harmony processes, the sort of processes that have been central since the dawn of the discussion of features in phonology, in the light of the understanding that harmony is typically agreement in the value of a particular feature, thus providing us with a handle on how the language assigns at least some of the features to its vowels. Yaka provides evidence that the representation of the vowel system proposed above is correct, based on rightward spreading of the privative feature [Low] and on leftward spreading of the equipollent feature [-Round]. There are two harmony rules, given in (6) and (7), and they apply as illustrated in (8).

(6) Low Harmony

\[
\begin{array}{c}
\text{Low} \\
\text{[-Round]}
\end{array}
\]

\[
\begin{array}{c}
\text{C} \\
\text{V} \\
\text{X} \\
\text{V}
\end{array}
\]

\[
\text{word}
\]

(7) Leftward Nonround Harmony (optional and iterative)

\[
\begin{array}{c}
\text{Low} \\
\text{[-Round]}
\end{array}
\]

\[
\begin{array}{c}
\text{Radical} \\
\text{V}
\end{array}
\]

\[
\begin{array}{c}
\text{Co}
\end{array}
\]

(8) Preliminary

\[
\begin{array}{c}
\text{[-Round]}
\end{array}
\]

\[
\begin{array}{c}
\text{[Low]}
\end{array}
\]

Another important point about vowels of the 1, underlining may to three. Which surprising: it is (1,1) set of vowel 9, i.e., \{i,u\}, that this vowel account for: v distribution, it be simply expressed features, modify of associations.

6. Pasiego

Many five vowels the /i/ and /e/, and /o/, in the Yaka, and characteristic. Restlessness of and not typical Montanes Iberia popularized in traditional (1984).

Montanes has, on (9). Calling it far as arithmetic clearly makes me canonical five feature has been 1 vowel system from High, non-Round superficially.
it begins with /i/, na meaning "with", prefix umu to give ass 2 prefix imi to

1 that Yaka, a less shows the internal e. I will briefly unt, discussed in two vowel harmony t have been central 1 of features in understanding that the value of a 3 with a handle on the of the features evidence that the proposed above is 7 of the privative spreading of the 3 are two harmony id they apply as

[+Round] [+Round] [+Round] [-Round]

b V k - V l - V k - V l V [bokwelekele] or [bokelwekele]

Another important point emerges from a look at Yaka. The first vowel of the stem may be any of the five vowels of the language, but the vowels in the suffixes underlyingly may only be chosen from a limited set of three. Which three those are, though, is hardly surprising: it is the subset which can be defined as the (1,1) set of vowels chosen from System 8, i.e., System 9, i.e., {i,u,a}. This illustrates an additional fact that this vowel system aims at providing a formal account for: when there are positions of limited distribution, the subclass of available segments should be simply expressible using the same assumptions about features, modifying only the minimum and maximum number of associations permitted in that position.

6. Pasiego

Many five vowel systems show limited contrasts between the /i/ and /e/, on the one hand, and also between /u/ and /o/, on the other. We have seen an example of this in Yaka, and provided a formal account of this characteristic. The history of Spanlan shows the restlessness of this contrast as well. An interesting and not atypical case is described by Penny for a Montanes Iberian dialect (the facts have been popularized in the generative tradition by a rendering into traditional autosegmental notation by McCarthy (1984)).

Montanes has, on the surface, a 9 vowel system, as in (8). Calling this a 9 vowel system may be correct as far as arithmetic goes, but in a systematic sense, it clearly makes more sense to to describe it as a canonical five vowel system on top of which another feature has been lain (call it Fronting), creating a 10-vowel system from which one vowel (the Fronted, non-High, non-Round vowel) has been removed, at least superficially.
(9) Fronted vowels  Normal vowel

\[
\begin{array}{c|c}
\text{i} & \text{i} \\
\text{u} & \text{u} \\
\text{o} & \text{e} \\
\text{a} & \text{a}
\end{array}
\]

Let us focus on the normal (non-fronted) vowels. As Penny demonstrates, when the stressed vowel is \( \text{i,u,e,o} \) -- anything but \( \text{a} \) -- then the other vowel positions of the word lose their five-way oppositions. Just as in Bantu, where in non-initial position only the three primary vowels may appear underlyingly, so here we find that only three vowels may appear. We may even say that the three vowels that may appear are here also \( \text{a,i,u} \) if we allow ourselves a bit of abstract leeway, for the fact is that if the stressed vowel is /e/ or /o/, then the unstressed vowels may be /a/, /e/, or /o/ (again, as in Bantu), a process which should be analyzed as a spreading of the privative feature [Lov], as in (10). (For example, we find words like /tenér/, /aňer/, /brél/.)

(10)  
\[
\begin{array}{c}
\text{[aRound]} \\
\text{[Lov]}
\end{array}
\]

When the stressed vowel is /i/ or /u/, then the vowels /a,i,u/ may appear in unstressed position (e.g., /mintira/, /ariña/, /kumida/). In short, when the stressed vowel is /e,o,i,u/, then the unstressed positions take on the minimum-maximum specification of (11). The crucial question arises at this point: given that this can only happen after stress has been assigned -- what happens to a vowel position that is, in effect, told that it can associate to only one vowel feature if it is already associated with two? The answer here is clear: as stated in (11), the privative feature [Low] is deleted.

(11) To meet the Well-formedness Condition: If the associations of a skeletal position exceed the permitted maximum, delete a privative feature (in the absence of language-particular rules).

Thus the derivation of a form like /bebér/ is as in (12).
(12)  
\[
\begin{array}{c}
\text{[Round]} \quad \text{[Round]} \\
\vspace{0.5cm}
\begin{array}{c}
\text{b} \quad \text{V} \quad \text{b} \quad \text{V} \\
\end{array}
\end{array}
\]

1: metrical structure assigned, stressing final syllable

2: deleted, by (11) and rule in text

3: by rule (10)


If the approach suggested here is correct, it lends credence to the analysis of the Hungarian and Finnish vowels systems, and their vowel harmony systems, suggested in Goldsmith (1985) [2]. The analysis, already suggested above in the list of basic vowel systems, is conceptually extremely simple, and carries with it its own internal reconstruction, interestingly. The analysis is based on what has been noted in traditional accounts of these vowel systems, but which is generally unformalized and unformulatable in earlier generative accounts, that is, the idea that these vowel systems are basically 5 vowel systems of the familiar sort with Fronting overlain onto them.

Our account of the 5 vowel system, again, is based on the presence of only two features, Round and Low. The feature Front is defined post-lexically in a totally "subphonemic" way, assigning Front to all [-Round] vowels, treating Front as a privative feature (the preferred kind of feature, a point we will return to below). Such a post-lexical insertion of a privative feature -- here, Front -- is perfect and ripe ground for a simple rule of Front harmony, which would spread this privative feature across a relevant span of syllables. At an early stage, one might well suspect this span to be a stress unit, such as the foot; in a language with simple word-initial stress placement, this could easily be reconstructed and reinterpreted as harmony within the word. Once this becomes obligatory, it is very easy to see how this Fronting could be reinterpreted not as having spread from a [-Round] vowel that appeared somewhere in the word, but rather as being a lexical characteristic of the word. In fact, we can be more specific as to why this reanalysis should have occurred. When a harmony process operates across a word, the language learner hears the prosodic feature -- whether it is tenseness, tone, nasality, or frontness -- spread over the entire word. The child must make a hypothesis as to which syllable that feature spreads from, and the
hypothesis the child will inevitably draw is that it comes from the most heavily accented syllable (this notion is formalized in Goldsmith (1987)). In the case of a system like Hungarian or Finnish, this means interpreting the Frontness as coming from a vowel that may not have been the historical source of the Fronting, if the first vowel is not [-Round], where a later [-Round] vowel in the word was actually the source.

The stages of this account for a word that was originally of the form CoCi, for example, are illustrated in (13).

Stage 1: A standard 5 vowel system

**Lexical**

[\[ +\text{Round} \]
\[ -\text{Round} \]
\[ \begin{array}{c}
\text{C} \\
\text{V} \\
\text{C} \\
\text{V} \\
\text{[Low]} \\
\end{array} \]

**Post-lexical**

[\[ +\text{Round} \]
\[ -\text{Round} \]
\[ \begin{array}{c}
\text{C} \\
\text{V} \\
\text{C} \\
\text{V} \\
\text{[Front]} \\
\text{[Low]} \\
\end{array} \]

Stage 2: A post-lexical spreading of the non-distinctive feature Front is added, adding another stage in the post-lexical derivation:

**Post-lexical**

[\[ +\text{Round} \]
\[ -\text{Round} \]
\[ \begin{array}{c}
\text{C} \\
\text{V} \\
\text{C} \\
\text{V} \\
\text{[Front]} \\
\text{[Low]} \\
\end{array} \]

Stage 3: Rule 5 (Redundant Fronting) is dropped, and the feature Front is lexical, but its deepest association is (only) with the stressed syllable, and is later spread by either a lexical or a post-lexical.

**Lexical**

[\[ +\text{Round} \]
\[ -\text{Round} \]
\[ \begin{array}{c}
\text{C} \\
\text{V} \\
\text{C} \\
\text{V} \\
\text{[Front]} \\
\text{[Low]} \\
\end{array} \]

8. Conclusion

We have suggested features that autosegmental theory might first, the privative/equipoise of counting of this counting maximum specific both in description and for descript neutralization, I have said little such vowel system I do not think too score. In general the language le oppositions the reasonable to as analyzed as a pr opposition, where opposition is chose. This is the cut-off work will provide to whether this seek a deeper understanding.

1. The extremely volume contains assumption that plays an important role.

2. The paper by Hungarian vowel considerable inter account sketched the front unround vowels act like a position, but act position. The essentially the same discussion of type of vowel sys accented syllable.
3. Conclusion

We have suggested a preliminary treatment of vowel features that departs minimally from familiar autosegmental theory, but which rests on two points: first, the feature-specific use of the privative/equipollent distinction, and second, the use of counting of associations allowed to a skeletal tier. This counting procedure, with both a minimum and a maximum specified for skeletal positions, is effective both in describing complete vowel systems as a whole, and for describing the character of positions of neutralization, both underlyingly and derivationally.

I have said little about the relative naturalness of one such vowel system compared with another, and in general I do not think there is much that can be added on that score. In general, the analysis of a vowel system by the language learner must encode the phonological oppositions that are encountered, and it seems reasonable to assume that an opposition is preferably analyzed as a privative opposition over an equipollent opposition, where possible, just as one equipollent opposition is chosen over two privative oppositions.

This is the outline of the proposal then: only future work will provide us with an answer to the question as to whether this is a fruitful and correct direction to seek a deeper understanding of the phonology of vowel systems.

Notes

1. The extremely interesting paper by Steriade in this volume contains several examples of this sort, where the assumption that the vowels have the features as in (2) plays an important role.

2. The paper by Parkas and Beddor in this volume on Hungarian vowel harmony raises two points of considerable interest. First, they point out that the account sketched here has offered no explanation for why the front unrounded vowels (the potentially neutral vowels) act like neutral vowels when not in word-initial position, but act like front vowels when in word-initial position. The reason for this, I suggest, is essentially the same as the reason given in the text in the discussion of the historical development of such a type of vowel system: in clear accentual systems, the accented syllable has a special status with respect to...
the harmonic feature(s).

The potential for the front unrounded vowels to be phonologically associated, or not, with the privative feature [Front] does not necessarily mean that words will randomly choose to have or not have the feature [Front] attached to such vowels. While it is reasonable for Parkas and Bedder to point out that there is a system to such assignment in Hungarian, they have the unfortunate impression that their proposal they are criticizing itself actually suggests that the [Front] assignment to neutral vowels is random or unprincipled. In fact, certain theoretical principles point in the right direction. Drawing on the proposal in Goldsmith (1987) let us consider the following (language-particular) statement: in cases of phonetic ambiguity (i.e., cases where harmonic feature assignment is not immediately determined by the phonetic facts), vowels are assigned a harmonic feature if and only if they are in a (primary) stressed position. This principle accounts for the first generalization in Parkas and Bedder's paper.

They raise a more difficult problem, albeit an entirely traditional one, when they consider the relation of root-level harmony and word-level harmony. This distinction was not addressed in Goldsmith (1985), but while there certainly is a relationship between the two, it has never been firmly established that in systems with a healthy number of disharmonic roots, as in Hungarian, the two principles are to be identified as one.

A reasonable approach to the Hungarian facts (and those of similar languages that I am aware of) that maintains the vowel system proposal offered here, and that—also meets Parkas and Bedder's criticisms—is the following. Let us take root harmony to be a condition on well-formedness (or, to neologize, "better-formedness"), rather than a rule in the familiar generative sense. (This notion is explored as well in Goldsmith (1987).) We express the sense in which fully harmonic words in Hungarian are "better-formed" than disharmonic words by defining the most highly-valued structure as that one with the most-associated harmonic autosegment. A word with a [Front] autosegment that is associated to all the vowels of a word is more highly valued than a word with the autosegment associated to only a subset of its vowels, and so forth. This same formation condition will ensure that words with front vowels at their beginning, when followed by neutral vowels, will have the [Front] autosegment associated to the root as unviolating for practical purposes.
ended vowels to be with the privative ly mean that words have the feature of the vowel is reasonable that there is some in, they leave the proposal they are that the [Front] im or unprincipled.plies point in the proposal in Goldsmith bowing (language-phonetic ambiguity assignment is notic facts), vowels and only if they are This principle on in Farkas and

albeit an entirely the relation of harmony. This dsmith (1985), but ip between the two, d that in systems nic roots, as in o be identified as ungarian facts (and aware of) that offered here, and criticisms, is the to be a condition ololize, better-in the familiar explored as well in use in which "fully etter-formed" than most highly-valued associated harmonic autosegment that is is more highly ment associated to forth. This same words with front allowed by neutral ment associated to

g all the vowels of the word, including, in particular, the neutral vowels. This answers Farkas and Beddor's second important objection. Other questions arise in comparing their own proposal and the present one, but the remarks in this footnote are intended as an elaboration of the system presented in Goldsmith (1985) and in the text, in the light of Farkas and Beddor's objections.

References


