Vowel coalescence and vowel harmony in the Korean language seem to require different types of underspecification. The radical underspecification version as proposed by Cho (1988) and Sohn (1987) provides a very simple explanation for Korean vowel coalescence. Consider the following vowel coalescence patterns in (1) and underspecification matrix in (2):

(1) Vowel coalescence (Sohn:1987)
   a + i --> ae
   e + i --> e
   i + any other vowel --> any other vowel
   (No other vowel coalescence is observed in normal speech.)

(2) Radical underspecification (Sohn: 1987)¹

-\[ \begin{array}{cccccccc}
  \hat{y} & i & e & \partial & \varepsilon & a & u & o \\
  \text{high} & - & - & - & - & - & - & - \\
  \text{low} & - & + & + & - & - & - & - \\
  \text{round} & - & + & + & - & - & - & - \\
  \text{back} & - & - & - & - & - & - & - \\
\end{array} \]

¹ /\hat{y}/ is unround high back vowel, equivalent to /\varepsilon/.

* 영어과 조교수
With this radical underspecification, it is quite straightforward to see that the merging of 
\(/a/\), which is \([+\text{low}]\), with \(/i/\), \([-\text{back}]\) would result in \(/æ/\), \([+\text{low}, -\text{back}]\). Likewise it is straightforward to see that the merging of \(/ø/\) and \(/i/\) results in \(/æ/\). However, as noted by McCarthy (1983:147), \([+\text{high}]\) and \([-\text{round}]\) should be specified underlyingly to properly explain the lack of spreading of harmony feature to high unrounded vowels such as \(/i/\) and \(/ø/\).

What makes the matter more complicated is the different grouping of vowels in ideophone harmony and the harmony in non-ideophone words. Traditionally, vowels in Korean are divided into three groups, light vowels, dark vowels and neutral vowels. The distribution of the dark (and neutral) and light vowels is shown in (3):

\[(3) \text{Korean vowel division}
\]

\[
\begin{array}{cccc}
\text{dark \\ & & & \\ & neutral vowels}&
\text{light vowels} \\
\text{i} & \text{ü} & \text{i} & \text{u} \\
\text{æ} & \text{o} & \text{a} \\
\end{array}
\]

It is virtually impossible to group \(/æ/\), \(/o/\), \(/a/\) and \(/o/\) to make a natural class in the SPE framework. Worse still, front light vowels \(/æ/\) and \(/o/\) behave as if they were dark vowels in regular verbal morphology harmony.

Many phonologists have attempted to deal with these problems. McCarthy (1983) discussed the vowel harmony in ideophones, Sohn (1986) and Kim (1988) discussed vowel harmony in ideophone and in regular morphology, and Sohn (1987) and Cho (1988) talked about vowel coalescence. But as pointed out earlier, the explanations for coalescence and vowel harmony are not compatible with each other at least in terms of the feature specifications they use. And there is no unified explanation that accounts for vowel harmony in both ideophones and in regular verbal morphology. Accordingly, Sohn (1987:187) concluded that ideophone harmony should be treated differently from the harmony in lexical morphology.

It will be shown in this paper that a consistent analysis is actually possible. However, such a consistent analysis of ideophone vowel harmony, verbal morphology vowel harmony and vowel coalescence in Korean require the interaction of the theory of Feature Geometry and with the underspecification of monovalent features.

Accordingly I will talk about feature geometry using monovalent features in section 2, before going into the discussion of Korean vowel phonology. In section 3, the feature theories motivated in section 2 will be used to explain the vowel coalescence and umlaut data to show that the same feature specification used in explaining vowel coalescence can also account for vowel
ideophone and verbal morphology will be discussed within a consistent framework. Critical comparisons will be made along the way between the explanations given here and some major analyses of Korean vowel harmony by recent researchers, such as McCarthy (1983), Sohn (1986) and Kim (1988). And section 5 is the conclusion.

2. Feature Geometry and Monovalent features

2.1 Root and Articulation node

The feature geometry that I am assuming in this paper is shown in (4):

(4) Feature Geometry

The feature geometry in (4) is very similar to Lahiri & Evers (1991:87). They present a very convincing argument that grouping front vowels with the coronal sounds is not only convenient but also necessary in explaining palatalization in many languages and that separating "Tongue Position" node is much simpler and clearer than Clements'(1989) postulation of "C-place node" and "V-place node" both of which dominate almost the same set of features.

But (4) is different from Lahiri and Evers (1991) in two respects. First is the relationship between [back] and [velar]. Here [back] is dependent upon [velar] as [front] is
dependent on [coronal]. This is the reflection of Steriade’s (1987) observation that [back] harmony can be spread across the velar consonants in some languages. Steriade postulated four place nodes [labial], [coronal], [dorsal], and [velar]. All the vowel features according to Steriade are dominated by the dorsal node while the velar node dominates back consonant features. According to the Feature Geometry given in (4), back vowels can spread across velar consonants, if it is [back] spreading. But if velar consonant blocks the spreading of [back] vowels, it may be taken as the spreading of [velar] node along with its dependent feature [back].

Another difference is that all the features used here are monovalent. There is no specification of the [-] value of these features. The immediate consequence of using monovalent features is to eliminate almost all of the redundancy rules. The major difficulty of the radical underspecification as in Archangelli (1984) is to justify the Redundancy Rule Ordering Constraint. The features that are in underlying representations are supposed to play an active role in the description of phonological phenomenon in underived environments or morpheme internal phonology. The feature geometry shown in (4) eliminate the possibility of the active phonological roles of such features as [-labial], [-round], [-anterior] or [-velar] in any human language. What is specified in the underlying representation is the feature that actively participates in the phonology of a given language.

There is phonetic evidence for using monovalent features. [+voice] is phonetically realized by the articulatory gesture of closing the glottis to produce the air turbulence in the larynx. But [-voice], on the other hand, does not need any articulatory gesture. It just means the absence of the articulatory effort to make voicing. Browman and Goldstein (1987) also claim that phonetic features or gesticular commands, are for the most part monovalent. Surely there are some features whose [+ -ATR] may be a case in point. One needs to make a conscious effort either to advance or to retract the tongue root. In this respect, there are some true binary features related to tongue movement, [±ATR], air stream flow [±continuant], and jaw height [±high]. [-continuant] therefore does not just mean the passive state of the absence of the effort to keep the continuant flow of the air stream. More than that, it needs gesticular effort to block the air stream. Therefore, ambiguities arise, at least in phonetic interpretation of the [-] feature. [-] in [-voice] means the lack of [+voice], but in [-continuant] it means the positive effort to block the

2 Lahiri & Evers used feature [dorsal] instead of [velar]. Here the term [velar] is used, since [dorsal] means the tongue body which is separated from place in (4).
3 This requires us to have entirely different idea of representation of the contour segment, such as pre-nasalized consonants and affricates. This is not dealt with in this paper, since it is not directly relevant to our discussion of Korean vowel harmony and coalescence. I will take up contour segments in a separate paper.
air-stream. Considering this phonetic observation, we can say that all the monovalent features here indicate the presence of articulatory efforts.

However, using monovalent feature does not necessarily eliminate all the redundant feature fill-in rule. It may be the case that some feature [F] may not be active underlyingly, but may play an important role in the lexical derivation. In those cases, the feature [F] may be supplied. This, however, is clearly different from the Redundancy Rule Ordering Constraint in which feature [F] is supplied to all the segments, which is essentially equivalent to a redundancy rule. On our account, [F] may be introduced as a floating morphemic feature as a part of the process of morpheme concatenation. This is convincingly argued for by Ito and Mester (1986) in their discussion of Japanese Rendaku, where [+voice] is introduced in the process of morpheme concatenation.

The basic assumption in using monovalent features is that only one value, whether it be [+] or [−], is active in phonology. Of course, this basic assumption is in need of further explanation, given the fact that much work on contrastive underspecification records apparently concrete example of using both values. The feature geometry given in (4) basically says that only one value of all the features are really active except for [continuant] [high] and [RTR]. Here [interrupt] is used as an equivalent of [-continuant], and [open], as an equivalent of [-high], and [RTR] as an equivalent of [-ATR]. These are introduced in the feature geometry in (4) to allow the possibility of the active use of both features in phonological description of natural languages.

A remark is in order about the representation: I will simply assume that functional class nodes are absent when they do not dominate any features. For example, if [coronal] is unspecified in a language, the coronal segment is assumed to have neither ART node nor PL node. This can be captured by the following principle of simplicity:

(5) Principle of Simplicity

Unless proven otherwise, a simpler representation is favored.

Note also that the Simplicity Principle in (5) is not only responsible for the absence of class nodes that does not dominate any features, but also motivates the underspecification theory. If a segment can be represented by [A, B, C] or by [A, B], where [A] and [B] are phonological features, the Principle of Simplicity tells us to take the simpler one, [A, B] in this case as the proper representation in the underlying representation⁴.

⁴The explanation using the principle of Simplicity may be problematic in choosing the representation between [A, B] and [A, C] combinations, if these two are the possible candidates. I will simply assume that we need the informations from phonology in this case. If the feature [C] is active in phonological derivation, then the representation with that feature will be taken for the underlying representation. This should be worked out in more detail.
One final remark on the interpretation of the feature [anterior]. Here I am using [anterior] to denote the consonants which are articulated in the dental region. Therefore, if a language does not have a contrast between dental and alveolar consonants that share the same manner of articulation, [anterior] is not used in the representation. This gives us a maximum three way distinction of coronal consonants as shown in (6):

(6) The three way contrasts in coronal consonants

<table>
<thead>
<tr>
<th>a. Interdental &amp; Dental</th>
<th>b. Alveolar</th>
<th>c. Alveopalatal &amp; Palatal</th>
</tr>
</thead>
<tbody>
<tr>
<td>ART</td>
<td>ART</td>
<td></td>
</tr>
<tr>
<td>PL</td>
<td>PL</td>
<td></td>
</tr>
<tr>
<td>[coronal]</td>
<td>[coronal]</td>
<td></td>
</tr>
<tr>
<td>[anterior]</td>
<td>[front]</td>
<td></td>
</tr>
</tbody>
</table>

Notice that the feature geometry model given in (4) is not complete. This is partly because some aspects not directly relevant to the discussion in this paper are not discussed, and partly because we probably have to keep open the possibility of parametrizing feature geometry. I believe that different languages may have different manner feature structures. For example, for a certain language, sonorant may be totally redundant if there is other sonorant

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5 An individual language may need further specification in the PL node. For example, the feature [retroflex] may be necessary in Sanskrit to explain n-retroflexion. (cf. Schein & Steriade:1986,717-719)

6 One problem in adopting (6b) as a representation of /h/ is the possible confusion between /h/ and /th/ which are separate phonemes in Korean. I will take Iverson's (1989, 286) suggestion that [continuant] is the relevant feature in underlying phonemic contrasts and make the following distinction:

   a. /h/       b. /th/       c. /s/

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LG</td>
<td>LG</td>
<td>[cont]</td>
</tr>
<tr>
<td>[cont]</td>
<td>[cont]</td>
<td>[S.G.]</td>
</tr>
<tr>
<td>[S.G.]</td>
<td>[S.G.]</td>
<td></td>
</tr>
</tbody>
</table>
features such as [nasal] or [lateral], or these sonorant features may be dominated by the feature [sonorant]. Let's consider the two different representations of lateral as in (7):

(7) Two possible representation of lateral

\[ \text{a. Root [cons] [lateral]} \]
\[ \text{b. Root [cons] [sonorant]} \]

If lateral delinking is applied to these two different structures, (7a) predicts that the outcome of the [lateral] deletion is a plain consonant possibly /t/, while (7b) predicts that the result of lateral delinking is another default sonorant, quite possibly a homorganic nasal /n/. Yagaria, a language of the East New Guinea Highlands shows a lateral-stop alternation (cf. Rice and Avery 1990: 11-12). And in Korean, a lateral-nasal alternation can be witnessed (cf. Hyman 1976: 117-118). Here we can see the necessity of parametrizing the sonorant features.

The possibility of parametrizing feature geometry is also open to place features. The feature [labial] may either be dominated by "place node" or form another constituent with velars as shown in (8):

(8) Two different place structures

\[ \text{a. Place \{coronal\} \{labial\} \{velar\}} \]
\[ \text{b. Place \{coronal\} \{peripheral\} \{labial\} \{velar\}} \]

(Rice and Avery : 1990)

(8b) is crucially important to explain the consonant assimilation in Korean. In Korean, coronals assimilate to velars and labials, labials assimilate to velars, and velars never assimilate to adjacent consonants. (For data, please refer to Cho (1988)). (8b) along with underspecification gives the following representation of Korean consonants:

---

7Sagey (1986) and Rice and Avery (1990) used [dorsal] instead of [velar]. However the difference in name does not bear any significance in our discussion.
(9) Feature Geometry of Korean consonants.

\[\begin{align*}
\text{a. /l/} & \quad \text{b. /p/} & \quad \text{c. /k/} \\
\text{R[cons]} & \quad \text{R[cons]} & \quad \text{R[cons]} \\
\quad \text{ART} & \quad \text{ART} & \quad \text{ART} \\
\quad \text{PL} & \quad \text{PL} & \quad \text{PL} \\
\quad \text{[peripheral]} & \quad \text{[peripheral]} & \quad \text{[verlar]}
\end{align*}\]

Now we can easily see the apparently hierarchical strength of Korean consonants. The assimilation rule is very simple. What we have in Korean is a regressive assimilation of features from the more specified place node to the less specified place node as shown in (10):

(10) Korean consonantal assimilation rule:

\[\begin{align*}
\text{R} & \quad \text{R} \\
\text{[cons]} & \quad \text{[cons]} \\
\quad & \quad \\
\quad \text{PL} & \quad \text{PL} \\
\quad & \quad \\
\quad \text{F1} & \quad \text{F2}
\end{align*}\]

Condition: Root tier adjacency  \( F1 < F2 \)

I believe this parametrization captures the observation by Cho (1991) without invoking the use of [-coronal] features. Her division of Place of Articulation Theory and Articulator Theory has the problem of using coronal features in two different ways as shown in (11):


\[\begin{align*}
\text{a. Place of Articulation Theory (=AT)} & \quad \text{b. Articulator Theory (=PT)} \\
\quad \text{Place} & \quad \text{Place} \\
\quad \text{[cor]} & \quad \text{[cor]} \\
\quad \text{[ant]} & \quad \text{[ant]} \\
\quad \text{Labial} & \quad \text{Labial} \\
\quad \text{Coronal} & \quad \text{Coronal} \\
\quad \text{Dorsal} & \quad \text{Dorsal} \\
\quad \text{[round]} & \quad \text{[round]} \\
\quad \text{[ant]} & \quad \text{[ant]} \\
\quad \text{[dist]} & \quad \text{[dist]} \\
\quad \text{[high]} & \quad \text{[high]}
\end{align*}\]

---

\(^8\) I do not have any clear evidence about the specification of place node for coronals. I will assume that coronal consonants do not have place node until it is shown otherwise.
In Place of Articulation Theory (henceforth PT), [coronal] is used as a binary feature and different languages choose different values [+ ] or [- ] for [coronal] and [ant ] features. But in Articulator Theory (AT hereafter), she claims that coronal is a monovalent feature. Further, the feature [ant ] in PT and in AT have different interpretations. [-Ant ] in PT includes alveopalatal and velar consonants while the same feature in AT does not include velar consonants. With all these observation, we can say that the parametrization given in (8) is much more natural and consistent in using and representing features.

2.2 Tongue Position node

Turning to the Tongue Position (TP) node, Lahiri and Evers (1991) provide a wide range of data that supports the necessity of separating out TP from the other place features. Three more features [open], [RTR] and [ATR] are introduced here. The feature [open] was first suggested by Clements (1989). This feature is equivalent to [-high] in the SPE framework. Clements uses [open] instead of [high] to consistently explain the sonority value of each segment. For the majority of sonority features such as [sonorant], [nasal] or [low], it is the [+ ] value that contributes to the increase of the sonority of a segment. But when it comes to [high], it is the [- ] specification, not the [+ ] specification, that contributes to the sonority value. However, if we use [open], then uniformly the [+ ] value of the sonority features can produce the overall sonority of a segment.

In the meantime, [open] here is introduced with a different purpose in mind. The feature [open] is used not to account for the sonority of segments, but to overcome a possible weakness of using monovalent features. In some languages, the [+ high] feature plays an active role in phonological and phonetic processes (English palatalization may be a good example.), while in other languages [-high] is very salient. And in some cases, both [+high] and [-high] features play active roles, which can not be captured either by radical underspecification (Archangelli, 1984) or by contrastive underspecification (Steriade :1987)9. In the framework given in (4), what are active in this case is not [+high] but separate features [high] and [open].

A similar explanation can be given to [ATR] (Advanced Tongue Root) and [RTR] (Retracted Tongue Root). As noted earlier, both [RTR] and [ATR] require the presence of the relevant phonetic gestures, and phonologically speaking, both of these can actively participate in the derivation. In passing, it must be noted that the present feature geometry incorporating TP predicts that [-low] may never be used as a salient feature in phonology.

---

9 In contrastive underspecification both [+ ] and [- ] values of [high] can be active, only if they contrast. But at the same time, contrastive underspecification also predicts that they are not active in segments that do not make any phonemic contrast. Here the prediction is that if both [+ ] and [- ] are active, they will also be active in such segments that do not contrast in [high] features, unless the feature is redundant because of the presence of other features.
In addition, it should be mentioned that though there are three height features [high], [open], and [low], this does not mean that they are equivalent to using [high], [mid] and [low] features. I assume that there is a complexity constraint in the feature geometry so that a language may not use all the three height features. For example, Korean makes active use of only the [open] feature. Then, the prediction is that [low] may not participate in phonological processing. This prediction is born out as will be shown in section 4.

It will be shown in this paper that positing the TP node is absolutely important in capturing the generalization concerning vowel harmony and coalescence in Korean. As will be discussed in Section 4, the problems of previous analyses of Korean vowel harmony can be obviated by incorporating the TP node in rule formulation.

Finally, I do not think that all the tongue position features are directly linked to the TP node. The internal structure of TP can also be parametrized. For example in Ogori (Pulleyblank, 1991), feature [RTR] (or [-ATR] in the traditional sense) spreads onto nonhigh vowels only. If we let [open] dominate [RTR], we can say that the [RTR] spreading rule scans the [open] tier and therefore requires minimal scansion adjacency. Further we do not have to invoke feature co-occurrence restrictions to eliminate [high, RTR] segments because when there is [RTR] then there is [open]. But since [open] and [high] require articulatory effort in opposite directions, they can not cooccur under the same root.

Again, [low] may be dependent on [open] and [RTR] or [ATR] may be dominated by [low] features. The dependency relation and parametrization of feature geometry is not fully investigated yet and is open to further research.

3. Coalescence and Umlaut

3.1 Vowel Coalescence.

In Korean, when two vowels are adjacent on the root tier, they sometimes fuse into one vowel. Let's look at the data:

(12) Vowel coalescence data

<table>
<thead>
<tr>
<th>a. a + i --&gt; ae</th>
</tr>
</thead>
<tbody>
<tr>
<td>sai</td>
</tr>
<tr>
<td>[sæ]</td>
</tr>
<tr>
<td>(a gap)</td>
</tr>
</tbody>
</table>

The consonantal changes are disregarded. For reference, obstruent consonants are voiced in between two vowels. And stem final /h/ is deleted when followed by a vowel initial suffix. The result of coalescence can be a long vowel, if it is in the initial position of a word, but short when they are in non-initial position. This may be due to a constraint on the foot level that the weak node should not branch. (For further discussion, see Lee (1991)).
ai \[re\] (a kid)
b. \(\partial + i \rightarrow e\)
\[\text{p\text{"o}ta}\] [peda] (to cut)
\[\text{th\text{"e}nte}\] [thende] (perhaps)
c. \(\text{\text{"i}} + \text{any other vowel} \rightarrow \text{any other vowel.}\)
\[\text{maim}\] [ma:m] (mind)
\[\text{kail}\] [ka:l] (Fall)

We may posit the following feature specification:

(13) Vowel feature specification\textsuperscript{11}

\[
\begin{array}{cccccccc}
\text{Open} & \text{i} & \text{e} & \text{\ae} & \partial & \text{a} & \text{\text{"i}} & \text{u} & \text{o} \\
\text{Front} & + & + & + & + & + & + & + & + \\
\text{Round} & + & + & + & + & + & + & + & + \\
\text{RTR} & + & + & + & + & + & + & + & + \\
\end{array}
\]

Following Kim (1968), Sohn (1987), and Lee (1987), I assume that Korean has an 8 vowel system. The front round vowels /iu/ and /iu/ are assumed to be derived by the postlexical operation of vowel merger, the so called "Nucleus degemination" as in Sohn (1987: 315)

The features used in this specification need some explanation. We can compare the specification in (13) with Sohn's (1987) given in (2). The feature [open] is used instead of [­high] and [front] instead of [­back] in (2). This much is self-explanatory. The difference is the introduction of [RTR] features and the elimination of the [low] feature. [RTR] is motivated by the fact that vowel harmony in many languages, notably West African Languages (cf. Archangelli & Pulleyblank: 1991), involves the spreading of the tongue root node whether it be [-ATR] ([RTR]) or [+ATR]. And, Kim (1988) has suggested that Korean vowel harmony can be explained as the [-ATR] spreading.

The elimination of [low] comes from the following considerations. First, it comes from the economy of underlying representations. Since all the segments are effectively contrasted with one another, it is completely redundant to specify [low] in the underlying representation. Second is the functional consideration. The feature [low] in Korean does not have any role to play in the phonological derivation. In other words, it is inert just like all other [-] values of the features given in (13). So the basic principle of using monovalent features, elimination of features without phonological function, prevents us from putting [low] in the phonological specification of features. Further, there is phonetic motivation. So far, at least some

\textsuperscript{11}The "+" in the feature specification means the existence of the feature.
phonologists working on Korean language seem to have agreed that /æ/ is a low vowel and /ə/ is a mid vowel. (McCarthy (1983), Sohn (1987), Cho (1988), etc.). However, the Korean phoneme represented as /æ/ is much higher than the /æ/ pronunciation in English. Some actually used the symbol /e/ instead, which reflects the actual height of the phoneme (cf. Kim, 1968). As for /ə/, it is definitely different from English Schwa. Korean /ə/ is more tensed and actually lower than its English counterpart. Further Archangelli and Pulleyblank (1991) posit /ə/ as a [−ATR] counterpart of a low vowel /a/ to explain the harmonic alternation between them in African languages.

We can also see in (13) that there are certain relationships that hold between features in segments. Following Archangelli and Pulleyblank (1991), the relations are expressed as Path conditions as in (14):

(14) Path Conditions
   a. if [RfR], then [open]
   b. if [open, round], then [RfR]
   c. if [front], then not [round]

The Path Conditions are utilized in different ways. First they account for the co-occurrence restrictions. The negative condition (14c) does not allow a [front, round] combination in the underlying representation. The Path Conditions are also equivalent to segmental redundancies. [Open] is redundant when it comes together with [RfR]. For example /o/ is represented by the combination of [round], [open], and [RfR]. The Path Condition correctly predicts the redundancies of [open] in [RfR] segments. Therefore /o/ may be represented by [round, RfR]. Given the Simplicity Principle (5), we will take the simpler form as the underlying representation. Then why not use [round, open] instead of [round, RfR] to represent /o/? The Path Condition (14b) predicts that [round, open] implies [RfR]. Here comes the functional consideration. [RfR], as will be seen in vowel harmony, plays an important role in phonology. And those features that are active throughout the phonological derivation are thought to be present in the representation. Now we have the underspecified matrix of Korean vowels as in (15):

(15) Underspecification of Korean vowels

<table>
<thead>
<tr>
<th></th>
<th>i</th>
<th>e</th>
<th>æ</th>
<th>ə</th>
<th>a</th>
<th>ɨ</th>
<th>u</th>
<th>o</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Front</td>
<td></td>
<td>+</td>
<td>+</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>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTR</td>
<td></td>
<td></td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Now let's consider Korean coalescence. With the feature specification in (15), we have a straightforward explanation about the vowel coalescence using feature geometry. I will assume that vowel coalescence is the root tier fusion of features as schematized in (16):

\[\text{(16) Vowel coalescence}\]

\[
\begin{array}{c}
\text{R [voc]} \quad \text{R [voc]} \\
\text{ART} \quad \text{ART} \\
\text{TP} \quad \text{PL}
\end{array}
\]

(1) Delinking of TP  
(2) Delinking of terminal Rt.  
(3) Spreading Rt to fill the mora  

(Condition: Root tier adjacency.)

The empty V slot of the second vowel may be filled by spreading the root node, which results in a long vowel.\(^{12}\) Now, (17) shows the fusion process for the examples given in (12):

\[\text{(17) Coalescence operation}\]

\[\text{a. } a + i \rightarrow æ\]

\[
\begin{array}{c}
\text{/æ/} \\
\text{TP [RTR]}
\end{array}
\]

\[
\begin{array}{c}
\text{/a/} \\
\text{TP [RTR]}
\end{array} + \begin{array}{c}
\text{/i/} \\
\text{PL [c coronal]}
\end{array} \Rightarrow \begin{array}{c}
\text{/æ/} \\
\text{TP [RTR]}
\end{array}
\]

\[\text{b. } ð + i \rightarrow e\]

\[
\begin{array}{c}
\text{/e/} \\
\text{TP [RTR]}
\end{array}
\]

\[
\begin{array}{c}
\text{/e/} \\
\text{TP [RTR]}
\end{array} + \begin{array}{c}
\text{/ð/} \\
\text{PL [c coronal]}
\end{array} \Rightarrow \begin{array}{c}
\text{/e/} \\
\text{TP [RTR]}
\end{array}
\]

\(^{12}\) Following Lee (1991), I will assume that the resultant long vowels are shortened in non-initial syllables of a phrase.
Notice that vowel coalescence takes two vowels which have a non-branching ART node, in other words, which lack either PL or TP, and combines them together to form a branching ART. We can see that with the present feature specifications and feature geometry as in (4), the rule severely limits the possibility of merging two vowels. With the underspecification given in (2), there is no reason why /o/ and /u/ are fused into /ø/, and /ʌ/ and /e/ into /e/. Here we see the crucial importance of positing TP node separate from PL. Only those that have non-branching ART node can be fused. Notice that /o/ and /e/ have branching ART nodes. The coalescence using feature geometry in (4) correctly rules out the possibility of fusing /o-u/ and /ʌ/ sequence.

Though not discussed in this paper, it is assumed that this rule applies to a string that is already syllabified. That explains why /ʌ/ and /i/ sequence surfaces optionally as /æ/, while a sequence of /i/ and /ʌ/ always surfaces as /æ/ and never as /æ/, though the rule description given in (14) allows the latter possibility. Coalescence is only possible when the second vowel is less sonorous than the first one, because whenever the first one is less sonorous, the syllabification process will take the first vowel making it into a glide and the structural description for coalescence is not satisfied.

3.2 Umlaut

13 In Kyeongsang dialect, the sequence /yʌ/ sometimes shows up as /e/.
In this section, I will argue that Umlaut, or Vowel Fronting, in the Kyeongsang dialect of Korean can also be clearly explained with the same feature geometry without resorting to Clements' (1989) type of C-place and V-place node geometry. Hume (1990) analyzed Korean umlaut using Clements' geometry and thereby arguing for the superiority of Two place node geometry over the Sagey (1986) type of three place feature geometry, or the Steriade's (1987) four place feature geometry. The major issue in Korean Umlaut is the blocking effect of the alveopalatal consonant. This provides the convincing evidence that alveolars should be grouped together with the front vowels.

I won't go into details of coronality of front vowels. Readers may refer to Lahiri and Evers (1991) for further discussion. Here, I will just show how some coronal sound can block the spreading of features between vowels. Let's take a look at the data.

(18) Vowel fronting (Data from Hume, 1990: 232)\textsuperscript{14}
a. Umlaut occurs:

\begin{itemize}
\item Across a non-coronal consonant:
  \begin{itemize}
  \item \textbf{koki} \quad [kegi] \quad (meat)
  \item \textbf{mokhi+ta} \quad [mehida] \quad (to be eaten)
  \item \textbf{cuk+i+ta} \quad [cigida] \quad (to kill)
  \item \textbf{api} \quad [aebi] \quad (father)
  \item \textbf{chaNphi} \quad [cheNphi] \quad (shame)
  \item \textbf{sum+ki+ta} \quad [shimgida] \quad (to hide)
  \end{itemize}
\item Across an anterior coronal
  \begin{itemize}
  \item \textbf{kili+ta} \quad [kirida] \quad (to draw)
  \item \textbf{salphi+ta} \quad [seelphida] \quad (to inspect closely)
  \item \textbf{titi+a} \quad [tedida] \quad (move slowly)
  \item \textbf{puti} \quad [pidi] \quad (by all means)
  \item \textbf{canti} \quad [ceendi] \quad (lawn)
  \end{itemize}
\item Umlaut blocked
  \begin{itemize}
  \item Across a palatal consonant:
    \begin{itemize}
    \item \textbf{kachi} \quad [kachi] \quad *[kechi] \quad (value)
    \end{itemize}
  \end{itemize}
\end{itemize}

\textsuperscript{14}the following is the notational convention that will be used for consonants in the data.

\begin{itemize}
\item i) "Stop or affricate + h" is an aspirated stop or fricative.
\item ii) "Sh" is an alveopalatal fricative [ʃ]
\item iii) [N] represents a velar nasal.
\end{itemize}

It must be noted that not all the data are actually found in my informants. For example, they do not show palatalization on /canti/ (lawn).
The umlaut in Kyeongsang dialect involves two different processes: the spreading of [front] and the delinking of [round] in the fronted vowels. The front vowels and alveopalatal consonants are represented as under in the present framework:

(19) Feature geometry of front vowels and alveopalatal consonants.

<table>
<thead>
<tr>
<th>a. Front vowels</th>
<th>b. Alveopalatal consonants</th>
</tr>
</thead>
<tbody>
<tr>
<td>R [voc]</td>
<td>R [cons]</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>ART</td>
<td>ART</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>PL</td>
<td>PL</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>[coronal]</td>
<td>[coronal]</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>[front]</td>
<td>[front]</td>
</tr>
</tbody>
</table>

The feature geometry clearly presents the nature of vowel umlaut in Kyeongsang dialect. It is an assimilatory process achieved by the spreading of the feature [front] to the preceding vowel. Since Korean does not show underlying contrast between dentals and alveolars, [anterior] is not necessary. And therefore we can fully constrain the rule by formulating it as [coronal] spreading as in (20):

(20) Umlaut
The rule (20) shows that umlaut in Korean can be viewed as an assimilatory process: back vowels become front vowels before other front vowels. Meanwhile the labial node delinking is motivated by the structure preserving principle, since there is no underlying front round vowels in Kyeongsang dialect.

Given the rule (20) and alveopalatal consonant representation as in (19b), we can immediately see that spreading across the alveopalatal consonant results in a violation of the line-crossing constraint. Goldsmith (1976) explicitly claims that whenever the association lines cross, the result is ill-formed. Take a look at the ill-formed example of the first word of (18c) "kachi" (value) as shown in (21):

(21) Ill-formed umlaut across a alveopalatal consonant.

\[\begin{array}{cccc}
\text{*/k/} & \text{/a/} & \text{/ch/} & \text{/i/} \\
\hline
\mu & \mu & \\
\end{array}\]

\[
\begin{array}{cccc}
\text{R [voc]} & \text{R [cons]} & \text{R [voc]} \\
\text{ART} & \text{ART} & \text{ART} \\
\text{PL} & \text{PL} & \text{PL} \\
\text{TP} & \text{[coronal]} & \text{[coronal]} \\
\text{[open]} & \text{[RTR]} & \text{[front]} \\
\text{[front]} & & & \\
\end{array}\]
The feature geometry and Association Line Convention can successfully explain the umlaut data in Hume. Further let's take a look at additional data where umlaut fails to apply:

(22) Further blocking of umlaut

a. When the target is preceded by an identical vowel

\[ \text{\text发扬} \rightarrow *[\text{\text发扬}] \text{ (mother)} \]

\[ \text{\text送命} \rightarrow *[\text{\text送命}] \text{ (ladder)} \]

\[ \text{\text送上} \rightarrow *[\text{\text送上}] \text{ (a badger)} \]

b. When a geminate intervenes between a target and a trigger.

\[ \text{\text母} \rightarrow *[\text{\text母}] \text{ (quickly)} \]

\[ \text{\text将} \rightarrow *[\text{\text将}] \text{ (far)} \]

\[ \text{\text上+} \rightarrow *[\text{\text上+}] \text{ (running)} \]

c. When \(/s/\) intervenes between a target and a trigger.

\[ \text{\text卡} \rightarrow *[\text{\text卡}] \text{ (a girl)} \]

\[ \text{\text子} \rightarrow *[\text{\text子}] \text{ (without)} \]

\[ \text{\text体} \rightarrow *[\text{\text体}] \text{ (again)} \]

It should be noted that (22a), (22b) and (22c) are my classification of umlaut blockings. Hume (1990) does not make such differentiations and tries to explain all the blocking effects in (22) by positing palatalization before umlaut. The gist of her explanation is that since the intervening consonant becomes palatalized by getting the [coronal] feature from the following vowel, it later blocks the application of umlaut. It would have been really simple and nice if her explanation worked. But in doing so, she has to argue against Hayes' (1986) Linking

15 Another way to explain the blocking effect is using the OCP and the Linking Convention (Hayes, 1986). The coronal nodes are adjacent and OCP fusion takes place as shown. Then the Linking Constraint, which says that association lines in the structure descriptions are interpreted as exhaustive, does not allow spreading because [coronal] is doubly linked and the structure description does not show a doubly linked structure.

16 Hume (1990:237) notes another example of blocking in /teni+ta/. She claims that [tenida] is ill-formed. This goes against the data that I got from my informants. If [tenida] is well-formed as my data suggest, her argument may be very much weakened, because she claims that if \(/n/\) intervenes between the target and the trigger of umlaut, the trigger \(/n/\) causes palatalization (cf. the first word of (22a)) and the palatalized consonant blocks umlaut.

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Constraint that says that the association line is exhaustive, and she has to postulate a dissimilation rule which actually undo the effect of umlaut in the examples given in (22).

(23) shows the explanation that Hume gives to explain the blocking effect.

(23) Schematic example of Palatalization and Umlaut interaction

a. Umlaut

\[
\begin{array}{c}
 V \\
 V-pI \\
 ([\text{+labial}]) \\
 [\text{+cor}] \\
 V-pI \\
 V \\
\end{array}
\]

b. Dissimilation

\[
\begin{array}{c}
 V \\
 V-pI \\
 +\text{coronal} \\
 C \\
\end{array}
\]

c. Outcome of Palatalization & Umlaut

\[
\begin{array}{c}
 V \\
 V-pI \\
 +\text{cor} \\
 \text{place} \\
 C-pI \\
 \text{place} \\
 \text{place} \\
 V-pI \\
 V-pI \\
 V-pI \\
\end{array}
\]

The framework with which she analyzed Korean umlaut is Clements' (1989) Two place theory of Feature geometry. The [+cor] feature spreads from the second V to the preceding consonant in palatalization rule application. Next in the umlaut operation, the [+cor] is spread onto the first vowel. But the outcome is subject to a dissimilation rule which delinks the [+cor]. Later the first vowel without the [+cor] specification will be interpreted as a back vowel. The explanation seems pretty straightforward. But each step of derivation is problematic.

Let's begin with the Linking Constraint. Hayes (1986:331) gives us the following definition:

(24) Linking Constraint

Association lines in structural descriptions are interpreted as exhaustive.
Both the umlaut rule and the dissimilation rule violate the Linking Convention. In umlaut, doubly linked [+cor] spreads, and in delinking, the first one of a triply linked [+cor] deletes. This means the loss of a very strong constraint that was successfully used in explaining the Coda Conditions in Ito (1986).

Secondly her palatalization is not sufficiently constrained. The intervening consonant may as well be a coronal stop. (18b), however, clearly shows that coronal stops are transparent. The problem is that Korean /l/ can also undergo palatalization to become /ty/ before front high vowels, and if the two segments are separated by a morpheme boundary /l/ becomes a palatal sound /c/. Therefore Hume has to separate /l/, /th/ and /t/ from /l/, /n/ and /s/, which is by no means easy given Two place node geometry. Coronal stops become palatal stops only when the following high front vowel is hetero-morphemic, but the environments are not shared by /l/, /n/ or /s/ palatalization.

Further we can see that the dissimilation rule does not have independent motivation. Hume (1990: 241) quotes Kim (1980) to provide the necessity of dissimilation in Korean phonology. But as I understand it, Kim's (1980) proposal is related to verb morphology and the dissimilation takes place between two vowel segments. Hume's dissimilation takes place between a vowel and a following consonant which is usually a hetero-syllabic consonant and strangely the dissimilation does not take place between a consonant and the following vowel in a same syllable.

As I mentioned earlier, it would have been really desirable to have a simple explanation to all the data given in (22). However we can find several independent observation that works here. (22a) may be an example of Geminate inalterability (Hayes, 1986). The fact that (22a) data have two identical vowels seems to indicate that the first vowel is realized by spreading the root node from the second vowel to make them a geminate. If it is correct, then the structure of (22a) words may look like (25):

(25) The representation and umlaut of "satali" (ladder)

\[
\begin{array}{c}
\mu \\
\mu \\
\mu
\end{array}
\]

s a t a l i

The umlaut rule (20) requires moraic tier adjacency condition. The rectangular block indicates the adjacency necessary for umlaut application. However, if the rule applies it results in the change of the second member of the geminate, which is not allowed by the inalterability condition (Hayes, 1986: 321). The adjacency condition working with Geminate inalterability successfully explain why umlaut does not apply to (22a).
The adjacency condition is also responsible in blocking umlaut application in (22b), though in a slightly different way. Hayes (1989) represents a geminate consonant as a root node being dominated by a mora and a following syllable as illustrated in (26):

(26) Geminate representation in moraic theory.

\[
\begin{array}{c}
\sigma \\
/\mu/ \\
a
\end{array}
\rightarrow
\begin{array}{c}
\sigma \\
/\mu\mu/ \\
an
\end{array}
(= \text{anna})
\]

If we represent the geminates in (22b) using Hayes type of geminate structure, we can get the following structure:

(27) The representation and umlaut of "p'alli" (quickly)

\[
\begin{array}{c}
\sigma \\
/\mu/ \\
p'
\end{array}
\rightarrow
\begin{array}{c}
\sigma \\
/\mu\mu/ \\
ai
\end{array}
(=p'alli)
\]

Now the target /a/ and the trigger /i/ are not adjacent on the moraic tier, because of the intervening moraic segment, thus failing to meet the rule description. I think the condition of the rule can successfully explain the blocking effect in (22a) and (22b), if the rule is formulated using moraic structure.

But moraic adjacency condition does not help in explaining the data in (22c). I do not have any concrete solution to (22c) except for an observation about Kyeongsang dialect. Kyeongsang dialect users' pronunciation of /s/ is a bit different from standard dialect users. Their pronunciation of /sul/ (the capital city of Korea) sounds like [ʃul]. It is more clearly witnessed when they pronounce foreign words. So the English word "soft" is pronounced as [ʃɔlt] especially among the less-educated. With this observation, we can venture to say that /s/ in Kyeongsang dialect is pronounced further back than that in standard Korean. Perhaps the /s/ segment for Kyeongsang dialect users are underlingly alveopalatal just like /c/. If this is correct, we can say that the application of umlaut is blocked because the intervening alveopalatal consonant causes association line crossing just like the (18c) examples.

In this section, it was shown that Korean Coalescence and umlaut can be explained with monovalent feature without any redundancy rules.

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4. Vowel Harmony

Vowel harmony (henceforth VH) in Korean ideophones has been extensively studied in the phonological literature. Among them, Kim-Renaud (1976), McCarthy (1983), Sohn (1987), and Kim (1988) are representative.

Kim-Renaud (1976) was the first to note that Korean vowel harmony may not be fully explained in the SPE style of features. As (3) shows, light vowels can not form a natural class using SPE features only. She introduced semantic features [±light] and [±dark] to explain the sound symbolism in Korean. She tried to capture the traditional three way distinction of light, dark, and neutral vowels by using these two features. According to her, light vowels are [+light, -dark] and dark vowels are [-light, +dark] while neutral vowels are [-light, -dark].

McCarthy (1983) presents an autosegmental analysis of Korean VH without resorting to exotic semantic features. He proposed that dark vowels including neutral vowels are [-low] and light vowels are [+low]. The most innovative aspect of his analysis is his suggestion that [+low] is considered a feature size morpheme which has its own tier. This morphemic feature is linked up to the base form of the ideophones to derive light or dark variations.

Sohn (1986) further developed McCarthy's idea of tier separation and incorporated two more phonological mechanisms: radical underspecification and feature spreading. She convincingly explains the vowel harmony as feature spreading. However she followed McCarthy and claimed that the spreading feature is [+low]. She tried, without much success, to move away from the problems that [+low] presents in McCarthy's analysis: namely the postulation of two absolute neutralization rules.

Kim (1988) recognized the problems of the feature [low] and suggested that the feature related to vowel harmony be [DVR] (Deep Voice Resonance), which he claimed to be equivalent to [RTR] or [-ATR]. He can successfully eliminate the problems that come from the feature [low], but he has to make the three way distinction of using [DVR]: [+] value, [-] value and [0] value of the feature.

All the analyses, introduced so far has some inherent defects. The most noticeable is the inability to discuss the difference of vowel harmony in ideophones and regular verbal morphology in a consistent way. In this Section, I will argue that an integrated theory of VH in Korean is possible without departing from the feature specifications or geometries presented in this paper.

4.1 Vowel Harmony in Sound Symbolism
As explained in the introduction, we usually find two or three different phonetic forms for basically identical ideophonic descriptions, which have been described as the light and dark alternations of ideophones. Dark ideophones are thought to denote "more intensiveness" or "heaviness" of sound symbolism.

Let's begin by looking at the data. Almost all the ideophones given in this sections are usually used in a reduplicated form. I assume, as in other analyses, that the reduplication applies to the ideophone, optionally or obligatorily if the base form is one syllable, in the last stage of the derivation. Therefore I will limit my attention to the unreduplicated forms.

(28) Ideophonic variations

<table>
<thead>
<tr>
<th>Type</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. /i/ - /æ/ alternation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pisil ~ pæsil</td>
<td>staggering</td>
<td></td>
</tr>
<tr>
<td>pithil ~ pæthil</td>
<td>staggering</td>
<td></td>
</tr>
<tr>
<td>kilc'uk ~ kælc'uk</td>
<td>(tall &amp; slim)</td>
<td></td>
</tr>
<tr>
<td>b. /e/ - /æ/ alternation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>kel ~ kæl</td>
<td>exhaustively</td>
<td></td>
</tr>
<tr>
<td>k'ectilak ~ kæcilak</td>
<td>(half-heatedly)</td>
<td></td>
</tr>
<tr>
<td>t'ekul ~ tækul</td>
<td>(rolling)</td>
<td></td>
</tr>
<tr>
<td>c. /u/ - /a/ alternation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>k'itak ~ k'atak</td>
<td>(nodding (one's head))</td>
<td></td>
</tr>
<tr>
<td>hinil ~ hanil</td>
<td>(in an airy manner)</td>
<td></td>
</tr>
<tr>
<td>hintil ~ hantil</td>
<td>(waving)</td>
<td></td>
</tr>
<tr>
<td>d. /u/ - /o/ alternation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ututuk ~ ototok</td>
<td>(crunching)</td>
<td></td>
</tr>
<tr>
<td>pusil ~ posil</td>
<td>(drizzling)</td>
<td></td>
</tr>
<tr>
<td>k'umthil ~ k'omthil</td>
<td>(wriggling)</td>
<td></td>
</tr>
<tr>
<td>e. /ɔ/ - /a/ alternation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ðiluk ~ allok</td>
<td>(colorful, stained)</td>
<td></td>
</tr>
<tr>
<td>tætk ~ tatak</td>
<td>(in clusters)</td>
<td></td>
</tr>
<tr>
<td>k'õNchuN ~ k'aNchoN</td>
<td>(hopping)</td>
<td></td>
</tr>
</tbody>
</table>

(29) The feature specification (reproduction of (15))
Given the feature specification in (29), we can immediately notice that the first vowel of the light counterpart (the second words in each pair), has [RTR] features, while the first words do not have the [RTR] feature. This tells us two implications: first, it is [RTR], not [+low] that is responsible for the alternation and with the "assimilation-as-spreading" approach, second (28) and (29) show that the base form is dark (without [RTR]) and the light counterparts are derived by introducing a floating feature size morpheme [RTR] to the dark ideophones. The second point is further evidenced by the fact that there are some dark ideophones which do not have light counterparts, but all the light ideophones always have dark counterparts as is noted correctly by Sohn (1986: 167, and subsequent footnote).

One additional observation necessary for the analysis here is the change in the second vowels. (28) shows that the second vowel also changes to a light vowel, if it is not one of the high unrounded vowels, /i/ or /u/. As a first approximation, we can say that [RTR] which is linked to the first syllable is spread onto the second or third vowel. Now the observations so far tells us that VH has two separate processes: the linking of floating [RTR] to a target and subsequent spreading of [RTR] to the following vowels. We may formulate the rule as in (30):

(30) Light ideophone derivation
Morpheme: floating [RTR] (meaning "lightness" of ideophone)
Linking target: First moraic segment.

Linking is done by creating necessary higher up nodes for anchoring the feature [RTR], as shown in the geometry in (4). For example, /i/ is not specified in terms of [open] or [RTR] and therefore by the Principle of Simplicity (5), there should not be a TP node. However, [RTR] needs an anchor. Here it is assumed that TP creation is the natural consequence of linking [RTR] to /i/. Let's take a look at sample derivations as in (31):

(31) Example of linking [RTR]

One apparent problem in the interpretation of the feature arises. In (31a) and (31b) the /æ/ sound is represented in two different ways. (31b) has the [open] feature while (31a) does not. The same is also true in the /iy/ - /i/, and /ui/ - /o/ alternations. But the problem is only apparent. The Path Condition (14a) will provide the [open] feature to all the [RfR] segments without [open].

Now let's turn to the spreading part. The [RTR] is spread onto the following vowels but high unrounded vowels are transparent to this harmony spreading. This has been a major problem hindering a consistent explanation of Korean VH. Sohn (1986) simply noted that high unrounded vowels are transparent in non-initial positions. This is a correct observation but she does not offer a convincing explanation to why it is so.
Kim (1988) maintains that [-RTR] is specified to high unrounded vowels if they are not in the initial position. According to him, high unrounded vowels are not specified in terms of [RTR] in initial position but [-RTR] is specified in non-initial position. His explanation is problematic in two ways: First, his explanation makes use of the three way contrasts of binary features. This type of positing [+ F], [- F] and [Ø F] has been one the major controversies in the underspecification literature. (cf. Ringen, 1988). But a more serious problem comes from the following data:

(32) /i/ and /u/ transparency

pusiløk-pusiløk ~ pasilak-pasilak    (rustling)
tølkiløk-tølkiløk ~ talkilak-talkilak (rattling)
dæbicøk-dæbicøk ~ akicak-akicak     (munching)

As shown in the data, the high unrounded vowels are transparent to vowel harmony and [RTR] can spread through them to the following vowels. Kim (1988) explains that the reason why non-initial high unrounded vowels are not affected by the spreading in disyllabic ideophones is that those vowels in non-initial position have prespecified [-RTR]. But this is not a complete explanation. If non-initial high unrounded vowels are specified as [-RTR], spreading of [+RTR] from the first vowel to the third in (32) would result in the violation of the Line crossing prohibition (Goldsmith: 1976) as schematically illustrated in (33):

(33) Ill-formed spreading

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

Here is the dilemma. The non-initial high unround vowels should not be specified [-RTR], in order to allow the spreading to go through them. But if it is not specified, there is no reason why [+RTR] should not spread to those vowels. One easy way out seems to posit a co-occurrence restriction that [+high, -round] should not co-occur with [+RTR]. Though such a co-occurrence restriction may explain the transparency of high vowels in non-initial positions, we can not explain why the co-occurrence restriction does not work in the initial high vowels. Further by specifying [+ high] and [-round], we lose the neat explanation of Korean vowel coalescence discussed in Section 2.

The common characteristic of high vowels, according to Feature Specification in (29) is that they do not have either [open] nor [RTR] feature. Those two features are dependent upon
the TP node. The absence of both [open] and [RTR] on high vowels naturally means they do not have TP node (cf. Principle of Simplicity in (5)). And if the spreading is done on the TP tier, it is only natural that the segments without a TP node, all consonants and high vowels should be transparent. The harmony spreading rule can, accordingly be formulated as in (34):

(34) Harmony Spreading in ideophone.

\[
\text{TP} \rightarrow \text{TP}
\]

Condition: TP tier adjacency.

The Harmony Spreading (HS hereafter) in (34) can successfully explain the different behaviour of high vowels from non-high vowels. A vowel, whether it be high or non-high, is the target for the anchoring of a floating [RTR] feature. Anchoring results in the creation of a TP node, if the target does not have one. HS is operated under TP tier adjacency, and therefore it skips over all the consonants and high vowels, both of which do not have TP nodes.

So far, we have talked about the transparency of high unrounded vowels in non-initial positions and under the present framework, their transparency is attributed to the lack of TP node. But there is one more high vowel, /u/, which should lack the TP node because it neither has [open] nor [RTR] specifications. HS (34) predicts that even the high round vowel should also be transparent in non-initial position. Consider the data (35):

(35) /u/ transparency

<table>
<thead>
<tr>
<th>Word</th>
<th>Meaning</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>kilc’uk</td>
<td>tall &amp; slim</td>
<td></td>
</tr>
<tr>
<td>p’it’ul</td>
<td>in zigzags</td>
<td></td>
</tr>
<tr>
<td>kòmus</td>
<td>black</td>
<td></td>
</tr>
<tr>
<td>cumullòk</td>
<td>kneading</td>
<td></td>
</tr>
</tbody>
</table>

As expected, non-initial /u/ remains unaffected by the spreading rule and they are transparent in HS. The transparency of /u/ has been a major problem for all the analyses that I have read about VH in Korean ideophones. The traditional three way distinction, light, neutral, and dark fails to capture the seemingly strange behavior of the high round vowel. The explanation in the present framework is pretty straightforward: they are transparent because they have no TP node.

---

18Syllable final /s/ is realized as /t/ by independent rule of coda neutralization (cf. Cho (1988)
What is problematic in the present analysis is the fact that some high round vowels are affected by HS. Sometimes there are two light counterparts to one dark ideophone. These are illustrated in the following data:

(36) /u/ - /o/ alternation in non-initial positions

a. without variations

hululuk ~ hololok, *holulok, *hololuk (sipping)
uttutok ~ ototok, *otutok, *ototok, (crunching)
p'yuluthuN ~ p'yolothuN, *p'yoluthuN (pouting)
sukun ~ sokon, *sokun (whispering)

b. with variations

silc'uk ~ saelc'uk, saelc'ok (grudging)
k'aNchuN ~ k'aNchuN, k'aNchoN (hopping)
p'atuN ~ pateN, pateN (struggling)

c. without alternation

t'ekul ~ t'ekol, *t'ekol (rolling)
hicuk ~ haecuk, *haecok (grinning)

(36a) is very interesting. We can see that there is no vowel other than /u/ in the base form. The simple explanation is that these words have unspecified vowel slots in non-initial positions and get their content by root spreading from the initial position as illustrated with the last word of (36a), "sukun":

(37) Root Spreading

\[ \mu \rightarrow s \]  \[ R \]  \[ k \]  \[ n \]  \[ (\text{[RTR]} \rightarrow s \]  \[ R \]  \[ k \]  \[ n \]  \[ (=sokon) \]  \[ \text{[voc]} \]  \[ \text{ART} \]  \[ \text{PL} \]

\[ \text{[RTR]} \]

\[ \text{[RTR]} \]

19 The second mora is assumed to be created in the process of syllabification. Though syllabification is not discussed in this paper, I suppose that the second mora takes /k/ and /n/ to form a CVC syllable. Therefore the surface form of (37) will be [sukun] and not [suukn].
(37) can be falsified if there is a geminate consonant that intervenes between two vowels, because the intervening geminate will gain moraic status and thereby block the Root Spreading. But as far as I know, there is no ideophone data of this kind that has geminates between two high round vowels. Further, it is worthwhile to take a closer look at the first two words of (36a) "ututuk". Following McCarthy and Prince (1986: 54), I assume that the forms "ututuk" and "hululuk" are derived by reduplicating the base form "utuk" or "huluk". This gives us additional evidence that the light counter parts of those ideophones are not derived by spreading of [RTR] features but a separate process of infixing, or suffixing with the last stem consonant extrametrical as maintained by McCarthy and Prince (1986) from "otok" or "holok". The evidence for this analysis comes from the observation that /o-u-u/ forms are rather more acceptable than /o-u-o/ or /o-o-u/. The spreading explanation alone can not account for why there are various degrees of acceptability in the wrong forms.

Now the final problem: the marginal case in (36b) may not be easily explained. It should be noted that the light forms with /u/ are more widely accepted and used than those with /o/ forms and there seems to be an implicational relationship between /u/ and /o/ in light ideophones. That a light ideophone has /o/ derived from /u/ in non-initial positions implies that it also has the /u/ variant, but not vice versa as (36c) shows. I assume that this is an evidence that there is another ideophone specific optional rule applicable to a handful of light ideophones that lowers round vowels in the final position as formulated in (38):

(38) [open] insertion

Now the Path Condition (14b) will provide the [RTR] feature, to correctly interpret the target sound as /o/. This solution allows us to maintain the consistency in using the TP node as the target of spreading. Also the rule correctly predicts that /u/ in non-initial and non-final position will remain transparent to HS and remain unaffected by the lowering rule.

4.2 Vowel harmony in verbal morphology.
Both the infinitival forms and past tense forms of verbs and adjectives normally take suffixes containing /ə/ as the vowel. But if the stem final vowels are /o/ or /a/, the infinitive or past suffixes appear as /a/, as shown in (37):

<table>
<thead>
<tr>
<th>Infinitive</th>
<th>Infinitive past</th>
</tr>
</thead>
<tbody>
<tr>
<td>cip-ə</td>
<td>cip-əs' (to pick)</td>
</tr>
<tr>
<td>pe-ə</td>
<td>pe-əs' (to cut)</td>
</tr>
<tr>
<td>kə-ə</td>
<td>kə-əs' (to fold)</td>
</tr>
<tr>
<td>ki-ə</td>
<td>ki-əs' (to draw)</td>
</tr>
<tr>
<td>cuk-ə</td>
<td>cuk-əs' (to die)</td>
</tr>
<tr>
<td>mək-ə</td>
<td>mək-əs' (to eat)</td>
</tr>
<tr>
<td>cop-a</td>
<td>cop-as' (to be narrow)</td>
</tr>
<tr>
<td>mak-a</td>
<td>mak-as' (to block)</td>
</tr>
</tbody>
</table>

We can make the safe assumption that the underlying forms of the suffixes are /ə/ (infinitive) or /əs'/ (past) but the suffix vowel is changed into /a/ if the stem-final vowel has the [RIR] feature. Given that /a/ is [RIR] we may explain the vowel change as the result of spreading from the stem final vowel onto the suffix-initial vowel. Notice that the process is very similar to that of the vowel harmony in ideophones except that the front open RIR vowel /i/ does not participate as a trigger.

The simplest way to limit the triggers to /o/ and /a/ is to posit a condition that the triggers should be back vowels. But we do not posit [back] feature in the underlying representation, and referring to the absence of the feature is generally disfavored in phonology. Here, I will simply assume that the infinitive suffix actually consists of two parts: the vowel /ə/ and the floating [back] feature.

(40) Infinitive suffix derivation
i) Morpheme: floating [back] + /ə/
ii) Linking target: last moraic segment of a stem.
iii) Path condition: if [front], then not [back]

Past suffix derivation is exactly like (40) except that the morpheme is floating [back] and /əs'/. The path condition here is functioning as a co-occurrence restriction. This path condition will prevent the linking of [back] to stem-final front vowels. I further assume that the unassociated [back] feature will be erased by the Stray Erasure Convention (Ito:1986) before...
moving onto the next cycle\textsuperscript{20}. Now with the introduction of the [back] feature we can formulate an assimilation rule. As with ideophones, the feature that spreads is assumed to be [RTR] as shown in (41):

(41) Harmony spreading.

\begin{center}
\begin{tikzpicture}
  \node [rectangle,draw] (art) {ART};
  \node [rectangle,draw,below of=art] (tp) {TP};
  \node [rectangle,draw,above of=tp] (tp2) {TP};
  \node [rectangle,draw, left of=tp] (velar) {velar};
  \node [rectangle,draw, above of=velar] (back) {back};
  \node [rectangle,draw, below of=velar] (rtr) {RTR};
  \draw [dashed] (velar) -- (back);
  \draw [dashed] (velar) -- (rtr);
  \draw [dashed] (tp) -- (tp2);
  \draw [dashed] (art) -- (velar);
  \draw [dashed] (art) -- (rtr);
  \node at (1,1) {Condition: TP tier adjacency.};
  \node at (1,0) {Trigger: [back] segment.}
\end{tikzpicture}
\end{center}

Now, we can see that the spreading of [RTR] is virtually identical in both the verbal morphology and in ideophones. The only difference is that in the former, the trigger should be a [back] segment. The analysis given here may look very ad hoc, in that the feature [back] which was not necessary in the underlying representation, and which is supposedly redundant given that [back] is virtually identical to [-front], is introduced by morpheme concatenation.

However positing [back] in the underlying representation causes several problems. First the underlying presence of [back] would play havoc with the vowel coalescence analysis. As shown in Section 2, whenever back and front vowels are fused, the outcome is a front vowel. If there is [back] we have to posit a coalescence-cum-delinking rule that delinks the [back] feature. And still, we are left with the problem to explain why it is [back] but not [front] which is delinked. However a more serious problem comes with the spreading rule. There would not be a clear evidence of harmony spreading in underived words as shown in (42):

(42) Lack of HS in underived words\textsuperscript{21}

\begin{align*}
  \text{coăn} & \quad \text{*coan} & \quad \text{(advice)} \\
  \text{apăn} & \quad \text{*apam} & \quad \text{(father)} \\
  \text{tocăhi} & \quad \text{*tocahi} & \quad \text{(by no means)} \\
  \text{toNsa} & \quad \text{*toNsa} & \quad \text{(brother-in-law)} \\
  \text{tasas'} & \quad \text{*tasas'} & \quad \text{(five)} \\
  \text{mochălăm} & \quad \text{*mochalam, *mochalăm} & \quad \text{(after a long time)}
\end{align*}

\textsuperscript{20}It should be noted that the introduction of features as part of the morpheme concatenation process is not new in the literature. The Japanese Rendaku (Ito \& Mester:1986) is similar in that it introduces a floating feature in the process of the lexical derivation.

\textsuperscript{21}Following Ahn (1985), I am assuming that Sino-Korean compounds are underived.
Then why shouldn't [back] be inserted to all the vowels in the derived environment? Here again the evidence against inserting [back] to all vowels is that vowel harmony takes place only in infinitive and past forms but not in noun concatenation or other type of verbal suffixation as shown in (43):

(43) Lack of HS in derived environments

<table>
<thead>
<tr>
<th>ka(gi)-kōla(imp.)</th>
<th>*kakala</th>
<th>(go)</th>
</tr>
</thead>
<tbody>
<tr>
<td>po(see)-kōla(imp.)</td>
<td>*pokala</td>
<td>(see)</td>
</tr>
<tr>
<td>th(a get on)-kōtān (if)</td>
<td>*takatān</td>
<td>(if .. get on)</td>
</tr>
<tr>
<td>ca(sleep)-tān(rel-past)</td>
<td>*catān</td>
<td>(that slept)</td>
</tr>
<tr>
<td>kap(pay)-tōla(recollection)</td>
<td>*kaptāla</td>
<td>(noticed that ..pay)</td>
</tr>
</tbody>
</table>

As clearly seen in (39), the HS takes place between the stem-final vowel and the suffix, if the suffix starts with /a/. (40) and (41) successfully capture the limited distribution of vowel harmony in regular lexical derivation without losing the uniformity of explanation of vowel harmony in general in Korean.

Notice that the analysis provides evidence that some features are active only in the derivational processes while remaining inert, and therefore unspecified, in the underlying representation.

Sohn (1986) attempted to propose an integrated theory of vowel harmony. She proposed two different mechanisms to exclude /ae/ from participation in VH in regular lexical phonology: these involved a convention on terminal feature spreading and a particular notion of feature dependency. The gist of her idea is that features have dependency organization as shown in (44):

(44) Sohn's (1986: 176) organization of tiers.

```
V
 | [round]  |
 | [high]   |
 | [low]    |
 | [back]   |
```

For her [+back] is underspecified, and therefore [+low], which is the harmonic feature in her analysis, is a terminal feature for back vowels, but in front vowels [+low] dominates [-]
Now her point is that only the terminal feature can spread, so that [+low] can spread from the back vowels but not from the front vowels. The condition that only the terminal feature can spread is not generally accepted. But more serious than that is the implication of the tier organization itself. In explaining the ideophone VH, she posits [+round] delinking rule to explain the three way variation such as /pusilək/-/posilak/-/pasilak/. She claims that /pasilak/ is derived from /posilak/ via [+round] delinking rule. Given (44), the [+round] delinking should result in the delinking of all of the vowel features, and therefore the first vowel should be the least marked one, which according to her is /ɨ/. The discrepancy of using tier structure in different ways in ideophone and regular lexical vowel harmony also possibly argues against her analysis.

Further, since the spreading feature is [+low], she has to assign the mid round vowel /o/ with a [+low] feature. She formulates a [+low] insertion rule which provides [+low] to a stem final vowel and then another rule that raises the round low back vowel to a mid vowel by delinking the [+low] feature. This constitutes another possible weakness in her theory. Notice that the analysis given here is totally free of the criticisms that can be levied against Sohn’s analysis. The analysis here is possible by positing the TP node, and taking [back] to be a floating feature.

5. Conclusion

In this paper, we have examined a variety of data showing vowel interactions in Korean. Specifically, four different phenomena, vowel coalescence,umlaut, and vowel harmony in ideophone and verbal morphology were explained in a unified manner by making use of Feature Geometry, Monovalent feature and Underspecification.

Introducing monovalent features obviates Archangeli’s Complement Rules, and drastically reduce the possibility of feature filling specification. Browman and Goldstein (1987) have suggested the use monovalent features along with in phonetic studies on the casual speech phenomena. It seems quite possible that the [-] values may not be necessary in phonetics at least for some features.

In Feature Geometry, a suggestion was made to separate the TP node from the Place node. Without the TP node, it is extremely difficult to explain the data of Korean vowel coalescence and VH in ideophones and lexical derivations in any consistent manner. Positing TP also makes it possible to limit the cases of vowel coalescence in Korean. A vowel with both PL and TP is not allowed to participate in the vowel coalescence with the preceding vowel.

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22 This three way variation is not discussed in Section 4. I think Kim’s (1988) explanation is much more convincing than Sohn’s. For Kim (1988) the base form is /piSiliaky/ and there is an ideophone specific rule that spreads [labial] from the onset /p/ to the vowel /ɨ/ which results in /pusilək/. Now if the harmony rule takes place before [labial] spreading the outcome is /pasilak/, but if Harmony rule takes place after [labial] spreading, /posilak/ is derived.
following vowel. For example, the vowel coalescence of /o/ and /u/ is not observed in Korean, because /o/ has both the TP and Place nodes.

Korean palatalization and the blocking effects of intervening alveopalatal sounds provides ample evidence for the coronality of front vowels. It was discussed that the palatalization and its blocking effects by the alveopalatalals can be accounted for under the proposal that [front] is a coronal dependent feature just like [anterior].

Vowel harmony in Korea is analyzed as a two stage process: linking a floating [RTR] feature and the subsequent spreading of the harmony feature [RTR]. There are two underlying features under the TP node: [open] and [RTR]. High vowels, /i/, /i/ and /u/, do not have either [open] or [RTR], and therefore, according to the Principle of Simplicity, those vowels do not have the TP node in the underlying representation. Since Harmony Spreading requires the TP node adjacency, it is only natural that these high vowels are transparent to Harmony Spreading. The traditional explanation that high round vowel /u/ undergoes Harmony Spreading can not be maintained according to the explanation in this paper.

There are, however, a handful of exceptions to the generalization about the VH: the apparent effect Harmony Spreading onto the high round vowel /u/. It is suggested in this paper that such exceptional cases can be accounted for by introducing ideophone-specific [open] insertion, or vowel lowering rule, if the high vowel is the last vowel of an ideophone base. This enables us to maintain the unified and simple explanation of VH in Korean as well as to correctly explain that /u/ will not be affected by Harmony processes, if it is neither the first or the last vowel in an ideophone.

The vowel harmony in verbal morphology is slightly different from that in ideophones in that the front low vowel, /æ/, does not trigger HS, another problematic aspect of VH. In this paper, the introduction of totally redundant feature [back] as a part of the morpheme concatenation process and subsequent condition of HS that only the [back] segment triggers the HS are shown to interact with each other to give the proper explanation of VH in verbal morphology and the difference from VH in ideophones.

A consistent explanation is proven to be possible in this paper that encompasses vowel coalescence, vowel fronting and vowel harmony in Korean. The interactions of different theories, theory of Feature Geometry, underspecification theory, and monovalent feature are proven to be indispensable in correctly and coherently explaining the phonology of Korean vowels. What is crucial in all the explanations given in this paper is the separation of the TP node from the Place node. Seen from the Korean data, the TP node is not just for convenience but an absolute imperative for the unified account for the four different vowel phenomena in Korean.
Reference


McCarthy, John J. & A. Prince (1986) Prosodic Morphology. Ms, University of Massachusetts, Amherst, and Brandeis University.


<h2><우리말 정리></h2>

비단선 음운론 (Non-linear phonology)의 기틀내에서 국어 음운 현상의 연구가 많은 발전을 이루었으나 학자들의 주장이나 견해가 항상 일치하지만은 않았다. 그 한 예로 McCarthy (1983)가 국어의 모음 조화를 설명하기 위하여 제안한 자질쓰기

이 글에서는 그러한 문제로 인하여 국어의 모음 음운 현상을 한결 같이 설명할 수 있는 블을 제안하여 보고자 하였다. 먼저 자질은 SPE 이후로 계속 유지되어온 양성 자질 (binary feature) 대신 단가 자질 (monovalent feature)을 제안해 보았다. 그리고 자질 기하론 (Feature Geometry)에서는 Lahiri & Evers의 방식을 따라 혜위치 마디 (Tongue Position Node)를 내 놓았으며 석축 (Retracted Tongue Root)이라는 자질이 모음의 능inality와 함께 혜위치 마디에 달려 있는 것으로 가정하였다.

이러한 둘을 바탕으로 우리말의 모음 음운 현상에 모음 합성, 전설 모음화 그리고 모음 조화등을 자세히 분석하여 보았다. 먼저 모음 음합에 있어서 혜위치 마디가 모음 음합을 일으키는 중요한 요인임을 보이고 손 향숙 (1987)의 근전적 자질 줄어 쓰기 (Radical Underspecification)처럼 단가 자질 쓰기 (Monovalent specification)가 설명력을 가지고 있음을 보였다. 전설 모음화 역시 전설 모음의 설정성 (Coronality)을 가정한 자질 기하론으로 Hume (1990)이 제안한 Clements의 자음 위치 마디, 모음 위치 마디 (C-place Node, V-place Node)보다 있던 이론을 편 고치고도 설명할 수 있음을 나타냈다. 이글의 주된 부분이라 할 수 있는 모음 조화에 관한 부분에 있어서도 이 글에서 제안한 자질 쓰기와 자질 기하 이론이 지금까지의 이론보다 새로운 설명력을 있음을 나타내 보였다.

이렇게 해서 단가 자질 쓰기와 자질 기하의 혜위치 마디의 설정이 우리말의 모음 음운 현상을 설명하는데에 매우 잘 썩인 블을 제공함을 알 수 있었다. 그러나 글 뿐만이 생각은 앞서의 두가지 제안이 단지 우리말에만 적용시키는 범위를 넘어서 범어질 (Universal)이라는 입장은 이 글 곳곳에서 밝혔으며 또 그러한 방향으로 계속 연구되기를 바란다.