1. Introduction

Sonorant assimilation in Korean, a well-known phenomenon in phonology, exhibits a very complicated set of data. But Iverson & Sohn (1994) provided a surprisingly simple account of the fact based on two ideas: feature geometry and the structure preservation convention. The former allows us to grasp the nature of the assimilation process as a spreading of features from more marked sites to less marked ones; the latter prohibits segments not employed in the lexicon from entering into phonological representation during the process of the phonological derivation.

I consider Iverson & Sohn’s work is a rare showpiece that can demonstrate in a nutshell the impressive advance our science of language has achieved in the last decades. Nonetheless, their presentation does not necessarily mean the end of the story. Only a fraction of feature geometry minimally necessary for fitting their account is provided. It is not clear what system they envisioned as the entire feature geometry that is to host their account. It would be fair to assume that their account, or a notational equivalent of it, can easily be embedded in any viable system of feature geometry; the descriptive adequacy of the account is not at issue. However, subtler points like possible redundancy in description could arise and lead to theoretically significant issues when one tries to embed Iverson & Sohn’s account into a more encompassing system of feature geometry than the fragment they presented.

One such issue is the relation between voicing and nasality, or more generally, between sonority and nasality. This is of course a perennial issue in phonological theory, not particular with Iverson & Sohn’s account. This note is not a place to take up this issue in a broad and general perspective. What I intend to do here is to present a conceivable step one might take in the design of feature geometry in connection with this issue, without arguing for this particular alternative as opposed to any other possible alternatives. I then point to a problem of redundancy that would arise with Iverson & Sohn’s account and show how it might be resolved. During this process I will introduce the idea of projection reversal that allows us to contextualize markedness conventions in the framework of features geometry.

But it turns out that our effort to eliminate one conceivable redundancy in a particular way results in a considerable improvement beyond Iverson & Sohn’s account. In fact, as a consequence, we will be able to see that in spite of the surprisingly complex appearance at the phonetic level, the Korean assimilation can be understood as a nearly optimal solution in phonology for adjusting sonority at the syllable boundary when two consonants come to contact with each other.

This work was initially undertaken as part of my project for exploring a new conception of feature geometry, aerodynamic feature geometry (ADFG): Kuroda (2002). Here I present the material of this paper in a more conventional terms without reference to ADFG for the sake of easier accessibility. Indeed, the theoretical significance of this work is not bound to ADFG. Nonetheless, the insight we gain by the present account of Korean assimilation, I believe, renders a considerable support to the approach underlying ADFG.
2. Korean sonorant assimilation: the data
I describe the observed facts following Iverson & Sohn.\(^2\) The facts are first divided into two apparently different processes, Regressive and Progressive Sonorantization; they are further subdivided into apparent distinctive processes.

Notation
- Q: obstruent; P: labial obstruent; K: dorsal obstruent; T: coronal obstruent
- N: nasal; L: liquid.

[1] Regressive sonorantization

[1.1] Nasalization

[1.1.1] Obstruent-to-nasal assimilation
- \(Q+N-N\)  >  \(NN\)  Iverson&sohn (1994:81)
  - /han-kuk-nal/  \(\text{[han\text{-}ku\text{-}nal]}\)  ‘Korean language’
  - /path+norsa/  \(\text{[p\text{-}\text{nor\text{-}sa}]}\)  ‘(dry) field farming’
  - /ap+nal/  \(\text{[am\text{-}nal]}\)  ‘front+day’  >  ‘future’

[1.1.2] Obstruent-to-liquid assimilation I
- \(P/K+L\)  >  \(NN\)  Iverson&sohn (1994:82 \[8a\])
  - /p\text{-}lyul/  \(\text{[p\text{-}\text{nyul}]}\)  ‘law’
  - /pak-lam/  \(\text{[pa\text{-}n\text{-}am]}\)  ‘exhibition’

[1.2] Late ralization

[1.2.1] Obstruent-to-liquid assimilation II
- \(T+LL\)  >  \(LL\)  Iverson&Sohn (1994:82 \[8b\])
  - /tik\text{-}liul/  \(\text{[tik\text{-}liul]}\)  ‘t..l’ (sequence in Korean alphabet)

[1.2.2] Nasal-to-liquid assimilation I
- \(n+L\)  >  \(LL\)  Iverson&Sohn (1994:84 \[10b\])
  - /han-lya\text{-}/  \(\text{[hallya\text{-}]}\)  ‘limit’
  - /ch\text{-}li/  \(\text{[ch\text{-}li]}\)  ‘natural law’

[2] Progressive Sonorantization

[2.1] Nasalization

nasal to liquid assimilation II
- \(m/\text{n}+L\)  >  \(m/\text{n}L\)  Iverson&Sohn (1994:84 \[10a\])
  - /sam-lyu/  \(\text{[sam\text{-}nyu]}\)  ‘third rate’
  - /ya\text{-}lak/  \(\text{[ya\text{-}\text{nak}]}\)  ‘down fall’

[2.2] Late ralization

lateral to nasal assimilation
- \(L+n\)  >  \(ll\)  Iverson&Sohn (1994:86 \[13\])
  - /mul+nan+li/  \(\text{[mull\text{-}li]}\)  ‘flood’ (‘water-disaster’)
  - /sol-nal/  \(\text{[sall\text{-}al]}\)  ‘New Year’s Day’
  - /tul+namul/  \(\text{[t\text{-}ll\text{-}amul]}\)  ‘wild vegetables’

\(^2\)See also Martin (1954).
Cf: lateral to nasal nonassimilation
Iverson & Sohn (1994:87 [17])
-L+m-
/kal+man/ [kalman] 'longing’
N.b. No morpheme-initial ın in Korean.

The following two tables summarize the above data.

[3.1] Summary: data

<table>
<thead>
<tr>
<th></th>
<th>Q</th>
<th>N-</th>
<th>L-</th>
</tr>
</thead>
<tbody>
<tr>
<td>-Q</td>
<td>na</td>
<td>-NN-</td>
<td></td>
</tr>
<tr>
<td>-T</td>
<td>na</td>
<td>na</td>
<td>-ll-</td>
</tr>
<tr>
<td>-P/K</td>
<td>na</td>
<td>na</td>
<td>-NN-</td>
</tr>
<tr>
<td>-N</td>
<td>na</td>
<td>na</td>
<td></td>
</tr>
<tr>
<td>-n</td>
<td>na</td>
<td>-ll-</td>
<td></td>
</tr>
<tr>
<td>-m/ı̈</td>
<td>na</td>
<td>-ll-</td>
<td>-(m/ı̈)n</td>
</tr>
<tr>
<td>-L</td>
<td>na</td>
<td>-ll-</td>
<td>na</td>
</tr>
</tbody>
</table>

[3.2] Summary: the types and the directions of assimilation processes.

<table>
<thead>
<tr>
<th></th>
<th>Q</th>
<th>N-</th>
<th>L-</th>
</tr>
</thead>
<tbody>
<tr>
<td>-Q</td>
<td>na</td>
<td>&lt;=N</td>
<td></td>
</tr>
<tr>
<td>-T</td>
<td>na</td>
<td>&lt;=L</td>
<td></td>
</tr>
<tr>
<td>-P/K</td>
<td>na</td>
<td>&lt;=N</td>
<td></td>
</tr>
<tr>
<td>-N</td>
<td>na</td>
<td>na</td>
<td></td>
</tr>
<tr>
<td>-n</td>
<td>na</td>
<td>&lt;=L</td>
<td>N=&gt;</td>
</tr>
<tr>
<td>-m/ı̈</td>
<td>na</td>
<td>L=&gt;</td>
<td>na</td>
</tr>
</tbody>
</table>

3. The Iverson-Sohn account of Korean sonorant assimilation

3.1. Features
Iverson & Sohn base their feature geometry on Clements' classificatory feature system given in the following table.

Classificatory feature system (Clements 1990)
Notation. Q: obstruent; N: nasal; L: liquid; G: glide

<table>
<thead>
<tr>
<th>Q</th>
<th>N</th>
<th>L</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

0 1 2 3 (relative sonority ranking)
This feature system is designed to represent the sonority degree of consonants by the number of plus entries; the more pluses, the more sonorant the consonant is. Iverson & Sohn convert the above classificatory table into the following feature geometry tree.

Geometric [Iverson-Sohn (1994:80)]

```
   C
  / \   \
 Root Q   N
       / \     \
      / \     L
     / \ [vocoid]
    / G
```

This tree indicates that the obstruent is the least marked and the glide the most marked consonant.

### 3.2. Rules and conventions

Iverson & Sohn introduce the following two rules and the two conventions to account for the data shown in section 2 above.

**Rule 1.** Spread [sonorant] to the left. [Iverson-Sohn (1994: 82 (7)]

**Rule 2.** Spread [approximant] to the right [Iverson-Sohn (1994: 86 (14)]

```
   C                C
  |                |   \
 Root            Root     \
   |           |      /       \
   |           |      /        \
 Place [sonorant] Place ^      Place
```

**The target-absorption convention:** Spread applies as a unification operation with the constraint: Source ≥ Target.

**The structure preservation convention:** The output of a Spreading application is subject to delinking to respect the structure preservation principle (SP).

As a consequence of the SP convention, we have the constraint: No labial or dorsal liquid (i.e., non-nasal labial or dorsal sonorant) may be introduced. Formally, the SP convention has the effect of delinking [approximant] when it coexists with an occurrence of Place dominating dorsal or Labial.
3.3. Derivations
We can examine the assimilation process according to the above rules and conventions case by case.

[1]  \(-Q+N- \Rightarrow -NN-\)
\(/\text{han-kuk+mal/} \Rightarrow [\text{hang\textgu}\text{\textmal}]\) ‘Korean language’

\[
\begin{array}{cccc}
\text{C} & \text{C} & \text{C} \\
\text{Root} & \text{Root} & \Rightarrow & \text{Root} \\
\text{Place} & [\text{sonorant}] & \text{Place} & \Rightarrow & \text{Place} & [\text{sonorant}] & \text{Place}
\end{array}
\]

[2]  \(-Q+L-\)
[2.1]  \(/tik\textgu+t+li\textgu/ \Rightarrow [tik\textgu\textli\textgu]\) ‘t..l’ (sequence in Korean alphabet)

\[
\begin{array}{cccc}
\text{C} & \text{C} & \text{C} \\
\text{Root} & \text{Root} & \Rightarrow & \text{Root} \\
\text{Place} & [\text{sonorant}] & \text{Place} & \Rightarrow & \text{Place} & [\text{sonorant}] & \text{Place}
\end{array}
\]

[2.2]  \(/p\textgu-p-lyul/ \Rightarrow [p\textgu\textm\textnyul]\) ‘law’

\[
\begin{array}{cccc}
\text{C} & \text{C} & \text{C} \\
\text{Root} & \text{Root} & \Rightarrow & \text{Root} \\
\text{Place} & [\text{sonorant}] & \text{Place} & \Rightarrow & \text{Place} & [\text{sonorant}] & \text{Place}
\end{array}
\]
[3] -N+L-

[3.1] /han-lyaŋ/ => [hallyang] ‘limit’

```
  C    C    C    C
 Root | Root | Root | Root
  \   \   \   \  \\
Place [sonorant] [sonorant] Place
  \   \   \   \  \\
[coronal] [approximant] [coronal] [approximant]
```

[3.2] /yəŋ-lak/ => [yəŋnak] ‘down fall’

```
  C    C    C    C
 Root | Root | Root | Root
  \   \   \   \  \\
Place [sonorant] [sonorant] Place
  \   \   \   \  \\
[Dorsal] [approximant] [Dorsal] [approximant]
```

[*4] -L+N-

/səl-nal/ => [səllal] ‘New Year’s Day’

Spread [sonorant] to the left cannot apply. [N.b. target > source]

```
  C    C
 Root | Root
  \   \  \\
Place [sonorant] [sonorant] Place
 [coronal] [approximant] (nasal)
```

The nonapplication of Spread [sonorant] accounts for the fact for the case N- = /m-/, but not for the case N- = /n-/. Hence, we also need Spread [approximant] to the right; see below.
3.4 Summary

We can summarize the above result as in the table below.

**Notation.**  S: sonorant; => direction of assimilation

<table>
<thead>
<tr>
<th></th>
<th>Q-</th>
<th>N-</th>
<th>L-</th>
</tr>
</thead>
<tbody>
<tr>
<td>-Q</td>
<td>na</td>
<td>&lt;=S</td>
<td>&lt;=S</td>
</tr>
<tr>
<td>-N</td>
<td>na</td>
<td>na</td>
<td>&lt;=S</td>
</tr>
<tr>
<td>-L</td>
<td>na</td>
<td>L=&gt;</td>
<td>na</td>
</tr>
</tbody>
</table>

4. The modified account

4.1. The issue to be addressed

There is one shortcoming in Iverson & Sohn's account. This point is not obvious from their presentation, because it contains only the part of feature geometry that is necessary for the account of sonority assimilation. Feature geometry as a whole must deal with other aspects as well, in particular, for our present concern, the issue of the relation between voicing and nasality, or more broadly, between sonority and nasality. Let us recall Iverson & Sohn's fragment of geometry:
Voicing is not distinctive for Korean, but it can be in general. Nasals, liquids and glides are in general redundantly voiced. One could assume that this redundancy is accounted for by a redundancy rule of the form [sonorant] => [voiced]. But there is another problem. The Iverson-Sohn geometry implies that nasality is not distinctive for sonorants: sonorants are either nasal or non-nasal. This may well be true, as long as we understand sonorants as consonants. In fact, that is how [sonorant] is to be understood with the Iverson-Sohn geometry, since the whole fragment is dominated by C[sonantal]. However, it is not the case that nasality is confined with sonorants in this sense. There are languages where nasal and non-nasal vowels phonologically contrast. Then, the issue arises how to accommodate nasality in a bigger picture of feature geometry.

It is plausible, if not necessary, to assume that in a bigger picture the Iverson-Sohn geometry is to be extended to the branch that represents the whole dimension where the sonority (or, in articulatory terms, stricture) aspect of segments, including vowels, is to be accounted for. But this perspective raises the question of how to deal the issue of nasality. We can leave N as is in the Iverson-Sohn tree and introduce another nasal node or feature to deal with nasal vowels; or we can remove N from the sonority tree and find a host somewhere else in order to make it responsible for consonantal as well as vocalic nasality. I would like to suggest a way for the second alternative below.

The key to the success of Iverson & Sohn’s account of Korean sonorant assimilation lies in the design of their geometry that makes N(asal) the unmarked [sonorant]. Here, N(asal) means nasal "obstruents" such as /m/, /n/. But in a broader perspective, this was achieved at the expense of excluding the possibility of accounting other nasal sonorants and nasal vowels as N(asal). If we wish to remedy the apparent flaw of Iverson & Sohn’s geometry, we need to keep it in mind how we preserve this key point of their geometry.

4.2. Feature geometry

I propose feature geometry G which has the following main branches:

```
STRICTURE
/  \\[stop] CONTINUANT
/    \\
[fricative] SONORANT
/      \\
[sonorant] VOCOID
/        \\
[glide ] VOCALIC
/          \\
[vowel]
```

```
VOICE-QUALITY
/  \\[voiceless] VOICED
/    \\
[voiced] NASAL
/      \\
[nasal]
```

The following abbreviation will be used below.

**Abbreviation:** STR: STRUCTURE; STR; CONT: CONTINUANT; STR; SONORANT: SONO; V-Q: VOICE-QUALITY; V-Q: V-QUAL.

In this geometry, NASAL implies VOICED. On the one hand, the redundancy of voicing in nasals is accommodated in this dominance relation. On the other hand, note that the meaning of [voiced] is "voiced non-nasal. [sonorant] is shared by nasals and liquids: nasals are NASAL SONORANT and liquids are non-NASAL SONORANT. I do not assume a universal redundancy to the effect that SONORANT => VOICED; voicing is not distinctive with Korean obstruents and it is useful to extend this lack of distinction to liquids, leaving them unmarked as to the feature VOICED.

Geometry G also has another main branch, PLACE of articulation. It suffices to note that the distinction between Coronal, Dorsal and Palatal is made under this branch. We are not concerned with the problem of exactly how these nodes are arranged under PLACE.

### 4.3. Rules

Iverson & Sohn's rules are replaced by the following two rules.

**Rule 1.** SPREAD CONT to the left.

**Rule 2.** SPREAD NASAL.

Rule 1 is formulated in terms of CONTINUANT instead of SONORANT; the rule is generalized to account for spirant assimilation as well. See 4.5 [0] below. Rule 2 is left unspecified as to its direction of application, keeping the most general, hence the simplest form.

### 4.4. Conventions and hypotheses

SPREAD must respect the same target-absorption convention (repeated below) as in §3.2.

**The target-absorption convention:** SPREAD applies as a unification operation with the constraint: Source \(\geq\) Target.

(Thus, the Source must be able to absorb the Target by the application of SPREAD.)

See §4.5 [3] below for the reason why this convention is formulated in terms of \(\geq\), not of \(>\).

According to the geometry in 4.2, nasals and liquids are distinguished by the presence or absence of NASAL under VOICE-QUALITY. Since the absence corresponds to the unmarked, it would follow that liquids are unmarked member of SONORANT. This unwelcome consequence follows from our failure to recognize that markedness characteristic is context-dependent. Indeed, it is obvious that if voicing is a marked feature for obstructions, it should be an unmarked feature for vowels. For sonorants, it may not be obvious that nasals count as unmarked as opposed to liquids, but phonological research in the past decades has brought this point forward; Iverson & Sohn's account of Korean sonorant assimilation has provided further evidence for this proposition.

In order to accommodate this insight in feature geometry, let me introduce the following conventions/hypotheses. The idea is that some sites get designated as sonorant sites; at such sites, the branch V-QAL reverses its markedness structure. How sonorant sites are determined is an empirical issue. I propose the following hypothesis and convention:

**The sonorant hypothesis**

A SONORANT segment adjacent to another SONORANT segment is a SONORANT SITE.

**The sonorant projection reversal convention:** The V-QAL is "projected upside down" at a sonorant site.
As the result of "projected upside down," we have the following tree at sonorant sites:

```
NASAL
 /     \
[nasal]  VOICED
 /     \
[voiced] V-QUAL
 |     |
[voiceless]
```

SPREAD CONT derives sonorant sites when the CONT node that is spread dominates a SONO node; at both the source and target sites, the original projection changes to the "sonorant" projection. The following convention is assumed to apply at these sites.

**The SPREAD-first convention for SPREAD NASAL:** SPREAD NASAL applies *before* the projection changes at the target and the source segments of the application of SPREAD CONT to the left.

The intuition behind this convention is this: take a sequence of the form C+L, where C is a consonant and L, a sonorant (i.e., dominated by SONO). At this stage, L still functions as a "consonant." SPREAD CONT applies to this sequence as an assimilation rule between two consonants. SPREAD NASAL conceivably can function either as an assimilation rule between two consonants or as one between two sonorants; its application before the projection change means that the first function is given priority.

I introduce a hypothesis particular to Korean phonology:

**The Nonvoice Hypothesis (Korean phonology):** The voice/voiceless contrast is neutralized.

Thus, the node V-Qual is suppressed in Korean phonology until it reaches the phonetics level. The suppressed form of the v-Qual branch and its "upside down"projection are:

```
V-Qual
 /     \
[voiceless] NASAL
 /     \
[nasal]   [nasal] V-Qual
 |     |
[voiceless]
```

Note, in particular, that the liquid /l/ is *not* specified as [voiced] in phonology.

In addition, we have the structure preservation convention as in Iverson & Sohn's account. Taking the Nonvoice Hypothesis into consideration, we see that the effect of this convention as stated below:

**The effect of the SP (structure preservation) convention:** Delink V-Qual at a sonorant site if PLACE dominates [dorsal] or [labial].

I supplement the SP with the following convention that restricts the application of the delinking:

**The no-delink convention for bi-directionally linked sites:** Delink is blocked for a node dominating two sites that are linked to each other in two directions (to the left and to the right).
I will explain and discuss the significance of this convention below in §4.5 [7].

4.5. Derivations

[0] First, let me note that the assimilation process I am describing can be generalized to cover the case of spirantization:

```
/kut+so/  =>  [kusso] 'harden+ending' (Cho: §3.4.2, (65))
```

We now go through examples described above in Iverson & Sohn's account.


```
V-QUAL  V-QUAL  V-QUAL  V-QUAL
[voiceless]  NASAL  [nasal]
```

11
Assume that SPREAD NASAL have to apply after the perspective reversal. Then, we would have the following undesired derivation.

```
Root                  Root                                          Root               Root
|                         |                                                      
NASAL                 NASAL                                                   NASAL
|                         |                                                            |
V-QUAL                  [nasal]                          =>                   V-QUAL
|                                                                                      |
[voiceless]                                                                     [voiceless]
```

[2]

[2.1] /tik+liul/ => [tiklliul] ‘t..l’ (sequence in Korean alphabet)

```
STRUCTURE                     STRUCTURE                  STRICTURE                STRICTURE
|                              |                                      ^                   /
[stop]                       CONT                 =>                    CONT
|                                                 |
SONO                                          SONO
```

```
V-QUAL                     V-QUAL                              V-QUAL            V-QUAL
|                              |                                        |                   |
[voiceless]           [voiceless]                           [voiceless]     [voiceless]
```

```
STRUCTURE                     STRUCTURE                  STRUCTURE                STRUCTURE
^                              /                                      ^                   /
\                          \                                      \                   /
CONT                 CONT
|                                          |
SONO                                          SONO
```

```
=>                                               =>                             ^            ^
NASAL         NASAL                                                   NASAL
|               |                                                           |
V-QUAL       V-QUAL                                                  V-QUAL
|               |                                                           |
[voiceless]  [voiceless]                                         [voiceless]
```

The double arrow in the above derivation:

```
Root                  Root
|                         |
NASAL                 NASAL
|                         |
V-QUAL                  V-QUAL
|                         |
[voiceless]                 [voiceless]
V-QUAL
```
indicates that the direction of \textit{Spread} cannot be determined and is immaterial.

[2.2] /pəp-lyul/ $\Rightarrow$ [pəmnyul] ‘law’

\begin{align*}
\text{STR\text{I\text{C\text{U\text{R\text{E}}}}} } & \quad \text{STR\text{I\text{C\text{U\text{R\text{E}}}}} } & \quad \text{STR\text{I\text{C\text{U\text{R\text{E}}}}} } & \quad \text{STR\text{I\text{C\text{U\text{R\text{E}}}}} } \\
[\text{stop}] & \quad \text{CONT} & \Rightarrow & \quad \text{CONT} \\
& \quad \text{SONO} & & \quad \text{SONO} \\
\text{v-qual} & \quad \text{V-QUAL} & & \quad \text{V-QUAL} & \quad \text{V-QUAL} \\
[\text{voiceless}] & \quad [\text{voiceless}] & & \quad [\text{voiceless}] & \quad [\text{voiceless}] \\
\hline
\text{STR\text{I\text{C\text{U\text{R\text{E}}}}} } & \quad \text{STR\text{I\text{C\text{U\text{R\text{E}}}}} } & \quad \text{STR\text{I\text{C\text{U\text{R\text{E}}}}} } & \quad \text{STR\text{I\text{C\text{U\text{R\text{E}}}}} } \\
& \quad \text{CONT} & \Rightarrow & \quad \text{CONT} \\
\text{SONO} & & & \text{SONO} \\
\text{NASAL} & \quad \text{NASAL} & & \text{NASAL} & \quad \text{NASAL} \\
\text{V-QUAL} & \quad \text{V-QUAL} & & \text{V-QUAL} & \quad \text{V-QUAL} \\
[\text{voiceless}] & \quad [\text{voiceless}] & & \text{[voiceless]} \\
\hline
\end{align*}
This example shows that the target -absorption convention must be formulated in terms of ≥, not in terms of >. If it were formulated in terms of >, SPREAD NASAL would not apply and we would have an undesired result; the delink due to SP would apply only to the first segment:

```
( delink due to SP )

PLACE  NASAL  NASAL
[labial]  V-QUAL  V-QUAL

[voiceless]  [voiceless]

[m]  [l]
```


The two segments in question here are adjacent and both dominated by a SONO node. Hence they
are at sonorant sites before the derivation starts.

\[3.2\] \(/\text{yəŋ-lak}/ \Rightarrow \text{[yəŋnak]} \quad \text{‘down fall’}\]
Unlike the Iverson & Sohn analysis we do not need a rightward spread rule here; as we have 
Source = Target, the leftward Spread CONT has the same effect as a rightward spread rule. Spread 
NASAL, in contrast, effectively applies to the right, due to the Source ≥ Target convention imposed 
on it.

[4.2] /kal+man/  =>  [kalman]  ‘longing’
The last step of this derivation must be blocked, hence *; otherwise we would get an incorrect form [kanman]. Delink V-QUAL must apply in [5], but may not in [7]. In [5], both SPREAD CONT and SPREAD NASAL link leftward; in [7] SPREAD CONT links to the left and SPREAD NASAL links to the right. The no-delink convention for bi-directionally linked sites blocks the delinking of V-QUAL. But, then, the violation of the SP, a general principle, resulting from the first step of the above derivation would not be removed. Hence, the first step may not take place, either. /kal+manʃ/ comes out as [kalman].

The intuition behind the no-delink convention for bi-directionally linked sites is this. More branches linked to one direction means the increase in the degree of the process of gemination by the marked member; the limiting case is total assimilation resulting in the genesis of a geminate. Branches of two sites being linked to opposite directions counters this move toward the assimilation of one member (the less marked one) to the other (the more marked one). The delinking is a process to help the assimilation of the two sites by removing a violation of SP at one site, possibly at the expense of the branch of the other site by forcefully neutralizing the offending marking. Thus, the delinking is inconsistent with the counter-assimilation effect of the bi-directional multiple linking.

4.6. Appendix. SPREAD NASAL OR SPREAD V-QUAL?

In general, when node A immediately dominates another B, it is evident that SPREAD A and SPREAD B have different effects. For example, SPREAD CONT causes spirantization but not SPREAD SONO. However, if all feature trees have node A, it is not evident that Spread A has any different effect from SPREAD B. (The question posed here, however, is more intricate than it first appears, and needs more careful formulation because of the possible reversal of the dominance relation due to perspective changes, but I ignore this complication for the presentation of the problem here.) We, then, face the problem of choosing between SPREAD V-QUAL and SPREAD NASAL. Which to choose between them derives different tree structures, yielding different configurations for possible delinking. To see this point, consider [3.2] above. If we have SPREAD V-QUAL instead of SPREAD NASAL, we would have the following derivation:
At this point, V-QUAL on the left branch would be delinked due to the violation of SP:

This tree looks ill-formed. We would be able to overcome this difficulty only with the expenses of introducing an undesirable convention that allows the delinking of the offending right branch as well once the left branch is delinked:
For this reason, choosing Spread Nasal is preferred.

5. Summary and Conclusion.
5.1. Summary.
The Korean assimilation observed in §2 (and §4 [0]) is explained as the combined effects of the two independent rules:

Rule 1. Spread \textit{CONT} to the left.
Rule 2. Spread \textit{NASAL}.

Rule 1 is asymmetric and unidirectional. The unidirectionality is empirically dictated, by the fact that the sonorant (and spirant) assimilation does not apply progressively. However, this fact is a manifestation of the universal tendency that the succeeding onset may not be more sonorant than the preceding coda: Cf: the Syllable Contact Law cited by Iverson and Sohn (1992:81).

Rule 2 is symmetric and non-directional; the direction is determined by the context of application. The rule functions (i) as assimilation between \textit{consonants} in the consonantal context, thus as nasalization (4.5 [1]) as well as spirantization (4.5 [0]), and (ii) as assimilation between \textit{sonorants} (ii-a) as lateralization, in the sonorant context, (ii-a.1) either derived (4.5 [2.1]) or (ii-a.2) underlying ([3.1], [4.1]), and also (ii-b) as nasalization [failed lateralization] due to the intervention of SP (4.5 [2.2], [3.2]) and, finally, (iii) the rule fails to cause assimilation due to conflicting forces among the two assimilation rules and the SP constraint (4.5 [4.2]).

Let us also note that no assimilation takes place in the sequence of a sonorant followed by an obstruent. The sequence NQ is affected neither by Rule 1 nor by Rule 2. Not by Rule 1, because it spreads only to the left; not by Rule 2, because Nasal linked to Q to the right is delinked due to SP: no nasal obstruent can exist in the lexicon. Neither Rule 1 nor Rule 2 affects LQ.

5.2. Conclusion
Iverson & Sohn’s account has two rules and ours too. However, the reason why we have two rules is that we have two separate branches for sonority and voice-quality in our encompassing geometry than theirs. Our two rules in effect correspond to one in Iverson & Sohn’s framework, by itself a significant simplification.

If we examine the content of these two rules, we realize that the effect of the rules is nothing but the realization of a number of constraints imposed on Korean by interface conditions mediated by universal grammar.

We may assume that the following principles are imposed on phonology from outside of it as interface conditions: the Syllable Contact Law [perception], Structure Preservation Principle [acquisition], and the two default (unmarkedness) conditions (the stop being the default consonant and the nasal the default sonorant) [acoustics/articulation]. These conditions are incorporated into the rules and the conventions introduced above and the design of our feature geometry. No condition specific to Korean is introduced except for the Nonvoice Hypothesis. This means that we do not specify anything special for Korean phonology other than the fact that the process of sonority assimilation exists. The leftward directionality of Rule 1 is imposed on it by the Syllable Contact Law; hence it should not need to be so stated. Rule 2 simply functions to dictate that less marked sites to assimilate to more marked sites, which is exactly what assimilation is. What counts as unmarked and marked sonorants are built in the design of our feature geometry. Then, the following rule must substitute for Rule 1 and Rule 2 in Korean grammar:

\textbf{Sonority Assimilation Rule:} Sonority, assimilate!

The data given in §3, complicated and disorderly as it is, turns out to be evidence for language being the best design meeting the interface conditions, rather a surprising outcome.
And reversing the perspective, we might also note that providing as it does an account of Korean as the beset design under the interface conditions, our feature geometry proves itself as the best theory in the relevant respects.\(^3\) Such is the outcome from the encounter of the spirit of our feature geometry with the genius of the Korean language.

**References**


\(^3\) For the best design and the best theory, see, for example, Chomsky (2002: 104).