

## Phonological Implications of Underspecification in Feature Hierarchy\*

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Recent studies on phonology concern two issues on distinctive features, i.e. its structural organization and underspecification. Hence, it is argued that distinctive features should not be represented as a flat feature matrix, but rather should be organized hierarchically since some phonological rules affect a certain feature or certain sets of features without affecting the remaining features (Clements 1985; Sagey 1986; K.-H. Kim 1987). And it is also proposed that feature representation should be only partially specified in order to better capture phonological generalizations, while simplifying the underlying representations (Archangeli 1984a, 1984b; Kiparsky 1985; Sohn 1987; K.-H. Kim 1987). In this paper I show that the theory of underspecified feature hierarchy not only properly describes phonological processes, but also provides a principled account for why they function as they do, and why other processes seldom or never occur in natural languages. Particularly, I am concerned with the neutralization and assimilation processes in Korean and I show that they are best accounted for by a theory which manipulates both underspecification and hierarchical feature organization.

With regard to neutralization, Houlihan and Iverson (1979) propose the following universal constraint (1), adopting Kiparsky's (1976) definition of neutralization:

(1) **Markedness Constraint:**

Phonologically-conditioned neutralization rules convert relatively marked segments into relatively unmarked segments.

(2) **Neutralization (Kiparsky 1976: 169):**

A rule of the form  $A \rightarrow B / XC\_DY$  is neutralizing iff there are strings

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of the form CBD in the input to the rule. Otherwise, the rule is non-neutralizing.

One good example conforming to this Markedness Constraint (1) is syllable-final obstruent neutralization in Korean. As can be seen in (3), both aspirated and tense obstruents are neutralized into the lax ones in syllable-final position:<sup>1)</sup>

- (3) /K\*ak\*+ta/ [k\*ak=t\*a] 'to cut (DEC)'  
 /puEkh+to/ [puEk=t\*o] 'kitchen also'  
 /kuk+to/ [kuk=t\*o] 'soup also'  
 (Note: [E] = [ə], [C=] = unreleased stop)

Since aspirated and tense obstruents are regarded as relatively marked ones, and there are unmarked segments in the input to the rule, the obstruent neutralization rule conforms to the Markedness Constraint (1). However, as pointed out by Wheeler (1981) and others, the neutralization rule should be distinguished from the assimilation rule, since the theory otherwise will face a number of counterexamples. For example, consider /l/-nasalization and /n/-lateralization processes in Korean:

- (4) /l/-nasalization:  
 [+lateral] → [+nas, -cont] / \$ \_\_\_\_  
 e.g. /lakwEn/ [nagwEn] \* [lagwEn] 'paradise'  
 /poklakwEn/ [poŋnagwEn] \* [poŋlagwEn] 'Paradise Regained'  
 cf. /sillakwEn/ [šillagwEn]<sup>2)</sup> 'Paradise Lost'
- (5) /n/-lateralization: n → l % l  
 e.g. /manlo/ [mallo] '10,000 roads'

1) The Korean obstruent system consists of the three-way stop contrasts, i.e. lax (p, t, c, k), aspirated (ph, th, ch, kh), and tense (p\*, t\*, c\*, k\*), where the superscripted asterisk identifies Korean's unusual glottally tense articulation.

2) When two /l/s are adjacent, they are coalesced as a geminate consonant by the /l/-gemination process. After this process, /l/-nasalization, purely syllable-initial strengthening process, cannot apply to this geminate /l/ by the Hayes' (1986:331) Linking Constraint: Association lines in structural descriptions are interpreted as exhaustive. (For further details, see Iverson and Kim 1987)

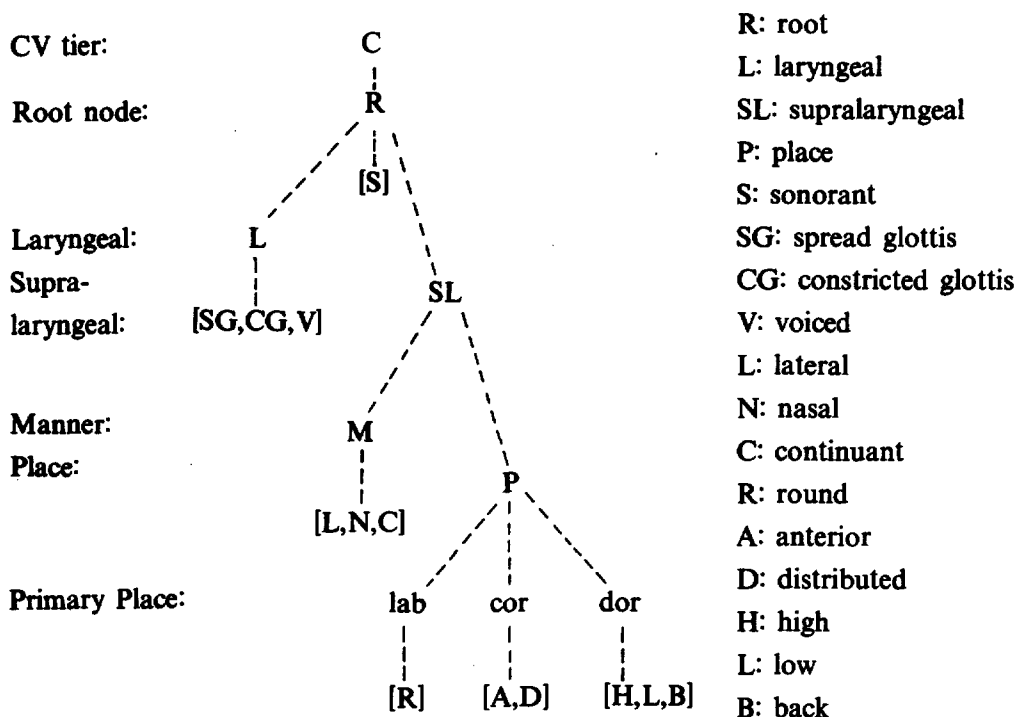
/talnala/	[tallara]	'moon land'
cf. /mallo/	[mallo]	'the end'

As can be seen in examples (4), the lateral /l/, the more marked sonorant segment, becomes the less marked [n] in syllable-initial position through the /l/-nasalization process. In contrast, /n/-lateralization converts the less marked /n/ into the more marked /l/ whenever /n/ is adjacent to the lateral /l/. According to the definition of neutralization in (2), this /n/-lateralization rule qualifies as a neutralization rule since there are marked segments in the input to this rule as seen in (5). However, this rule violates the Markedness Constraint (1) since it produces the marked segment as output. But we should note here that there is a fundamental difference between /n/-lateralization and syllable-final obstruent neutralization. That is, the latter is true neutralization, similar to Trubetzkoy's (1969) 'structurally-conditioned' neutralization, while the former is assimilation, similar to Trubetzkoy's 'contextually-conditioned' neutralization. Noting this difference between assimilation and other true neutralization, Wheeler proposes that if we assume that the Markedness Constraint applies only to true neutralization rules and not to assimilation rules, then the constraint can be strengthened by requiring that the output always be relatively unmarked, thus allowing only true neutralization rules to be subject to this Markedness Constraint, not assimilation rules. In short, what both Houlihan and Iverson (1979) and Wheeler (1981) argue with regard to neutralization may be summarized as the following Neutralization Markedness Constraint (6):

(6) Neutralization Markedness Constraint (Kim 1987:107):

Structurally-conditioned neutralization rules convert relatively marked segments into relatively unmarked ones.

However, in the framework of underspecified, hierarchical feature representation, this Neutralization Markedness Constraint is naturally expected. Kim (1987) proposes the following hierarchical organization of distinctive features in (7), similar to Clements' (1985) and Sagey's (1986) geometric feature representation:

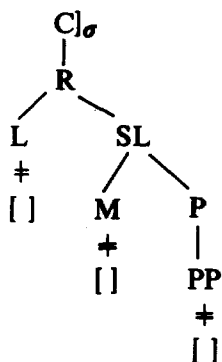


Furthermore, in the framework of underspecification, only unpredictable, or marked features and feature nodes will be specified in underlying representation. And the predictable, or unmarked features, feature values and feature nodes will be rather supplied by default rules. Thus, if neutralization is interpreted as delinking of the feature or feature node, as a distinguished process from other phonological processes, then the Neutralization Markedness Constraint (6) will naturally come out. That is, once the specified, or marked, features are delinked by neutralization, the derived structure will be similar to the underlying representation of the corresponding unmarked segments. Then, default rules which supply the predictable, or unmarked features or feature values to the maximally underspecified segments will supply the same unmarked feature values to the missing features and feature nodes. Therefore, the true structural neutralization will convert marked segments into relatively unmarked.

Hence, concerning the obstruent neutralization examples in (3), in underlying representation, only marked features, i.e. [+SG] and [+CG] will be specified as the laryngeal feature of the aspirated and tense features, respectively. Obstruent

neutralization in Korean, then, will delink these specified laryngeal features along with other specified terminal features, as illustrated in (8):

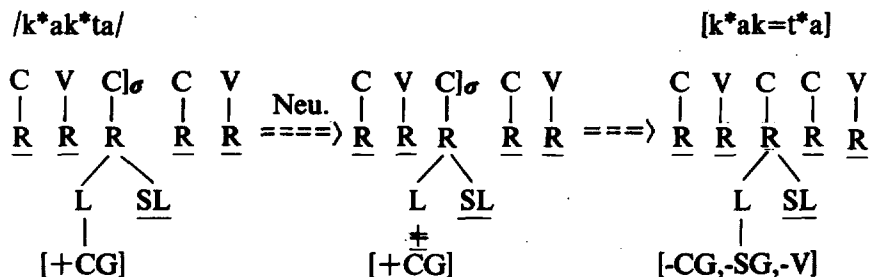
(8) Obstruent Neutralization:



Once these marked features are delinked, the derived structures of the aspirated and tense obstruents will have the same structure as the underlying representation of the corresponding lax obstruents, to which the default laryngeal features, i.e. [-SG], [-CG], and [-V] will be supplied by the redundancy rules in (9a). The derivations of the examples in (3) is illustrated in (9b), where underlying of a node indicates that it may dominate other nodes or features (i.e. is not unspecified).

- (9) a. DR for laryngeal: [ ] --> [-SG]
- DR for laryngeal: [ ] --> [-CG]
- DR for laryngeal: [ ] --> [-V]

b. /k\*ak\*ta/



As seen in (9b), true neutralization will delink the already specified features, which are marked. Since redundancy rules supply only predictable, or unmarked

features, neutralizations will naturally produce the unmarked features as their output. Hence, if structurally-conditioned neutralizations are interpreted as de-linking of the terminal feature or feature nodes, then the output of neutralization will always be unmarked. In other words, the Neutralization Markedness Constraint in (6) is a natural result of the theory of underspecified, hierarchical feature representation.

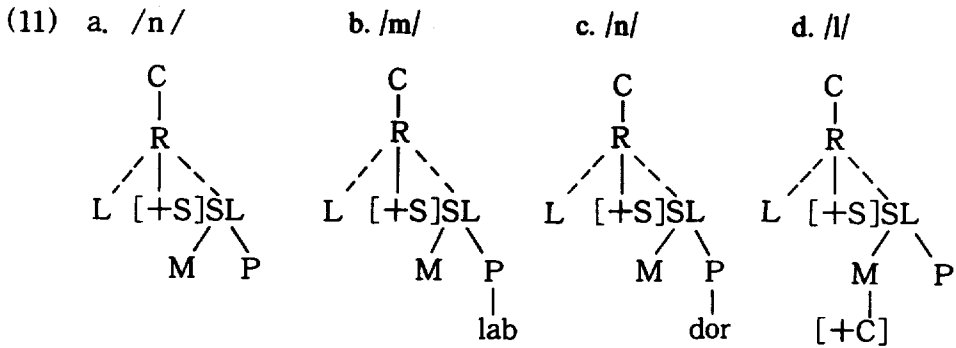
In addition to this prediction with regard to neutralization, the theory of underspecified feature hierarchy also provides an explanation as to why certain kinds of assimilation occur more frequently than others in natural languages. With respect to the direction of assimilations, some tendencies can be observed. One of these tendencies<sup>3)</sup> is that unmarked segments tend to assimilate to marked ones. This tendency of assimilation can be easily predicted within the framework of underspecified hierarchical feature representation. For example, consider Korean nasalization. As for consonants, [-sonorant] is the unmarked, or default sonorant feature value. Of interest here is that in syllable-final position, obstruent assimilates to sonorant consonants as in (10a) but sonorant consonants do not assimilate to obstruents, as illustrated in (10b):

- (10) a. /pap+mul/     [pammul]     'rice soup'  
           /mEk+mul/    [mEgmul]     'chinese ink'  
           /cap+lok/     [camnok=]    'a miscellany'  
       cf. /pap+to/     [pap=t\*o]    'rice also'
- b. /inpu/        [inbu]<sup>4)</sup>    \*[ippu]     'a porter'  
           /taŋku/      [taŋku]     \*[takku]    'billiard'  
           /toltam/     [toldam]    \*[tottam]   'stone wall'

In the framework of underspecified feature hierarchy, sonorant segments such as /n/, /m/, /ŋ/, and /l/ will be represented underlyingly as illustrated in (11):

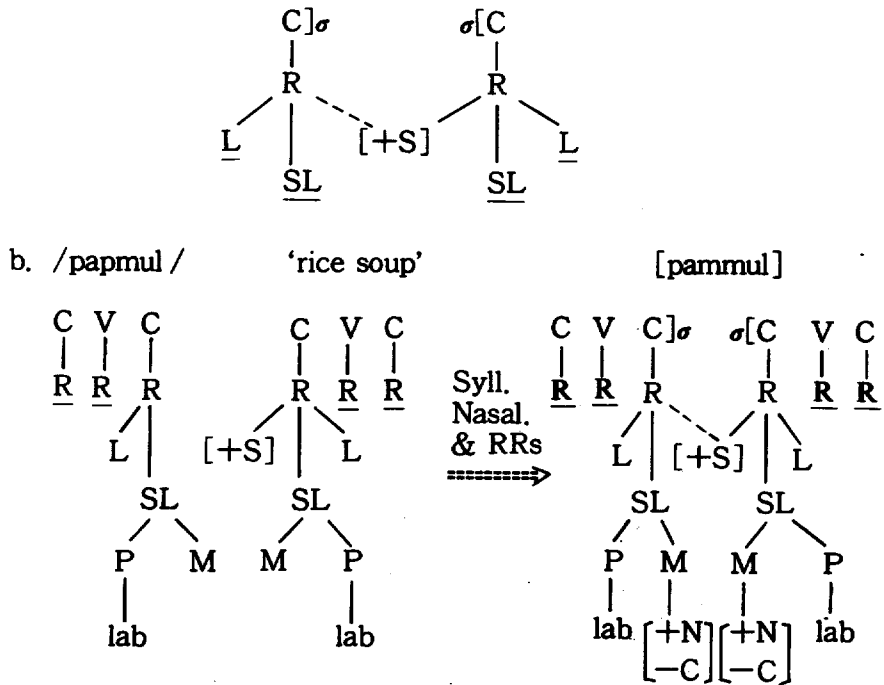
3) The common tendency for a syllable-final segment to assimilate to the following syllable-final segment can be accounted for by the universalists' claim that syllable-final position is weaker than syllable-initial position (Hooper 1972, 1976; Vennemann 1972). Since assimilation is a weakening process, it is natural to expect that the segment in weaker position will assimilate to the segment in stronger position.

4) Lax stops in Korean become voiced in intervocalic position. This voicing process will be discussed later.



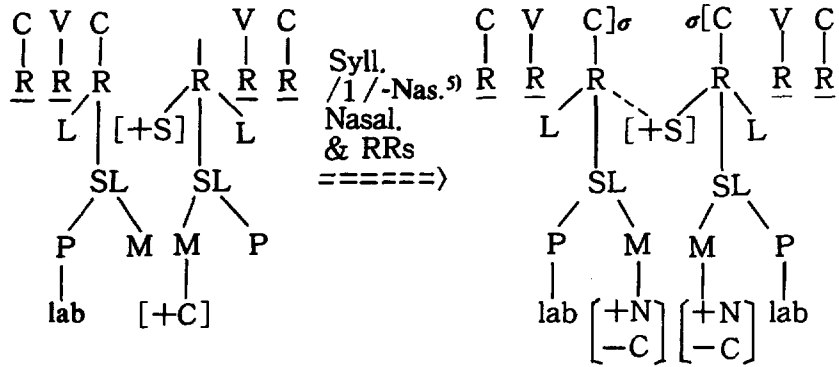
Nasalization in Korean, then, can be accounted for as spreading the specified root feature [+sonorant] of the syllable-initial consonant to the unspecified root node of the syllable-final obstruents as in (12a), and examples in (10a) such as [pammul] and [cannok=] will be derived, as illustrated in (12b,c):

(12) a. Feature [+sonorant] Spreading (=Nasalization)



c. /caplok / 'a miscellany'

[camnok=]



d. RRs (Redundancy Rules) for consonants (manner):

- i) [ ] --> [+N] / [+sonorant, \_ ]
- [ ] --> [-C]

As illustrated in (12), if obstruents are underspecified for their root feature in syllable-final position, then the root feature [+sonorant] of the following sonorant segment such as /m/, /n/, and /l/ will spread to the underspecified root node of the obstruent. Once the root feature [+sonorant] is supplied by assimilation, then, by the Elsewhere Condition in (13), this specification of the root feature will properly block the application of the default feature [-sonorant] by redundancy rules:

(13) Elsewhere Condition (Kiparsky 1984:3):

Rules A, B in the same component apply disjunctively iff

- a. The input of A is a proper subset of the input of B.
- b. The output of A and B are distinct.

In this case, A (the particular rule) is applied first, and if it takes effect, then B (the general rule) is not applied.

Once the manner feature [+sonorant] is supplied by nasalization, the segments

5) In this framework, /l/-nasalization (4) is interpreted as the simple delinking of the manner feature [+continuant]. For further details, see Kim (1987).



in question will be spelled out as the corresponding nasals after redundancy rules apply. In other words, the output of nasalization in Korean will turn out with the marked value instead of unmarked one. In contrast, assimilation of a marked segment to an unmarked one as in (10b) will involve more complex processes than the reverse one. The theory of underspecification allows for interaction between phonological rules and redundancy rules, and thus nothing excludes the possibility of assimilation to unmarked features. However, after redundancy rules have filled in the unspecified (unmarked) feature or feature nodes, the spreading of the newly-filled-in feature(s) will necessarily require the delinking of the already specified feature(s). Hence, assimilation to the unmarked segment constitutes two processes, i.e. both delinking and spreading, while assimilation to the marked one constitutes just one process, i.e. spreading the specified feature node to the unspecified node. So, in this framework, it can easily be accounted for why assimilation to the specified (marked) feature(s) occurs more frequently in natural languages than the reverse one: that is, the former is simpler, and presumably therefore more natural than the latter.

Place assimilation in natural languages also shows the general tendency of assimilation towards the marked segment. With respect to place features, coronals are regarded to be relatively weaker than labials or velars. Of interest here is that assimilation of coronals to labials or velars occurs more frequently than assimilation in the opposite direction in natural languages (see Foley 1970). For example, alveolar sounds in Korean optionally assimilate their place features to those of labials or velar sounds, as in (14a) and (14b), but not vice versa, as in (14c):

- (14) a. alveolar > labial  
         /nunmul/     [nunmul]     ~ [nummul]     'tears'  
         /sinpal/     [sinbal]<sup>6)</sup>     ~ [simbal]     'shoes'
- b. alveolar > velar  
         /kunki/     [kungi]     ~ [kungi]     'military discipline'  
         /pak+to/     [pat=k\*o]     ~ [pak=k\*o]     'to receive'

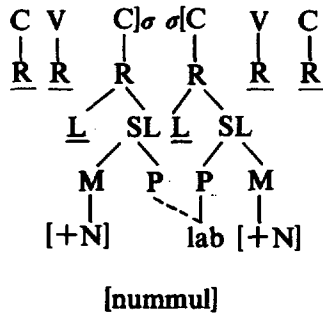
6) The segment /s/ in Korean becomes [s] before /i/ or /y/ by palatalization.

c. \*lab > alv, \*vel > alv

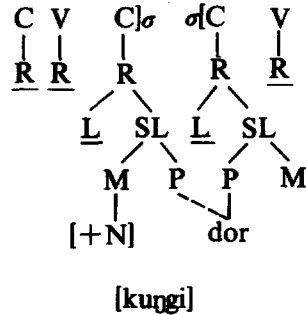
/pap+to/	[pap=t*o]	*[pat=t*o]	'rice also'
/kakto/	[kak=t*o]	*[kat=t*o]	'angle'

In the framework of underspecified, hierarchical feature representation, this unilateral direction of place assimilation in Korean can be easily accounted for. Since 'coronal' is regarded as the least marked place feature for consonants, alveolars are represented with their place features unspecified in underlying representation, while labials and velars are represented with their primary place features specified as labial and dorsal, respectively. The examples in (14a) and (14b) are accounted for as spreading of the specified place features of the syllable-initial segment to the unspecified place node of the preceding, syllable-final segment, as illustrated in (15a,b):

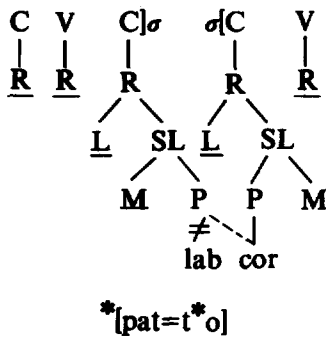
(15) a. /nummul/



b. /kunki/



c. /pap+to/



In contrast, assimilation to the unmarked one in the examples (14c) involves

two processes, i.e. delinking of the already-specified, marked features and spreading of the newly-filled-in features, as illustrated in (15c). Hence, in the underspecified hierarchical feature representation, it becomes clear why assimilation to the marked one occurs with greater frequency, while the reverse one seldom occurs: the former is simpler, and thus presumably more natural than the latter.

So far I have shown that the peculiarities of nasalization and place assimilation can be directly accounted for as autosegmental spreading in underspecified feature hierarchy. Now let us turn to the controversial so-called /p/ and /t/ extreme weakening processes in Korean. Lax stops in Korean become voiced between voiced segments. Thus before vowel-initial affixes, the stem-final /p/ and /t/ of the regular verbs becomes voiced to [b] and [d], respectively, by voicing. Some examples are given in (16):

- (16) a. /kop+ta/ [kop=t\*a] 'to be numb'  
           /kop+A/<sup>7)</sup> [koba] (stative)  
           /kop+ini/ [kobini] (effective)  
           /kop+im/ [kobim] (nominative)  
       b. /mut+ta/ [mut=t\*a] 'to bury'  
           /mut+A/ [mudE] (stative)  
           /mut+ini/ [mudini] (effective)  
           /mut+im/ [mudim] (nominative)

Unlike the regular verbs, however, before vowel-initial suffixes, the stem-final /p/ of the so-called /p/-irregular verbs shows alternations between [p] and [w] or [u] and the stem-final /t/ of the so-called /t/-irregular verbs emerges as [r], as illustrated in (17a) and (17b):

- (17) a. /ko:p+ta/ [kop=t\*a] 'to be beautiful'  
           /ko:p+A/ [kowa] (stative)  
           /ko:p+ini/ [kouni]<sup>8)</sup> (effective)

7) The archiphoneme-type vowel /A/ will surface as either [a] or [E] depending on the preceding vowel through vowel harmony. The hierarchical feature analysis of vowel harmony will be presented in Kim (in preparation).

8) The vowel /i/ in suffix will surface as [u] through vowel coalescing when preceded by [w] in derivation. For details, see Kim (in preparation).

	/ko:p+im/	[koum]	(nominative)
b.	/mu:t+ta/	[mut=t*a]	'to inquire'
	/mu:t+A/	[murE]	(stative)
	/mu:t+ini/	[murini]	(effective)
	/mu:t+im/	[murim]	(nominative)

If we compare the extreme weakening processes of the so-called irregular verbs with the normal weakening process, or voicing, we find some interesting facts. That is, both the irregular verb conjugation and voicing are kinds of weakening processes, due to the sonority of the environment. In other words, these processes are a kind of assimilation to the greater sonority of the neighboring segments. The main difference between them is that the strength scale of sonority assimilation in the former is stronger than in the latter: the /p/- and /t/-weakening processes will change from level 1 to level (6) and (5) respectively on the sonority hierarchy in (18), while voicing will increase the sonority level just by one:

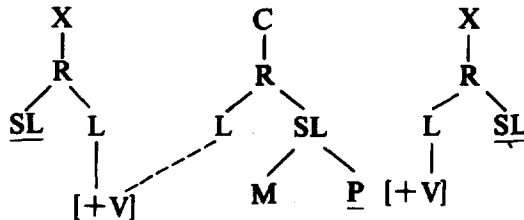
- (18) Sonority Hierarchy (Jespersen 1932:191, also cited in Hooper (1976) and many others)
1. Voiceless consonants
    - a. stops (p,t,k)
    - b. fricatives (f,s)
  2. Voiced stops (b,d,g)
  3. Voiced fricatives (v,z)
  4. Nasals and laterals (m,n,l)
  5. Trills and taps (r)
  6. Close vowels (y,i,u,w)
  7. Mid vowels (e,o)
  8. Open vowel (a)

Due to this different degree of sonority assimilation, the former has frequently been called as inter-vocalic 'extreme weakening' process, while the latter has been regarded simply as an intervocalic 'weakening' process.

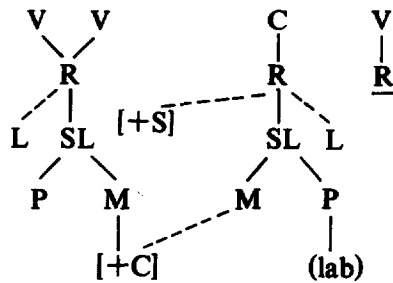
As can be seen in feature geometry (7), distinctive features are hierarchically organized, and thus it is very logical to assume that the different levels of sonority

assimilation may be reflected by the spreading of the different levels of features, i.e. either the level of the root node or the level of class nodes. Because the irregular verb conjugations and voicing in Korean are a kind of weakening, or assimilatory process, in the framework of underspecified hierarchical feature representation they will be similarly accounted for as the spreading of marked features to underspecified feature nodes. In this framework, the weakening, or voicing process will be accounted as spreading of laryngeal feature [+voiced] as illustrated in (19). furthermore, Kim (1987) formulates the /p/- and /t/-extreme weakening processes as one process, i.e. a spreading of both root feature [+sonorant] and manner feature [+continuant], as illustrated in (20):

(19) Voicing Feature Spreading:



(20) Feature [+son] and [+cont] Spreading:  
 (= /p/- and /t/-extreme weakening)

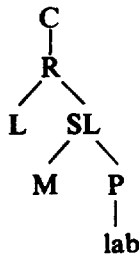


Rule (20) states that if a consonant is maximally underspecified or specified for the primary place feature with 'labial', and preceded by a long vowel and followed by a vowel, then the root feature [+sonorant] and the manner feature [+continuant] of the adjacent vowel will spread to the underspecified root and manner node of the segment in question. In other words, /p/-extreme weakening

and /t/-extreme weakening are not two separate processes as argued in previous studies (Kim-Renaud 1974, Ahn 1985, Sohn 1987, and others), but they are rather a single process of spreading of both [+sonorant] and [+continuant].

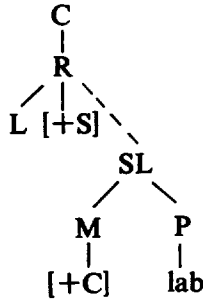
This autosegmental spreading rule in (20) provides a clear account of why the segment /p/ and /t/ turn out as [w] and [r] respectively. In the framework of underspecified hierarchical feature representation, the segment /p/ is represented with the place node specified with the primary place 'labial', but the laryngeal, manner and root features are underspecified, while the segment /t/ is represented as a maximally underspecified segment in underlying representation. After the extreme weakening in (20) applies, the segments in question will be represented with root and manner nodes specified with [+sonorant] and [+continuant], respectively, as in (21b) and (22b). This constellation of features will later turn out specifically as [w] and [r] respectively by the independently motivated redundancy rules of (23), as illustrated in (21c) and (22c):

(21) a. /p/



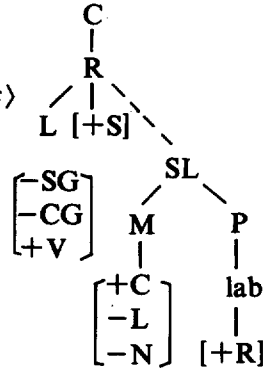
(20)  
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b.

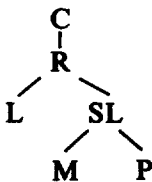


RRs  
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c. [w]

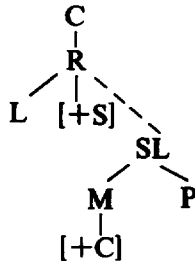


(22) a. /t/



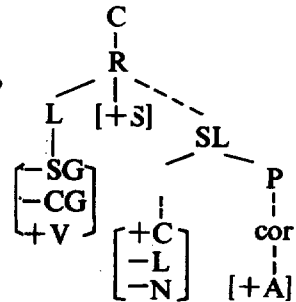
(20)  
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b.



RRs  
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c. [r]



## (23) RRs (Redundancy Rules) for consonants:

- a. [ ] → [-SG]
- b. [ ] → [-CG]
- c. [ ] → [+V] / [+S, \_\_\_\_]
- d. [ ] → [-N]
- e. [ ] → cor
- f. [ ] → [+A] / [cor, \_\_\_\_]
- g. [ ] → [+R] / [+S, lab, \_\_\_\_]
- h. [ ] → [-L]

This autosegmental feature spreading account in (20) expresses the assimilatory character of /p/- and /t/-extreme weakening in a unique way, as a process of spreading the marked features to the underspecified feature nodes. Thus in the framework of underspecified hierarchical feature representation, we can easily capture the similarity and difference between the mere 'weakening', or voicing process and the 'extreme weakening' processes. That is, both voicing and these two extreme weakening processes are similar in the sense that they are both assimilatory processes due to the surrounding extreme sonority. And these facts are expressed by the particular character of assimilation, i.e. spreading the specified or marked feature(s) to the unspecified feature node. The environment of the extreme weakening, however, is more sonorous than that of voicing, since the former has underlying long vowels, while the latter has underlying short vowels. Hence the difference between these two processes rather lies in the difference in the strength scale of sonority assimilation. In other words, the difference between two processes is that the former involves just spreading of the laryngeal feature [+voiced] as in (19), while the latter constitutes a more complex processes, i.e. spreading of both the root feature [+sonorant] and the manner feature [+continuant] as in (20). In short, the similarity of these two processes is captured by the spreading of the features which are relevant to determinations of relative sonority, but the difference derives from the spreading of hierarchically different features.

It is also interesting to note that Korean has a very limited number of verbs which undergo these extreme weakening processes, in comparison with the number of those which undergo the general voicing (19). Under present assumptions,

it is natural to expect that extreme weakening will occur less frequently than voicing, since the former involves the spreading of both the root feature [+sonorant] and the manner feature [+continuant], while the latter involves just spreading of the laryngeal feature [+voiced]: thus the former is more complex than the latter.

In summary, the theory of underspecification within the framework of feature hierarchies provides a unique way of characterizing neutralization and assimilation. That is, neutralization is interpreted as delinking of features and feature nodes, while assimilation is interpreted as spreading of marked features to unmarked nodes. In underlying representations, only marked, unpredictable features and feature values are specified, and redundancy rules supply only predictable, or marked features and feature values. Hence, by delinking the specified, marked feature nodes, neutralization such as obstruent neutralization will automatically convert the marked features and feature values to the unmarked ones, which conforms to the Neutralization Markedness Constraint. Assimilation processes in Korean such as place assimilation and nasalization are accounted for as a spreading of the specified features to the underspecified feature node of the neighboring segment. Both inter-vocalic voicing and inter-vocalic extreme weakening processes are also kinds of assimilation due to their sonorous environments. But the difference between these two processes are accounted for as spreading of features in different hierarchies. Thus the autosegmental feature spreading and delinking approach within the framework of underspecified hierarchical feature representation not only accurately describes the phonological processes, but also provides a principled way of accounting for why they function precisely as they do, and other processes seldom and never occur in natural languages.

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