

An Overview of the Theory of Underspecification

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The purpose of this paper is to observe the nature and characteristics of underspecification in phonology. For this purpose, I first discuss the motivation and the governing principles of the recent theory of underspecification. Then, it will be shown that the theory of underspecification is not only about the simplicity of segmental feature representation, but also about the overall generalization and simplicity of phonological specification. Thus the theory of underspecification provides a more systematic way of providing a phonological description with minimal specifications in underlying representation. Moreover, the interaction among phonological rules and redundancy rules is discussed, including certain constraints on the ordering of redundancy rules. Furthermore, I also discuss how this theory fits in other fields of phonology, such as Lexical Phonology and Feature Geometry. Finally, different views on “radical underspecification” theories are presented.

1. Introduction

The notions of economy and simplicity have always been of major concern implicitly or explicitly in linguistic description, especially in the framework of generative phonology. For example, a solution with fewer phonemes or rules is judged more economical than a solution recognizing more phonemes or rules. Economy is thus a quantitative measure by which a solution can be evaluated as requiring fewer or more mechanisms than other solutions. Moreover, the distinction between idiosyncratic properties and predictable properties have been systematized in the literature on phonology. For example, in Trubetzkoy (1939), any phonological specification is left out in the underlying representation if it is predictable by

a phonological rule within a language. Moreover, in the standard theory of distinctive features, all predictable features are expected to be left out from feature matrices in order to prevent redundancy. For example, the existence of [+syllabic] eliminates the necessity of [+sonorant], [+continuant], [+obstruent], ...etc., within the same feature matrix.

Furthermore, an evaluation metric in universal grammar provides a means of selecting between possible grammars for a particular language. For instance, Chomsky & Halle (1968, SPE henceforth) proposed an evaluation metric preferring the grammar in which only the idiosyncratic, not the predictable, properties are lexically listed.

With this much background, the essence of underspecification theory was proposed by Archangeli (1984, 1985) to specify only unpredictable features or feature values in the underlying representation and derive predictable properties by rules. In other words, any predictable information (i.e., derivable by rule) is underspecified. (The "information" here refers to all types of phonological characteristics, phonemes, features, tones, syllable structure, stress, and even templates (i.e., timing units.) For example, it has been shown that forms are typically listed without syllable structure because it is predictable and thus derivable from the segmental string (Kahn 1976; Clements & Keyser 1983; Levin 1985). Stress assignment is also shown to be predictable in many languages and is left out from the underlying representation of the string since it is derived during the course of the phonology (Lieberman & Prince 1977; Hayes 1980; Prince 1983). The same consequence applies to skeletal structure. For example, the representation of the timing units in terms of the underspecified X's rather than the (pre)specified C and V is proposed by Levin (1985). Furthermore, Pulleyblank (1986) discussed tonal phenomena in Yoruba where all High, Low and Mid tones surface, but only High and Low tones are mentioned in the structural descriptions and changes of rules throughout the phonology. Thus the Mid tone never mentioned in Yoruba is assumed to be supplied by redundancy rules.¹ (Those rules supplying missing (or underspecified) features or feature values are redundancy rules in underspecification theory. I will discuss them later in this paper.)

Viewed in this way, the theory of underspecification is not only about the simplicity of segmental features; rather, through underspecification, we

can not only achieve the simplicity of underlying representation, but also the overall generalization and simplicity of phonological specification. Thus the theory of underspecification provides a more systematic way of providing a phonological description with minimal specifications in underlying representation.

2. Development of the theory

2.1. Underlying representation: Spanish

Spanish has five underlying vowels, as listed in (1).

(1) i e a o u

According to Harris (1980), Spanish also has a number of epenthesis rules.

- (2) a. $\emptyset \rightarrow e / \# \# ___ sC$ e.g. *esfera* 'sphere'
 b. $\emptyset \rightarrow e / C ____ rC$ e.g. *aber+tura* 'opening (noun)'
 c. $\emptyset \rightarrow e / CC ___ C$ in the diminutive e.g. *novye+cito* 'groom'
 d. $\emptyset \rightarrow e / [[\dots] ___ s]$ in certain plurals
 e.g. *tapiz/tapices* 'tapestry/ies'

Here we find a curious fact shown: the same vowel is coincidentally inserted in all four cases. Recognizing this problem, Harris (1980) proposes to mark a featureless skeletal position as a syllable head, such as V or X, which is to be inserted. Then a general rule supplies the vowel /e/ to all empty (i.e., featureless) skeletal slots.

(3) /sfera/
 Xsfera $\emptyset \rightarrow X$
 esfera $X \rightarrow e$

This account by Harris treats the epenthetic vowel /e/ as a single unit. Here we note that in the theory of underspecification, the epenthetic vowel is assumed to turn out as a single vowel in a given language, which is regarded as the least marked (and thus the default vowel) in this language. However, when we consider the features representing this "default" vowel, there are two ways to represent the rule of /e/-epenthesis: a single rule inserting a feature matrix or a group of rules each inserting a single feature.

$$(4) \text{ a. } [] \rightarrow \begin{bmatrix} \text{--high} \\ \text{--low} \\ \text{--back} \\ \text{--round} \end{bmatrix} \quad \text{b. } \begin{array}{l} \text{i. } [] \rightarrow \text{[--high]} \\ \text{ii. } [] \rightarrow \text{[--low]} \\ \text{iii. } [] \rightarrow \text{[--back]} \\ \text{iv. } [] \rightarrow \text{[--round]} \end{array}$$

While the single rule approach (4a) by Harris (1980) is very commonly used, we can examine the alternative approach (4b). Notice that assuming that the four rules in (4b) are part of Spanish grammar, the theory of underspecification uses these rules to specify not only the epenthetic vowel /e/ but also the underspecified features of the other vowels.

For example, the feature matrices of the underlying vowels are shown in (5a). As the least-marked, default vowel is considered to be /e/, all the features (i.e., [–high] [–low] [–back] [–round]) shown in (4b) can be unspecified. Then, those features of other vowels are also unspecified when they are identical to those default feature values. These feature values are parenthesized in (5b) for convenience. Next, in (5c), those values have been removed from the matrix and the rules of (4b) supply the missing values.

$$(5) \text{ a. } \begin{array}{c|ccccc} & \text{i} & \text{e} & \text{a} & \text{o} & \text{u} \\ \hline \text{H} & + & - & - & - & + \\ \text{L} & - & - & + & - & - \\ \text{R} & - & - & - & + & + \\ \text{B} & - & - & + & + & + \end{array} \quad \text{b. } \begin{array}{c|ccccc} \text{i} & \text{e} & \text{a} & \text{o} & \text{u} \\ \hline & + & (-) & (-) & (-) & + \\ & (-) & (-) & + & (-) & (-) \\ & (-) & (-) & (-) & + & + \\ & (-) & (-) & + & + & + \end{array} \quad \text{c. } \begin{array}{c|ccccc} \text{i} & \text{e} & \text{a} & \text{o} & \text{u} \\ \hline & + & & & & + \\ & & + & & & \\ & & & + & + & \\ & & & + & + & + \end{array}$$

For example, /i/ and /a/ are represented simply as [+high] and [+low] [+back] respectively. Rules (4b ii~iv) then supply the missing (but redundant) values.

$$(6) \begin{array}{c|cc|c} & \text{[e]} & \text{[i]} & \text{[a]} \\ \hline & [] & [+H] & [+L] \\ & & & [+B] \\ \hline & [-H] & [-L] & [-H] \\ & [-L] & [-B] & (4bi) \\ & [-B] & [-R] & (4bii) \\ & [-R] & & [-B] \\ & & & (4biii) \\ & & & (4ibv) \end{array}$$

Here we notice that each (redundancy) rule in (4b) inserts the complement (i.e., opposite) of the feature value in (5c). Redundancy rules of this type

¹ Low and Mid tones are in general regarded as the unmarked tones in two-way and three-way tonal systems respectively, and thus filled in by universal default rules.

$\alpha \neq \beta$; or α is an integer and β is minus. Two strings X and Y are distinct if they are of different lengths, that is, if they differ in the number of units that they contain, or if they contain, or if the i th unit of X is distinct for the j th unit of Y for some i .³

The distinctness condition and the definition of "distinct" block application of redundancy rules for a given feature to matrices already specified for that feature. This is because $[\alpha F]$ and $[-\alpha F]$ are distinct, but $[\alpha F]$ (or $[-\alpha F]$) and $[\]$ are not distinct. Thus this Distinctness Condition relieves the underspecification theory from a ternary use for binary features, by which the earlier criticism on the markedness theory cannot apply here.

2.2. Types of redundancy rules

In the previous section, we saw that, in (5) and (6), each rule inserts the complement of the feature value in (5c) and that rules of this type are called complement rules. In the underspecification theory, learning complement rules and learning which feature values are present in underlying representation is a single process, not two distinct tasks (Archangeli 1985:5).

However, we need another type of universal rule since not all features, such as [high], [low], [back] and [round], should be present in the underlying representation. For example, the values for [back] in Spanish can be predicated from the values for [round] and [low]. In other words, all the nonlow vowels (i.e., except /a/) have the values for [round] agreeing with the values of [back]. Thus we can reduce the number of feature values for better underspecification of underlying representation, based on the Feature Minimization Principle of Archangeli (1984:50).

(13) Feature Minimization Principle

A grammar is highly valued when underlying representations include the minimal number of features necessary to make different the phonemes of the language.

Adopting this principle, we can eliminate either [round] or [back] from underlying representation.

First, when we eliminate [back], we will have the underlying representation (14a) and need the redundancy rules in (14b) to supply the missing

values.

| | | | |
|---------|---|-------|--|
| (14) a. | $\begin{array}{cccccc} & i & e & a & o & u \\ \hline H & + & & & & + \\ L & & & + & & \\ R & & & & + & + \end{array}$ | b. i. | []→[+back]/[$\frac{\quad}{+low}$] |
| | | ii. | []→[αback]/[$\frac{\quad}{around}$] |

The values of [back] for nonlow vowels will be supplied by (14bii). But we need the rule (14bi) as well, since the feature value of [back] for /a/ would become [+back] if we posit only (14bii) for [back] and [round]. In other words, Rule (14bi) marks the [+low] vowel /a/ as [+back] and then Rule (14bii) marks all other vowels as agreeing in values on [round] and [back]. This sort of rule ordering is predicted from the “Elsewhere Condition” by Kiparsky (1982:8).

(15) Elsewhere Condition

Rules A, B in the same component apply disjunctively to a form if and only if

- i) The structural description of A (the special rule) properly includes the structural description of B (the general rule).
- ii) The result of applying A to ϕ is distinct from the result of applying B to ϕ .

In that case, A is applied first, and if it takes effect, then B is not applied.

By this condition, Rule (14bii) must follow Rule (14bi). Moreover, as /i, e/ should be specified as [−back], Rule (14bii) should follow the complement rule inserting [−round] to /i, e/.

On the other hand, suppose that we eliminate the feature [round] rather than [back]. Then we would have the underlying representation (16a) and the redundancy rules in (16b).

| | | | |
|---------|---|-------|--------------------------------------|
| (16) a. | $\begin{array}{cccccc} & i & e & a & o & u \\ \hline H & + & & & & + \\ L & & & + & & \\ B & & & + & + & + \end{array}$ | b. i. | []→[−rnd]/[$\frac{\quad}{+low}$] |
| | | ii. | []→[αrnd]/[$\frac{\quad}{αback}$] |

This latter option seems to operate as effective as the former one. For example, by (16bi), /a/ can be first specified as [−round]. Then, by (16bii), /o, u/ are specified as [+round]. And as /i, e/ should be specified

as [-round], Rule (16bii) should follow the complement rule supplying [-back] to /i, e/. However, we should note that although both rules in (16b) are universal default rules, Rule (16bi) is more general (i.e., more common universally) than Rule (16bii). Thus if we follow the Elsewhere Condition for the application of these two rules, we will have to apply (16bii) first, deriving [+round] for /a/ and then readjust the [round] value to minus. But this sort of operation is not only costly, but also defective as it might cause the problem of arbitrariness in rule formulation. Thus we take the first approach (14a) as the underlying representation of Spanish.⁴

Now recall that the complement rules in (4b) fill in the value opposite to the one already present in underlying representation and that they are assumed to be learned as part of the process acquiring the underlying representation. However, we can notice that those rules in (14b) are somewhat different from the complement rules since they supply the values by "default", as part of universal grammar. Thus in Archangeli (1984, 1985), adopting these rules as universal default rules, it is conceived that the grammar of Spanish is simplified since these rules are not to be learned. Moreover, the concept of relative frequency of vowel system can be encoded in universal grammar. For example, most languages are likely to have a back-round match, rather than a mismatch, among the nonlow vowels. Furthermore, the first rule in (14b) indicates that the least marked low vowel is marked as [+back].

On the universal default rules, we also note that there are two types: those which are required and thus cannot be violated, and those which are just preferred (i.e., extremely common). For illustration, we list the following default rules.

(17) Universal default rules: [high] and [low]

- Required a. [] → [-high] / [$\frac{-}{+low}$]
 b. [] → [-low] / [$\frac{-}{+high}$]

⁴ Archangeli (1984, 1985) simply assumes the first alternative without any argument against the second option. Thus this part of the discussion is intended to convince the reader to prefer the first proposal.

Preferred c. [] → [+low] / [$\overline{-high}$]

d. [] → [+high] / [$\overline{-low}$]

(18) Universal default rules: [back] and [round] (Preferred)

a. [] → [$\begin{matrix} -round \\ +back \end{matrix}$] / [$\overline{+low}$]

b. [] → [around] / [$\begin{matrix} \alpha back \\ -low \end{matrix}$]

c. [] → [αback] / [$\begin{matrix} \overline{around} \\ -low \end{matrix}$]

In other words, those rules in (17a, b) are required in the sense that if either [+high] or [+low] is present, the opposing feature must be filled in as “-”. However, the preferred rules (17c, d) and (18a-c) indicate common vowel distribution which may be violated. For example, (17a-d) provide [+high, -low] and [-high, +low] matrices. (18a) indicates that the preferred low vowel is /a/ universally. (18b, c) state that [back] and [round] generally agree for nonlow vowels.

These rules may rank the five vowels /i, e, a, o, u/ in terms of their distribution. First, /a/ is the least marked vowel since specifying [+low] or [-high] is sufficient to distinguish the vowel /a/ and all other values are supplied by universal default rules. Second, in order to distinguish /i/ and /u/, we need to specify [+high] or [-low] and some value for [back] or [round]. Third, to distinguish /e/ and /o/, both [-high] and [-low] should be specified as well as some value for [back] or [round]. Consequently, the vowels are ranked as in (19).

(19) a < i, u < e, o

Furthermore, we can also figure out the preferred vowel systems as shown below.

⁵ It might be controversial to decide the least marked vowel in Japanese if the decision should be based on vowel-epenthesis as often appeared in Archangeli (1984, 1985). For example, there are cases in which the inserted vowel may surface as [u], [o], or [a], rather than [i]: [reiru] ‘rail’, [naito] ‘night’, [sarada] ‘salad’. Sohn (1987) attempts to categorize these cases with respect to their phonological environments, but the decision criterion for the least marked segment, based on epenthesis, still remains a problem.

3. Implications

3.1. Yawelmani: Epenthesis, Harmony, Dissimilation

In this section, it will be shown that three independent rules—epenthesis, vowel harmony, and dissimilation converge on the underspecified underlying representations in Yawelmani.

3.1.1. Epenthesis and underlying representation

There are four (short and long) underlying vowels in Yawelmani, which surface as five vowels. (Kenstowicz & Kisseberth 1979)⁶

| | | | |
|------------------|------|----------|------|
| (24) Underlying: | i/ii | Surface: | i/ii |
| | a/aa | | e/ee |
| | o/oo | | a/aa |
| | u/uu | | o/oo |
| | | | u/uu |

The surface vowel alternations are derived by a series of rules such as the following rules. (Archangeli 1985)

- (25) a. Epenthesis: $\emptyset \rightarrow i / C ______ C\{C, \#\}$
 b. Harmony: $i \rightarrow u / u C ______$
 $a \rightarrow o / o C ______$
 c. Lowering: $V \rightarrow [-high]$
[+long]
 d. Shortening: $V \rightarrow [-long] / ______ C\{C, \#\}$

Here we notice that the surface long and short /e/ are derived by Lowering and Shortening.

| | | |
|--------------------------|-----------------------------|--------------|
| (26) /miik+tVw/ (aorist) | /mii + kVt/(passive aorist) | 'swallow' |
| taw | kit | Harmony |
| mee | mee | Lowering |
| me k taw | — | Shortening |
| [mektaw] | [meekit] | Surface rep. |

Now it is assumed that the child initially hypothesizes the equivalence of the surface and underlying vowels, i.e., /i, e, a, o, u/. (Archangeli 1985) Upon discovering epenthesis, the child takes /i/ as the least marked vowel in this language. Moreover, when both Lowering and Shortening are

learned, all occurrences of [e] are derived from /i/, which results in the following underlying representation.

(27)

| | i | a | o | u |
|---|---|---|---|---|
| H | | - | - | |
| L | | + | | |
| R | | | + | + |
| B | | + | + | + |

Then, by the Feature Minimization Principle (13), we can eliminate the redundant features in the following way. First, the feature [high] divides the vowels into two equal groups: [+high] {i, u} and [-high] {o, a}. But the feature [low] cannot divide the features evenly since /a/ is the only [+low] vowel, while others are [-low]. Second, two vowels are [+round] and two are [-round]. But [back] cannot do the same even division. Thus, we take only two features [high] and [round] which can make even divisions, as illustrated in (28).

(28)

| | | |
|---|---|------------|
| i | u |]] |
| a | o | |
| | | [-high] |
| | | [+round] |

Based on this, we can get the following underspecified underlying representation with minimal specifications of the two features and the two complement rules.

(29) a.

| | i | a | o | u |
|---|---|---|---|---|
| H | | - | - | |
| R | | | + | + |

b. [] → [+high]
[] → [-round]

However, the complement rules in (29b) cannot supply all the underspecified feature specifications. In order to do this job, we need the following default rules.

- (30) a. [] → [+low] / [_____, -high]
 b. [] → [-low] / [_____, +high]
 c. [] → [+back, -round] / [_____, +low]
 d. [] → [aback] / [_____, -low, around]

e. [] → [-low] / [____, +round, -high]

Still, however, these rules are in the wrong order: e.g., (30a) must follow (30e) in order to prevent /o/ from being specified as [+low]. Here we employ the already introduced the Elsewhere Condition (15) by Kiparsky (1982:8), which is repeated below for convenience.

(15) Elsewhere Condition

Rules A, B in the same component apply disjunctively to a form if and only if

- i) The structural description of A (the special rule) properly includes the structural description of B (the general rule).
- ii) The result of applying A to ϕ is distinct from the result of applying B to ϕ .

In that case, A is applied first, and if it takes effect, then B is not applied.

By this condition, (30a, b) must follow the special rule (30e). Moreover, (30a, b, e) must precede (30c, d). Otherwise, there is no value on the feature [low] triggering (30c, d).

Now, we can take a look at the contribution of underspecification to phonological description. For example, the rule of epenthesis (25a) in Yawelmani inserts the least marked vowel /i/. If we take the traditional approach of full specification, this rule must specify all the features and feature values for the epenthetic segment /i/.

(31) $\emptyset \rightarrow \left[\begin{array}{l} +\text{high} \\ -\text{low} \\ -\text{back} \\ -\text{round} \end{array} \right] / \text{C} ______ \text{C} \{ \text{C}, \# \}$

Within the framework of underspecification, however, this rule of *i*-epenthesis is interpreted as the insertion of feature-empty vowel slot. And the underspecified features and feature values are filled in later by the redundancy rules discussed above.

(32) $\emptyset \rightarrow [] / \text{C} ______ \text{C} \{ \text{C}, \# \}$

Therefore, it can be claimed that the contribution of the underspecification theory is not limited to the simplification of underlying representation. It

also leads to capturing the simplification of phonological rules.

3.1.2. Vowel harmony

The harmony process in Yawelmani causes a special attention in phonological description. According to (25b), /i/ and /a/ become [u] and [o] after /u/ and /o/, respectively. As Lowering and Vowel Shortening apply after Harmony, the underlying quality of the vowels is sometimes disguised.

| | | | | |
|------|----------------|------------|-------------|----------------------------|
| (33) | passive aorist | dubitative | future | |
| a. | ʔooʔ'ut | ʔooʔ'al | ʔooʔ'on | 'steal' |
| | goonit | goonol | goonen | 'fall' |
| b. | /ʔuuʔ'-t/ | /goon-al/ | /ʔuuʔ'-iin/ | /goon-iin/ Underlying rep. |
| | ...t'it | _____ | _____ | Epenthesis (23a) |
| | ...t'ut | ...ol | ...uun | _____ Harmony (23b) |
| | ʔoo... | _____ | ʔooʔ'oon | ...een Lowering (23c) |
| | _____ | _____ | ...on | ...en VS (23d) |
| | [ʔooʔ'ut] | [goonol] | [ʔooʔ'on] | [goonen] Phonetic rep. |

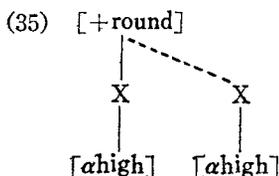
As shown in (33), [e] sometimes harmonizes after [o] but sometimes it does not: e.g., [gooʔ'on]~[goonen] Sometimes [a] harmonizes after [o] but not always: e.g., [ʔooʔ'al]~[goonol] Moreover, [i] may or may not alternate with [u] after [o]: e.g., [ʔooʔ'ut]~[goonit]

In the early generative study on Yawelmani, Kuroda (1967:14) presents a linear rule formulation employing distinctive features.

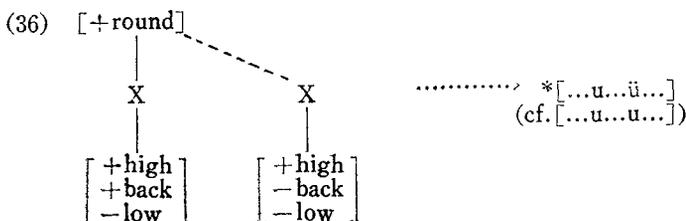
$$(34) V \rightarrow [-\text{round}] / VC_1 ______ \\ [+ \text{round}] / \left[\begin{array}{c} \alpha \text{diffuse} \\ + \text{round} \\ V \end{array} \right] C_1 \left[\frac{______}{\alpha \text{diffuse}} \right]$$

This rule expresses the relationships between the height and the roundness of the vowels since the feature [diffuse] is related with the vowel height. This rule, however, have a couple of crucial problems. First, in (34), it appears as totally coincidental to insert [+round] in an environment conditioned by a [+round] vowel. Second, this rule would generate the undesirable [ü] and [v]. Thus, besides this harmony rule, we are forced to formulate a special rule to change [ü] and [v] to back and nonlow vowels respectively.

On the other hand, the standard theory of autosegmental phonology would posit the harmony rule as spreading the [round] feature on a following feature matrix of the same height.

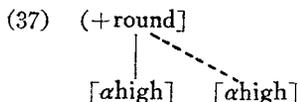


This nonlinear rule formulation is preferred over the linear one (34), since the first problem of (34) does not hold here. In other words, the relation of the identical vowel height is expressed in the rule formulation here. When matrices are fully specified, however, the harmony rule should be quite complicated. For example, when /i/ harmonizes after /u/, it should surface as [u], not [ü]. (And /a/ after /o/ also should become [o], not [ɔ]).



In order to solve this problem, we would have to add a sort of readjustment rule to change [ü] and [ɔ] to [u] and [o], respectively. Or we should add [back] and [low] to the rule formulation. But these considerations would either complicate the grammar or obscure the nature of rounding harmony in Yawelmani.

Within the framework of underspecification, however, the harmony rule is simply expressed as (37).



By (37), when the feature value [+round] is supplied to the underlying representations of /i/ and /a/, the feature specifications for /i/ and /a/ will become identical to those of /u/ and /o/.

| | | | | | | |
|---------|---|-----|-----|---|-----|---------------------------|
| (38) a. | H | i | a | o | u | Underlying matrices |
| | R | - | - | + | + | |
| | | | | | | |
| | H | <+> | - | - | <+> | After [high] default rule |
| | R | + | + | + | + | |
| | | | | | | |
| | H | + | - | - | + | After Harmony |
| | R | <+> | <+> | + | + | |

Finally, after Harmony, the redundancy rules discussed already will spell them out as [u] and [o], respectively.

3.1.3. Dissimilation

Yawelmani also has a rule which operates in certain noun paradigms to insert a vowel with a value for [high] opposite that of the preceding vowel.

(39) Dissimilation

$\emptyset \rightarrow i / \{a, o\} ______$

$\emptyset \rightarrow a / \{i, u\} ______$ in certain morphological contexts.

Examples are given in (40). (The results of Harmony, Vowel Shortening, and Epenthesis are not represented here.)

| (40) | | singular | plural | |
|------|---------------------------|----------|----------|-------------------|
| a. | insert / i / after / a /: | naʔaad | → naaʔid | 'older sister' |
| b. | insert / i / after / o /: | nopoop | → noopip | 'father' |
| c. | insert / a / after / i /: | niʔiis | → niiʔas | 'younger brother' |
| d. | insert / a / after / u /: | nusuus | → nuusas | 'parental aunt' |

With full specification, the rule formulation becomes highly complex since alpha notation is used to capture the values of [back] and [low], as well as [high].

- (41) $\emptyset \rightarrow \begin{bmatrix} \alpha\text{high} \\ -\alpha\text{low} \\ -\text{round} \\ -\alpha\text{back} \end{bmatrix} / [-\alpha\text{high}] \text{ ____ } \text{ in certain morphological contexts.}$

Here the dependence of [back], in particular, and [low] on the values of the preceding vowel for [high] is an unintuitive move at best. (Archangeli 1984:207)

With underspecification, however, we can simply insert a [-high] matrix. Then the redundancy rules will spell out [i] or [a].

- (42) Dissimilation

$\emptyset \rightarrow [\alpha\text{high}] / [-\alpha\text{high}] \text{ ______ } \text{ in certain morphological contexts.}$

As we have seen so far, the theory of underspecification simplifies not only the underlying representation but also rule formulation. Moreover, it also captures the generalization of phonological processes. Furthermore, it is observed that the three different rules, Epenthesis, Harmony and Dissimilation converge on the same underlying representation of vowels.

3.2. Redundancy-Rule Ordering Constraint

3.2.1. Interaction of redundancy rules and phonological rules

So far we have seen that redundancy rules fill in missing feature specification in underlying representation, and that, by the Distinctness Condition (10), redundancy rules just insert feature values, but do not change the already specified values. Moreover, there are certain constraints on the ordering of redundancy rules. For example, we have observed that they are subject to the Elsewhere Condition; if a language particular rule, the harmony rule in Yawelmani for example, supplies a value for some unspecified feature, this language particular rule takes precedence over the redundancy rules. In this section, we discuss another constraint on the ordering of redundancy rules and see how this constraint explains the interaction of redundancy rules and phonological rules.

According to Archangeli (1984), all redundancy rules are expected to apply as late as possible.⁷ However, it is also claimed that not all redun-

⁷ This contrasts to the assumptions in SPE and in Kean (1975), where it is assumed that rules providing feature values apply prior to any phonological rule.

dancy rules may be postponed until the last moment, since, in their structural descriptions, certain phonological rules refer to features which should be supplied by redundancy rules. Archangeli (1984:85) thus proposes the Redundancy-Rule Ordering Constraint (RROC henceforth) as follows.

(43) Redundancy-Rule Ordering Constraint (RROC)

A redundancy rule assigning “ α ” to F, where “ α ” is “+” or “-”, is automatically ordered prior to the first rule referring to [α F] in structural description.

By the RROC, along with the Elsewhere Condition, rule ordering among phonological rules and redundancy rules are predictable.⁸

Consider the phonological rules in (44a) and the redundancy rules in (44b).

- (44) a. i. $A \rightarrow B / \text{ ______ } [+F]$
 ii. $[+F] \rightarrow B$
 b. i. $[\] \rightarrow [+F] / \text{ ______ } Q$
 ii. $[\] \rightarrow [-F]$

The environment of the phonological rule (44ai) refers to [+F] and the focus of the rule mentions [+F] in (44aii). Thus, as the redundancy rule (44bi) supplies [+F], it should be ordered before the phonological rules (44ai) and (44aii). Then, by the Elsewhere Condition, (44ai) and (44aii) precede (44bii). Consequently the rules in (44) are automatically ordered as shown in (45), by reordering (44bi) only.⁹

- (45) b. i. $[\] \rightarrow [+F] / \text{ ______ } Q$
 a. i. $A \rightarrow B / \text{ ______ } [+F]$
 ii. $[+F] \rightarrow B$

⁸ The formal difference between redundancy rules and phonological rules are described as follows. (Archangeli 1984:86 note 18)

In the structural description of phonological rules, a feature or structure to be changed is necessarily mentioned, while redundancy rules are not since they never change structure. Redundancy rules can change structure/value in a derived environment if the redundancy rule does not specify that the segment being changed has no structure/value.

⁹ Note that a similar constraint was proposed but rejected in SPE, because it was conceived of as a constraint on derivations, not on rule order. With the RROC, however, examination of the grammar itself, not of specific derivations, decides whether the grammar is well formed or not.

b. ii. []→[- F]

3.2.2. Automatic consequences

Now we discuss how the RROC contributes to phonological theory both theoretically and practically. First of all, from a theoretical point of view, we may wonder whether the underspecification theory allows a ternary use of binary features and is thus subject to the objections raised by Lightener (1963) and Stanley (1967). In Lightener (1963) and Stanley (1967), it was observed that if a feature F is represented as any one of [+F], [-F] and [] (or [0F]) in the same environment, three distinct matrices can be derived from these matrices, since [] may have the role of a third feature value. By the RROC, however, there exists no possibility in the underspecification theory for a three-way distinct matrix such as (46).

(46) X Y Z
 F + -

In other words, the RROC forces the redundancy rule providing [+F] or [-F] and so filling in Z to apply prior to the first phonological rule referring to that value for [F] in the structural description. Thus the RROC automatically reorders the rules in (47) into those in (48) and gives (49).

(47) phonological rule: a. []→[- G]/[_____, + F]
 redundancy rule: b. []→[+ F]
 c. []→[+ G]

(48) b. []→[+ F]
 a. []→[- G]/[_____, + F]
 c. []→[+ G]

(49) X Y Z
 F + - +
 G

As a consequence, there is no motivation for positing the underlying representation (46) and the Lightener-Stanley objection does not hold here.

Second, the alpha notation can only be used to refer to both “+” and

“-” as distinct from each other. If a phonological rule refers to [αF], then both [+F] and [-F] must be specified before the application of the rule. For example, we already observed the underspecified Yawelmani vowel system and Harmony which spreads [+round] by referring to [αhigh] in the environment. The RROC will fill in the value [+high] before the application of Harmony, resulting in the following matrices.

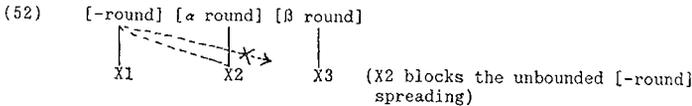
$$(50) \text{ a. } \begin{array}{ccccc} & i & u & a & o \\ \text{H} & & + & - & \\ \text{R} & & + & + & \end{array} \Rightarrow \text{ b. } \begin{array}{ccccc} & i & u & a & o \\ & + & + & - & + \\ & + & + & + & + \end{array}$$

Then harmony applies resulting in (51a), and the redundancy rules supply the rest of the feature specifications as shown in (51b). (The vowel pairs which undergo Harmony are represented with the the double lines.)

| | | | | | | | | | | |
|---------|---|----------|----------|----------|----------|----------|----------|----------|----------|------------------|
| (51) a. | | <u>u</u> | <u>i</u> | <u>o</u> | <u>i</u> | <u>o</u> | <u>a</u> | <u>u</u> | <u>a</u> | Underlying rep. |
| | H | + | + | - | + | - | - | + | - | Harmony |
| R | + | + | + | - | + | + | + | - | | |
| b. | B | + | + | + | - | + | + | + | + | Redundancy rules |
| | L | - | - | - | - | - | - | - | + | |
| | | <u>u</u> | <u>u</u> | <u>o</u> | <u>i</u> | <u>o</u> | <u>o</u> | <u>u</u> | <u>a</u> | Phonetic rep. |

If Harmony applies before filling in all values for [high], we should define “0”, as distinct from or non-distinct from a specified value. But the RROC prevents this problematic possibility.

Third, for Yawelmani Harmony, if we want to spread [-round] instead of [+round], then [-round] should be specified in the Yawelmani vowel alphabet (50a) by the RROC. But when [-round] is specified, all X-slots bear some value for [round] and unbounded spreading may not be applied consequently.



As we see in (52), the Redundancy-Rule Ordering Constraint predicts asymmetries in rule spreading.

Therefore, the Redundancy-Rule Ordering Constraint contributes to phonological theory by providing several automatic consequences which

enable us to avoid any problematic possibilities.

3.3. Underspecification vs. markedness

As we have seen so far, within the theory of underspecification, any predictable feature or feature value is left out in the underlying representation and it is supplied later by a redundancy rule during the course of phonological derivation. A similar proposal, however, was made in the early generative approach, such as SPE, under the name of "markedness theory".¹⁰ The markedness theory was intended to describe the universal implicational relations among features and the markedness degree of segments. For example, in addition to "+" and "-", the markedness of a feature is represented by the value "m", while the unmarked value is left out in the lexical representation, using the symbol "u". The representations [u voice, -sonorant] and [m voice, -sonorant] would thus be interpreted as [-voice, -sonorant] and [+voice, -sonorant] respectively. Therefore, similar to the case of underspecification, a feature matrix unmarked for all features is not represented phonologically. The left-out matrices are later filled in by the so-called "Morpheme Structure Rules" which consist of Segment Structure Rules and Sequence Structure Rules. Segment structure rules are in some sense similar to redundancy rules of the underspecification theory since they supply predictable feature matrices. Sequence structure rules, on the other hand, fill in the features which are also predictable, but this predictability is derived from the sequential phonemic constraints of a specific language. However, there are at least two problems here. First, a phonological generalization may be achieved by applying both sequence structure rule and later phonological rule, and this sort of process is not only redundant but also ad hoc. Second, as we have seen in the previous section, we may have to confront the problem of undesirable ternary use of binary features, which was already criticized by Lightener (1963) and Stanley (1967). Of course, we may be able to avoid this problem by applying morpheme structure rules before phonological rules, enabling phonological rules to apply to fully specified matrices. This alternative, however, cannot be accepted since it would then be impossible to take

¹⁰ See SPE (chapter 9) for details on the markedness theory. You may also refer to Cheun (1977:138-169) for discussion on this theory.

advantage of the simplicity of lexical representation.

Overcoming all these problems, the theory of underspecification differs from the markedness theory of SPE and Kean (1975) in several ways (Archangeli 1984, 1988). First, underlying representations (i.e., features and feature values) are language dependent in the underspecification theory, but universal in the markedness theory. Moreover, as the underlying representations vary, the features representing the segment and the rules filling in missing values on the segment also vary. Second, the redundancy rules of a language in the underspecification theory interact with the phonological rules, governed by the Redundancy Rule Ordering Constraint, the Distinctness Condition, the Elsewhere Condition, and the Strict Cycle Condition which will be discussed in the next section. (See also Kiparsky (1982:41) for details on the strict cycle condition). Redundancy rules apply as late as possible otherwise. In the markedness theory, on the contrary, there is no rule interaction since the markedness rules immediately precede any phonological rules, in order to supply the specified feature matrices necessary for the application of the phonological rules. Third, underspecification plays a major role in all aspects of phonology, markedness theory is mostly limited to the simplification of distinctive features.

4. Interaction with other fields

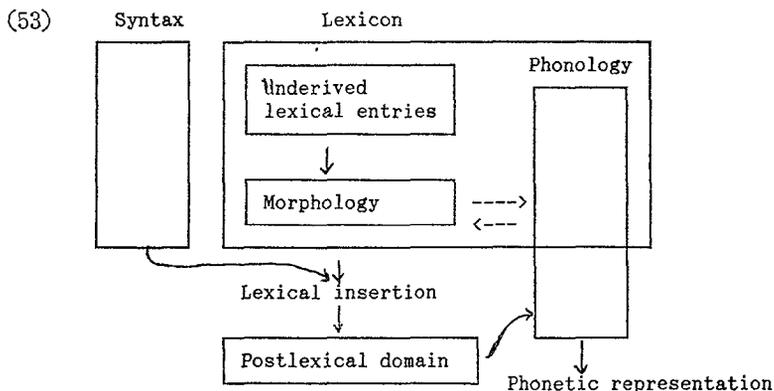
In this section, it will be shown how the underspecification theory contributes to phonology by interacting with other phonological theories. For this purpose, I discuss the roles of underspecification in Lexical Phonology and Feature Geometry, in which it will be shown that underspecification contributes not only to restrict phonological theory, but also to simplify phonological description.

4.1. Underspecification in Lexical Phonology

The basic concept of Lexical Phonology is that a certain class of phonological rules applies only in a (phonologically as well as morphologically) derived environment, and that the lexicon, consisting of several levels, is the domain of not only morphological rules, but also certain phonological rules. It was developed based on those morphological works by Siegel (1974), Aronoff (1976) and Allen (1978), cooperating with the several

revised versions of "Alternation Condition" of Kiparsky (1973) and the cyclic theory of Mascaró (1976) and Halle (1978).¹¹

During the development of Lexical Phonology, it was discovered that those rules applying only in derived environments are cyclic non-automatic neutralizing rules, unlike those noncyclic automatic neutralization rules. Lexical Phonology thus proposes a dichotomy of rule type: lexical (cyclic) and postlexical (noncyclic). Therefore, according to the model of Lexical Phonology as sketched in (53) below, when morphological operation is finished, the output exits the lexicon, forming the lexical representation, and, after exiting from the lexicon, it undergoes postlexical rules.¹²



Here we note that as lexical rules are supposed to interact with morphological rules in the lexicon, the cyclicity of lexical rules is not a special condition on each rule, but it follows from the organization of the model of the lexical phonology, *viz.*, lexicon. In other words, lexical rules, applying in the lexicon, are categorized as cyclic since they may reapply to the output of morphological operation, which produces a derived environment.

Due to the dichotomy of rules in Lexical Phonology, lexical rules cannot operate in the postlexical domain and this restriction is governed by the constraint on phonological rule application, the "Strict Cycle Condition"

¹¹ See Kaisse & Shaw (1985) for an explanatory overview of Lexical Phonology.

¹² This model reflects those proposals of standard Lexical Phonology of Mohanan (1982) and Kiparsky (1982). See other views on the model of Lexical Phonology in Halle & Mohanan (1985) and Booij & Rubach (1987).

by Kiparsky (1985:89) reformulating the earlier version (Kiparsky 1982:41).¹³

(54) Strict Cycle Condition

If *W* is derived from a lexical entry *W'*, where *W'* is nondistinct from *XPAQY* and distinct from *XPBQY*, then a rule *A*→*B*/XP___QY cannot apply to *W* until the word level.

The Strict Cycle Condition prevents phonological rules from changing material of a previous cycle, unless the context for the rule is created on the previous cycle. Thus, lexical rule applications are cyclic and are therefore subject to the Strict Cycle Condition. For example, in (55), as the output of each cycle is a (derived) lexical entry, the cyclic application of the English lexical rule, Trisyllabic Shortening, to those non-derived words is blocked by this Strict Cycle Condition. Such cases as the failure of Korean *t*-palatalization in non-derived words work the same way, as shown in (56).

(55) Trisyllabic Shortening

V→[-long]/ _____ C₀V_iC₀V_j
[-stress]

e.g. [[divin] ity], [[seren] ity]
 /ay/→[i] /ey/→[ɛ]

(cf. [nightingale], [ivory]
 /ay/→*[i] /ay/→*[i])

(56) *t*-palatalization (Korean)

t → c / _____ {i, y}

e.g. [[mat] i] 'eldest', [[kut] i] 'firmly'
 /t/→[c]→[j] (c→j/V___V)

¹³ Kiparsky's first version (Kiparsky 1982:41) of the Strict Cycle Condition was proposed as in the following description.

a. Cyclic rules apply only to derived representations.

b. Definition: A representation ϕ is derived with respect to rule R in cycle j iff ϕ meets the structural analysis of R by virtue of a combination of morphemes introduced in cycle j or the application of a phonological rule in cycle j.

As this Strict Cycle Condition is a constraint on rule application, it differs from the earlier Alternation Condition which is a constraint on underlying representation.

(cf. [mati] 'node')

/t/→*[j]

On the other hand, postlexical rules are not allowed to apply in the lexical domain by the principle of Structure Preservation. In English, for example, the voicing feature is distinctive only for obstruents, not for sonorants. Kiparsky (1985:92) expresses this by a marking condition which prohibits voicing from being marked on sonorants in the lexicon.

(57) * $\left[\begin{array}{l} \alpha \text{ voiced} \\ +\text{sonorant} \end{array} \right]$ ¹⁴

A language, like Korean, in which voicing is entirely non-distinctive, would have the following condition.

(58) * $[\alpha \text{ voiced}]$

In Kiparsky (1985), Structure Preservation means that marking conditions such as (57) and (58) must be applicable not only to underived lexical representations but also to derived lexical representations, including the output of word-level rules. In other words, the same rule may apply both lexically and postlexically, but because of Structure Preservation and underspecification the rule may operate on a different set of inputs and yield a different set of outputs. For example, the marking condition (57) entails that voiced obstruents and sonorants form a natural class [+voiced] only in the postlexical domain in English. In the lexical domain, sonorants remain unspecified for voicing and their union with voiced obstruents would require a disjunctive specification, {[+sonorant], [+voiced]}. In the same manner, the class of voiced obstruents can be specified in the lexical domain simply as [+voiced], but needs the additional specification [−sonorant]

¹⁴ According to Mohanan (1990:21), however, Kiparsky's marking condition (57) causes an unnecessary duplication problem since it is a combination of *[+son, −voice] and *[+son, +voice]. What Kiparsky's solution does is to use both the structure-building rule "[+son] ↓ [+voice]" and the constraint "[*+son, −voice]" within the same theory. Mohanan thus criticizes this as follows:

"If we want to appeal to the "blocking-type" structure preservation, we must abandon the structure-building rules in favor of constraint. And in a theory that employs constraints, structure-building rules are redundant. This result has important consequences for radical underspecification, which crucially depends on structure building rules."

in the postlexical domain. Therefore, lexical voicing assimilation in English is triggered by and applies to obstruents as in (59a), but not sonorants as in (59b).

(59) a. a [d̥z], wi[t̥+θ] (cf. *a[tz], *a[bs])

b. to[k̥n], war[m̥+θ]

On the other hand, postlexical voicing assimilation in English can not only apply to sonorants, as in (60a), but also be triggered by sonorants, as in (60b).

(60) a. p[̥]ay, s[̥]ow, c[̥]y

b. back[s̥], bag[z̥], badge[iz̥]

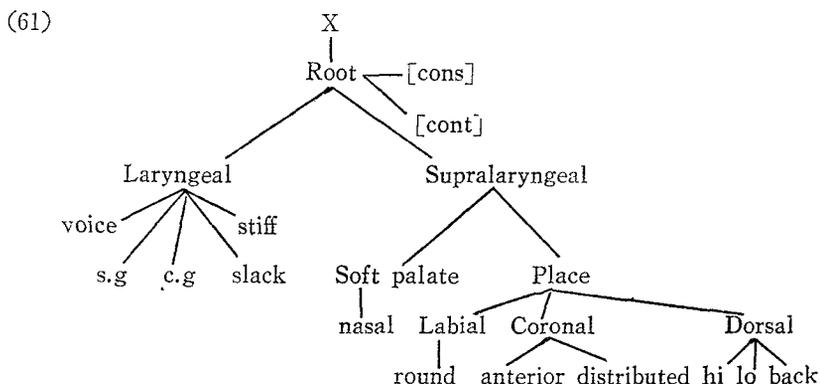
Based on the discussions so far, we see that Structure Preservation, related with the underspecification theory, contributes to restrict phonological theory since it enables us to determine that any rule introducing marked specifications of lexically non-distinctive features is postlexical.¹⁵ In other words, Structure Preservation prevents a phonological rule from application in the lexical domain if it specifies features which are non-distinctive in the underspecified underlying representation. Therefore, those rules such as aspiration and glottalization cannot be lexical in English since they are structure-changing, rather than structure-building, and thus have to be postponed until the postlexical domain.

4. 2. Underspecification in Feature Geometry

A nonlinear approach in phonological theory was originally motivated from Goldsmith (1976). This sort of framework has been applied to

¹⁵ Thus, in Kiparsky (1985), it is assumed that the partial devoicing in the sonorants in words like those in (60a) are due to the postlexical application of the same rule that lexically devoices the /v/ in *fifth* (←*five*) and *bereft* (←*berieve*). According to Mohanan (1990:30, note 26), however, this assumption cannot be correct as the sonorants in *dreamt* and *dealt* do not undergo partial devoicing. Furthermore, he claims that it is unclear in Kiparsky's analysis why the relaxation of structure preservation in the postlexical module should derive full devoicing of the obstruent in *Jack[s̥] here* (cf. *John[z̥] here*), but only partial devoicing of the sonorant in *cry*.

syllable, harmony, reduplication and other suprasegmental aspects. (Kahn 1976; Clements & Keyser 1983; Pulleyblank 1983; Levin 1985, etc.) In recent years, moreover, various attempts have been made to analyze even features within a framework of nonlinear phonology, under the name of "Feature Geometry." According to Clements (1985) and Sagey (1986), for example, it is claimed that phonological features are organized nonlinearly in a hierarchical manner. (See Ahn (1990a) for the various proposals in Feature Geometry.) Thus, a phoneme is composed of a root node dominating a certain number of class (or articulator) nodes and each class node is again composed of one or more terminal features. In (61) below, we see the model proposed by Sagey(1986).

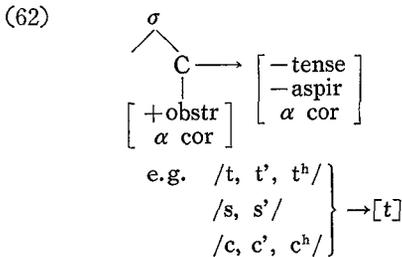


Now it will be shown that this type of feature representation invokes another type of underspecification, which is called inherent "node-dependent" underspecification.¹⁶ This new view on underspecification substantially modifies the earlier, i.e., radical, theories of underspecification in Kiparsky (1982) and Archangeli(1984, 1985, 1988). For instance, in Sagey's model, class nodes are represented only for their presence or absence of an articulator, whose terminal feature may be specified with a plus or a minus

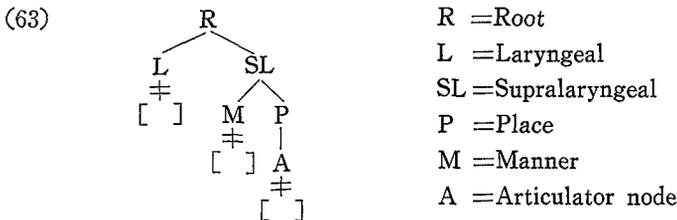
¹⁶ There is another type of inherent underspecification, called "inherent monovalent underspecification." (Archangeli 1988:190) This idea is similar to the concept of "privative" feature opposition in Trubetzkoy (1939). According to this view, if some feature is monovalent, then that feature is either present or absent. For example, if [voice] is monovalent, segments are specified as [voice] or unspecified for [voice], but no segment is marked as [-voice].

value. Thus there is no, for example, “-coronal” node in this model. In other words, a segment not specified for a certain articulator node, such as coronal, may not be specified for any of the bivalent terminal features that the class node dominates, e.g., [anterior] and [distributed]. Thus it is claimed that underspecification of the features, such as [anterior], [round], and [back], is inherent for all segments except those characterized by the relevant class node.

The merit of node-dependent underspecification is not only the simplification of phonological description, but also its explanatory power during the course of phonological derivation. For example, Korean has a rule of syllable-final obstruent neutralization, which was described as (62).



This nonlinear rule is quite complex by employing the α -notation. In the theory of feature geometry, however, these neutralization processes can be described in a uniform as well as a simpler way. (K.-H. Kim 1987)¹⁷



(64) Redundancy rules:

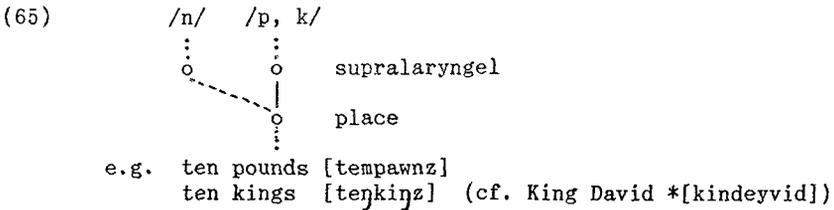
R: [] → [-son]

¹⁷Here we derive the prediction that the output of the neutralization rule is the unmarked value. It is shown, however, that this may not be universal. For example, Harris (1984) shows that neutralization in Spanish results in the coronal nasal in some dialects but the velar nasal in others.

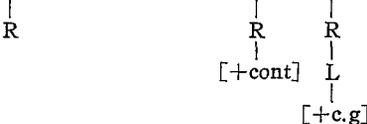
- L: [] → [-s.g]
- [] → [-c.g]
- [] → [-voice]
- M: [] → [-cont]
- [] → [-nas]
- [] → [-lat]
- P: [] → coronal
- cor: [] → [+ant]

In other words, as shown in (63), the obstruent neutralization is described as a simple process delinking all the terminal features. (K.-H. Kim 1987)¹⁸ And we of course need the default rules listed in (64) but, as they are needed anyway in Korean phonology, they do not give any burden to the grammar.¹⁹

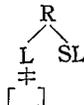
Furthermore, it has been attested that coronals assimilating to noncoronals are very common in natural languages, while cases of noncoronals assimilating to coronals are very rare. For example, English allows syllable final [mp], [nt] and [mt], but not *[np]. Now, employing the concept of underspecification, we can assume that coronals are unmarked and thus



¹⁸ K.-H. Kim's view on this node-dependent underspecification is not radical. If we want to posit a more underspecified rule formulation, we should delink even relevant class nodes, not just terminal features. Thus we can represent /t/ simply as X, and /s/ and /t'/ as X and X, respectively. (Ahn 1990b)



¹⁹ Final devoicing in German or many Slavic languages can be described in a similar way. (Ahn 1990a:41)



universally unspecified for place.

In (65), it appears that it is simpler to use the underspecification theory depending on structure-building rules rather than the full specification theory employing structure changing rules.²⁰

5. Other Views

In Sections 2 and 3, I have already discussed the so-called “radical” views on underspecification by Kiparsky (1982) and Archangeli (1984, 1985, 1988). In the previous discussion in 4.2, however, another view on underspecification was observed, invoked by the theory of Feature Geometry. In this section, I will also discuss another modified view on underspecification, Contrastive Specification, advocated by Steriade (1987).

Contrastive specification assigns specific values to a feature in underlying representation only where that feature is being used to distinguish segments in the respective contexts; non-contrastive values are left blank. In Latin, for example, Steriade claims that both [+lateral] and [–lateral] should be present for the underlying representations of the liquids, /l/ and /r/. As shown below, the adjectival suffix *-alis* (66a) has the alternative form *-aris* (66b) if the preceding liquid is /l/. In (66c), however, *-alis* does not change to *-aris* due to the intervening /r/, even though the liquid /l/ precedes the suffix.

- (66) a. nav-*alis* ‘naval’ flor-*alis* ‘floral’
 b. sol-*aris* ‘solar’ milit-*aris* ‘military’
 c. liber-*alis* ‘liberal’ litor-*alis* ‘of the shore’

Steriade argues that the liquids in Latin are distinguished by the feature [lateral], and only these segments, but no other segments, are specified for this feature: /l/ as [+lateral] and /r/ as [–lateral]. Under this assumption, dissimilation is interpreted as a rule eliminating adjacent identical sequences of [lateral] since all the consonants are transparent to this rule.

²⁰ But also note Mohanan (1990:31) claiming that this assumption conflicts with the observation that a number of phonological regularities at Stratum 1 in English require that alveolars be specified for place.

$$(67) \quad * \begin{array}{c} [+lat] \quad [+lat] \\ | \quad | \\ \dots X \dots + \text{alis} \end{array} \rightarrow \begin{array}{c} [+lat] \quad [+lat] \\ | \quad \neq \\ \dots X \dots + \text{alis} \end{array}$$

However, if a $[-lat]$ intervenes two $[+lat]$ features, dissimilation does not apply since the two $[+lateral]$ features are not adjacent.

$$(68) \quad \begin{array}{c} [+lat] \quad [-lat] \quad [+lat] \\ \quad \quad \quad \quad \quad \quad | \\ \quad \quad \quad \quad \quad \quad \text{liber} \quad + \quad \text{alis} \end{array}$$

Thus, Steriade claims that both $[+lateral]$ and $[-lateral]$ should be specified for segments for which $[lateral]$ is distinctive.

In an argument against this contrastive specification, Archangeli (1988) claims that the same effect can be obtained under radical underspecification by inserting the unspecified value $[lateral]$ on all liquids, not on any other segments. She argues that this result can be achieved in a principled manner if structure preservation restricts the feature $[lateral]$ to non-nasal sonorants and if the rule of dissimilation refers to $[-lateral]$ by the ordering principle of radical underspecification theory. This alternative proposal, however, looks more complicated than the approach by contrastive specification. Moreover, we also note that it needs additional devices such as the ordering principle and structure preservation, which could be subject to other criticism. (Mohanani 1990) Furthermore, the alternative view of contrastive specification has been vigorously attested in many recent works. (Mester & Itô 1989; Yip 1989; Kang 1990).

More recently, on the other hand, there appear various doubts on the bases of radical underspecification. Mohanani (1990), for example, extensively discusses the problems of Radical Underspecification, which can be sketched roughly as follows. First, radical underspecification depends on the mechanism of segmental structure building rules but it is unmotivated and redundant. Second, although both radical underspecification and contrastive underspecification subscribe to the assumption that underlying representations may not contain the specification of predictable information, this assumption cannot be maintained. Finally, it is shown that radical underspecification theories assume that the value specified in underlying representations is the marked one. But radical underspecification theories cannot adequately express the asymmetry of feature values that the above assumption is expected to

express. (For example, see note 14 for his arguments against the use of structure preservation by radical underspecification theories.)

Based on his criticism, Mohanan goes further to suggest a possibility of reviving the concept of "linking convention" in SPE. For example, underspecification and structure-building rules simplify the statement of phonological alternation but structure-changing linking rules, or constraints and repair, will yield equally simple or better results. For instance, in analyzing Yoruba [ATR] harmony, he showed that by allowing fewer rules, his alternative analysis was much simpler than the radical underspecification approach by Archangeli & Pulleyblank (1989) allowing more rules as well as constraints.

Furthermore, Mohanan (1990:26) also expresses a strong doubt on the status of the maximally underspecified consonant, considering many analyses using underspecification on the nature of coronals across languages. Note that Archangeli (1988) states that the maximally underspecified segment in a language is not identical across languages: /i/ in Yoruba, /e/ in Tiv, /a/ in Paseigo. On this, Mohanan claims that a theory allowing free choice of /e/, /a/, etc. as the maximally underspecified vowel, also allow the free choice of coronal, velar, or labial or even uvular as the maximally underspecified consonant. Such a theory cannot make cross linguistic predictions such as "In no language can the front rounded vowel be the epenthetic vowel." or "In no language can the uvular consonant but not the coronal consonant undergo place assimilation." He thus states that the claims about underspecification capturing crosslinguistic patterns of the special status of coronals are inconsistent with the free choice of vowels for underspecification.

Additionally, related with this argument, we find a possible problem about the criteria determining the least marked vowel in a language. According to Archangeli (1984, 1985), the least marked vowel is to be determined by epenthesis or vowel harmony. Thus, in Spanish, the epenthetic vowel /e/ is determined as the default vowel, while, being neutral to vowel harmony, /e/ is considered as the default vowel in Khalkha Mongolian. However, this sort of mechanism may run into a trouble if a language does not have vowel epenthesis or if a language has more than two vowels neutral to vowel harmony. (In fact, Korean has two neutral vowels in

vowel harmony, as revealed in Ahn (1985) and Sohn (1987).) Therefore, what we need to develop are more devices or at least a better device to find the least marked segment in a language. All of these problems and others should be solved by investigating the underspecification theory much more closely.

6. Concluding summary

Throughout this paper, we have observed that theory of underspecification is not only about the simplicity of segmental features. Rather, we can achieve not only the simplicity of underlying representation, but also the overall generalization and simplicity of phonological specification. Thus the theory of underspecification provides a more systematic way of providing a phonological description with minimal specifications in underlying representation. Moreover, I also discussed how this theory fits in other fields of phonology, such as Lexical Phonology and Feature Geometry.

In Section 2, the motivation and the governing principles of the underspecification theory were discussed. Here it was described how the theory is theoretically founded, based on those principles such as Feature Minimization Principle and the Distinctness Condition. Also discussed were the three types of redundancy rules, complement rules, default rules, and the learned rules, and how they supply redundant feature specifications. Moreover, it was noted that redundancy rules fill in missing feature specification in underlying representation, and that redundancy rules just insert feature values, but do not change the already specified values. Furthermore, it was observed that the Distinctness Condition relieves the underspecification theory from a ternary use for binary features, by which the earlier criticism on the markedness theory cannot apply here.

In Section 3, I discussed the theoretical implications which the underspecification theory provides. For instance, in 3.1, I observed that the theory of underspecification simplifies not only the underlying representation but also rule formulation, and that it also captures the generalization of phonological processes. Moreover, in 3.1.2, it was observed that the three different rules, Epenthesis, Harmony and Dissimilation converge on the same underlying representation of vowels.

In 3.2, the interaction among phonological rules and redundancy rules

was discussed, including certain constraints on the ordering of redundancy rules. It was argued that by the Redundancy-Rule Ordering Constraint, along with the Elsewhere Condition, rule ordering among phonological rules and redundancy rules are predictable. Moreover, the Redundancy-Rule Ordering Constraint also makes it possible to block the possibility for a three-way distinct matrix, which was subject to Lightener-Stanly's problems. Furthermore, the Redundancy-Rule Ordering Constraint contributes to phonological theory by providing several other automatic consequences which enables us to avoid any problematic possibility.

In 3.3, it was argued that the theory of underspecification differs from the markedness theory of SPE and Kean (1975) in several ways which the markedness theory lacks, such as language particular as well as universal application and interaction with phonological rules. Moreover, it was also argued that underspecification plays a major role in all aspects of phonology, while markedness theory is mostly limited to the simplification of distinctive features.

In Section 4, the interaction of the theory of underspecification interact with other fields of phonology was considered. First, in 4.1, it was shown how the underspecification theory, cooperating with Structure Preservation, contributes to restrict phonological theory. For example, Structure Preservation prevents a phonological rule from application in the lexical domain if it specifies features which are non-distinctive in the underspecified underlying representation.

In 4.2, it was shown that the theory of Feature Geometry invokes another type of underspecification, which is called inherent "node-dependent" underspecification. In other words, a segment not specified for a certain articulator node, such as coronal, may not be specified for any of the bivalent terminal features that the class node dominates, e.g., [anterior] and [distributed]. Then it was argued that the merit of node-dependent underspecification is not only the simplification of phonological description, but also its explanatory power during the course of phonological derivation.

Finally, in Section 5, different views on "radical underspecification" theories were presented. Here I first discussed the theory of Contrastive Specification by Steriade, which assigns specific values to a feature in underlying representation only where that feature is being used to distinguish

segments in the respective contexts. Then I briefly sketched the strong criticism by Mohanan on radical underspecification. Finally, some possible problems in the underspecification theory, which should be further investigated, were discussed.

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