ON THE BASES OF RADICAL UNDERSPECIFICATION*

Radical Underspecification theories omit from underlying representations the specification of redundant feature values as well as one member of each contrastive pair of feature values. These theories also crucially employ structure building rules, delinking rules, and constraints on representations. This paper attempts to identify the empirical substance that these formal devices aim to express, and thereby to evaluate the claims of Radical Underspecification. The basic insights of Radical Underspecification theories are the preservation of distributional regularities in patterns of alternation, and the asymmetric status of feature values in distribution and alternation. A careful examination reveals that the formalism of Radical Underspecification is neither successful nor necessary in expressing these insights.

1. Introduction

1.1. *The Mechanics of Underspecification*

Theories of phonological underspecification are based on the formal device of omitting certain kinds of specifications from underlying representations and supplying them at a subsequent stage of the derivation through structure building rules. Most theories subscribe to assumption (1), from Halle (1959) and Chomsky and Halle (1968) (henceforth SPE):

(1) Underlying representations may not contain the specification of predictable information.

In addition, theories of "radical" underspecification (e.g. Kiparsky (1982, 1985), Pulleyblank (1983), Archangeli (1984, 1988)) subscribe to either (2a.i)) or (2a.ii).[1] Those that subscribe to (2a.i) also subscribe to (2b):

(2)a. Underlying representations may not contain the specification of both values of a feature

* I am grateful to David Ingram, Michael Kenstowicz, Tara Mohanan, Carol Paradis, Douglas Pulleyblank, Joseph Stemberger, and the reviewers of NLLT for extensive and valuable comments and criticisms on earlier versions of this paper which have resulted in considerable improvement in both content and exposition. I have also benefitted from discussions with Lubna Alsagoff, Diana Archangeli, Jared Bernstein, Yong Mee Cho, Larry Hyman, Paul Kiparsky, Will Leben, John McCarthy, and Bill Poser.

[1] These assumptions are not shared by theories of "contrastive" underspecification (e.g. Clements (1987), Steriade (1987), Christdas (1988)).

Natural Language and Linguistic Theory 9: 285–325, 1991.

(i) in the same environment.
(ii) in any environment.

b. The value specified in underlying representations is the marked one.

Assumption (2a.i), which we refer to as CONTEXT-SENSITIVE RADICAL UNDERSPECIFICATION (CSRA) is found in Kiparsky (1982, 1985). This theory also subscribes to (2b). The result of combining (2a.i) and (2b) is that *underlying representations may not contain the specification of unmarked information*, another assumption that is traceable ultimately to the "marking conventions" in SPE (pp. 404–415). While (2a.i) allows the use of both values of a given feature as long as they appear in different (segment-internal or segment-external) environments, (2a.ii) forces the choice of a single value independent of environment. The latter, CONTEXT-FREE RADICAL UNDERSPECIFICATION (CFRA) is found in Archangeli (1984, 1988) and Abaglo and Archangeli (1989: 478). Common to both CSRA and CFRA is the assumption that *feature values are asymmetric for every feature* (2a).

As pointed out in Pulleyblank (1983, 1986), if we accept CFRA, we have to abandon the assumption that information that is underlyingly specified is the marked information (2b). For example, in a language in which rounding is contrastive for front or back vowels, CFRA is forced to choose either plus or minus as the value that is specified for [round], irrespective of context. If the specified value of [round] is minus, then /i/ will be specified for its unmarked value [−round]. On the other hand, if the specified value of round is plus, then /u/ will be specified for its unmarked value [+round]. Thus, (2a.ii) and (2b) cannot both be part of the same theory.

A consequence of (2b) is that underlying feature values must be determined on universal grounds, as markedness cannot vary from language to language. Some researchers, such as Archangeli (1988) and Abaglo and Archangeli (1989) explicitly reject this position, and argue for the freedom to stipulate different segments as maximally underspecified in different languages. For them, "maximally underspecified" does not correspond to "maximally unmarked".

The purpose of this paper is to identify and evaluate the empirical basis of the two types of radical underspecification. In discussing underspecification theories, it is necessary to separate assumptions about the rule system (structure building vs. structure changing rules) from assumptions about the representations (assumption (1) above), even though these are related issues. I will first show that the mechanism of segmental structure

building rules is unmotivated and redundant, whether or not we subscribe to assumption (1). Independently required structure changing mechanisms of linking or repair can replace structure building rules. I will then show that (1) cannot be maintained. These arguments apply to both radical and contrastive underspecification. Finally, I will show that radical underspecification theories cannot adequately express the asymmetry of feature values that (2) is expected to express.

1.2. *The Uses of Underspecification*

CSRA uses underspecification primarily to express predictability (1) and asymmetry of feature values (2a). To illustrate, consider the vowel inventory /i e a o u/. Since all and only nonlow back vowels are round, the value of [round] is predictable from the values of [back] and [low]. Therefore (1) demands that the specification for [round] be omitted from the underlying representations of the vowels in this inventory. Similarly, since there is only one low vowel, the value of [back] is predictable for the [+low] vowel, and hence should be omitted. But, since a [−low] vowel can be either [+back] or [−back], the value of [back] is not predictable, and therefore (1) does not require the specification of [back] to be omitted from [−low] vowels.

The basic insight of Radical Underspecification is that the two values of a feature do not have the same status in phonological patterning. Thus, even though backness is not redundant in the above example, [+back] and [−back] may not function alike in distribution and alternation. In order to spell out the substance of the formalism, I will use the term DOMINANT to refer to one of the values of an asymmetric feature. The precise meaning of "dominant" will become clear as we proceed. Let us restate the assumptions in (2) as (2′):

(2′)a. Every feature has a dominant value
(i) in any given environment
(ii) irrespective of its environment
Non-dominant values may not be present in underlying representations.

b. Marked feature values are dominant.

Suppose that [+back] is the dominant value for [back]. It follows that [−back] will be omitted from the underlying representation of /i/. A structure building rule of the form [ ] → [−back] ("If the value of [back] is unspecified, specify it as minus.") will supply the value of [back] for /i/. Similarly, if the dominant value of [high] is negative, and that of [low]

is positive, it follows that /i/ will be completely unspecified for [high], [low] and [back]. (2′b) then implies that /i/ is the maximally unmarked vowel.

The notion of dominant and non-dominant feature values is important for the statement of generalizations observed in assimilation, neutralization, and epenthesis. Thus, it has been noticed that non-dominant feature values fail to trigger and block further propagation of assimilation (transparency), while dominant values fail to undergo assimilation. Similarly, it has also been noticed that the output of neutralization and epenthesis bear non-dominant feature values. Radical Underspecification claims that these generalizations follow from the representation of non-dominant as unspecified. CSRA claims that dominant and non-dominant feature values are determined by Universal Grammar. CFRA rejects this claim.

The distinction between "predictable" and "non-dominant" values outlined above requires a word of explanation. In a language that contrasts /i/ and /u/, the value of [back] is not predictable, since we cannot tell when a high vowel is [+back] or [−back] on the basis of any other information. Leaving /i/ unspecified for [back] is therefore a notation for [−back], with the convention that whenever the value of [back] is unspecified, we interpret it as [−back]. This convention has nothing to do with predictability. Yet, the literature on radical underspecification often confuses this convention with predictability. "Values are considered 'predictable' if either a context-free or a context-dependent rule can be formulated to insert the absent values" (Archangeli (1988: 192)). In its normal sense in empirical sciences, "predictable" is the opposite of "unpredictable" or "random": When one tosses a coin, the result is random or unpredictable because we cannot tell whether the outcome will be heads or tails. Suppose we use the following convention: if it is heads, we write [+head], and if it is tails, we write nothing. Since there is now a "rule" that interprets the absence of any specification as tails, Archangeli's notion of predictability would imply that tails is predictable, but heads is not! Clearly, we must not confuse rules that interpret linguistic notation with rules that predict what can be observed in linguistic phenomena.

Even though "predictability" may refer to the presence of any type of regularity (either distribution or alternation), its use in (1) is generally restricted to the regularity of distribution or the cooccurrence of units in a structure. The meaning of "predictable" in (1) can be explicitly stated: *If the cooccurence of units P_i and P_j is prohibited in structure α, the specification of $\sim P_i$ in an α containing P_j, and the specification of $\sim P_j$ in an α containing P_i are predictable.* To illustrate, if a language prohibits the cooccurrence of [+son] and [−voice] in a segment, then the specific-

ation [−son] is predictable in [−son, −voice] and the specification [+voice] is predictable in [+son, +voice]. Given this rationale, assumption (1) is equivalent to the requirement that all distributional regularities must be formally expressed in terms of rules (rather than constraints).

In addition to expressing predictability and dominance of feature values, underspecification has also been employed to express lexical exceptionality, or the distinction between alternating and nonalternating forms. For example, to account for the fact that *Malthusian* does not undergo palatalization, in contrast to *Parisian*, we may specify the coronal fricative of the former, but not the latter, as underlyingly [−high]; this specification prevents the spread of the palatalizing [+high] to the fricative in *Malthusian*. Here underspecification expresses neither distributional predictability nor markedness of information. Instead, it expresses the predictability of alternation.

This paper attempts to identify the substantive claims behind these uses of underspecification just reviewed to encode (a) predictability of distribution, (b) asymmetry of feature values, and (c) lexical exceptionality in alternation. I will clarify the cross-linguistic generalizations that theories of underspecification try to formalise, determine whether these are true generalizations, and check if they are indeed predicted by underspecification theories. I will also try to establish whether the predictions follow from assumptions (1) and (2), rather than other, independent assumptions.

Lest I be misunderstood, I should emphasize that my goal is not to propose a particular theory or formal device, but rather to clarify the substantive issues at stake in the use of underspecification and structure building rules, so that we can evaluate the claims in a meaningful fashion.

2. Predictability and Underspecification

What motivates elimination of predictable information from underlying representations (1)? This question is tied up with the issue of rule systems. That is to say, we must formulate our question as: what is the motivation for underspecification-and-structure-building-rules? In this section, I will show that the motivation for combining (1) with structure building rules is the need to account for the phenomenon of distributional regularities persisting in alternation.

2.1. *Formal Expression of Distributional Regularities*

2.1.1. *Rules and Constraints*

In order to evaluate how the combination of underspecification and structure building rules account for the persistence of distributional regularities in alternation, it is important to lay out the formal devices available to express distributional regularities, whether segment internal or cross segmental. Let us take the distribution of feature values within segments first. The restriction that English does not allow voiceless sonorants can be stated as a rule (3a), an implicational constraint (3b), or as a filter (3c).

(3)a. [+son] → [+voice]

b. If a segment is [+son], then it is [+voice]

c. *[+son, −voice]

SPE employs structure changing rules such as (3a). These rules apply whenever their structural conditions are met. For example, if the random combination of features ever produces the representation [+son, −voice], it will be immediately changed to [+son, +voice] by this rule. Either (3b) or (3c) will also forbid the appearance of [+son, −voice] in underlying representations (or in subsequent stages of the derivation, depending on where the constraints hold). Thus, any of the devices illustrated above can successfully capture segment internal distributional regularities.

In contrast to the formalisms illustrated in (3a–c), underspecifiation employs structure building rules. While the application of a structure CHANGING rule automatically overrides the prior conflicting specification, a structure BUILDING rule cannot override any prior specification and can only provide new information.[2] To put it differently, in a structure changing mechanism, the later specification overrides the prior specification; in a structure building mechanism, prior specification overrides later specification by default and complement rules. Unfortunately, the same notation (the arrow →) has been used in the literature to express structure building and structure changing rules. To avoid confusion, I will use "$\rightarrow_{sc}$" for

[2] There have been arguments in the literature that a structure changing rule that effects both deletion and addition is inherently more complex than a structure building rule that effects addition alone. (Archangeli and Pulleyblank (1986)). However, this holds only if a structure changing rule must *stipulate* the deletion of old information independently of the addition of new information. A nasal assimilation rule that says "Delink the place node of the nasal, and spread to the nasal the place node of the following plosive," would no doubt be more complex than "Spread to the nasal the place node of the following plosive." However, there is no reason to assume that the deletion of information needs to be stipulated in a structure changing rule that automatically overrides conflicting prior specification.

structure changing rules, and "$\rightarrow_{sb}$" for structure building rules. (3a) can then be more clearly formulated as (3a′), its structure building version being (3d):

(3)a′. [+son] $\rightarrow_{sc}$ [+voice]

d. [+son] $\rightarrow_{sb}$ [+voice]

Unlike (3a′), (3d) does not prevent the appearance of the structure [+son, −voice]. (3a′) overrides the prior specification [−voice] in this structure, changing it to [+son, +voice], but (3d) cannot do so. Therefore (3d) does not express the distributional restriction against voiceless sonorants.

One can think of two ways of rectifying this inadequacy of (3d). One solution is to assume, adopting CFRA (2a.ii) that the negative value of [voice] is not available to underlying representations in English, and therefore the combination [+son, −voice] cannot exist underlyingly in this language. The only possible feature specifications would then be {[+son] [+voice]} and {[+son]}. In the latter case, rule (3d) would insert the value plus for [voice].[3] However, this strategy fails when it comes to distributional gaps involving both values of segments. In Yoruba, for example, only mid vowels contrast in [ATR]. High vowels are redundantly [+ATR] (*[+high, −ATR]) and the low vowel is redundantly [−ATR] (*[+low, +ATR]). The assumption that [+ATR] is not available underlyingly rules out the structure [+low, +ATR], but it does not rule out the structure [+high, −ATR].[4]

A second strategy supplements structure building rules with constraints. For example, Kiparsky (1985: 92) proposes (3e) for Russian:

(3)e. *[+son, α voice]

(A [voice] specification cannot be linked to a segment that is [+son].)

An alpha constraint such as (3e) forbids the appearance of both values of a feature in a particular environment. It combines the statements in (3c) and (3f):

(3)c. *[+son, −voice]

f. *[+son, +voice]

[3] Implicit in Archangeli's (1988) "derivation" of the vowel inventory {i, e, a, o, u} in terms of "free combination of elements" is the assumption that only one feature value is available at the underlying level independently of contexts (assumption (2a.ii)) (See note (5) below).

[4] Within the analysis in Archangeli and Pulleyblank (1989), this structure would be a segment that is unspecified for both [high] and [low], but associated with [−ATR].

But (3f) is entirely redundant, since it merely rules out the predictable value of [voice] from underlying representations. In other words, the language particular constraint (3f) duplicates what the universal constraint in (1) already does. Therefore, (3e) should be simplified to (3c).

Once we recognize that (3e) is in effect (3c), and postulate this constraint for the statement of segment structure regularities, a surprising conclusion emerges. Given (3c) as a language particular constraint, language particular structure building rules like (3d) are totally redundant. Given the underlying representation [+son], the appropriate feature value for [voice] can be filled in by the following universal convention:

(4) Fill in feature values freely.

If the free filling in of the values of [voice] results in [+son, +voice], it will be consistent with (3c). If, on the other hand, it results in [+son, −voice], it will be filtered out by (3c).[5]

The conclusion that emerges from this discussion is as follows. Whether or not we subscribe to (1), we need either constraints or structure changing rules to account for distributional regularities. Given that we need either structure changing rules or constraints, structure building rules are entirely redundant. In a theory that employs structure changing rules, the missing feature values of an underspecified underlying representation will be supplied by the structure changing rules.[6] In a theory that employs constraints, these missing specifications will be supplied by the universal convention

[5] (4) is analogous to move alpha in GB syntax ("move everything freely"). Constraints such as (3b)/(3c) are analogous to the conditions on representations in GB (e.g. the binding conditions, ECP, case filter). I have not seen this proposal in the published literature on underspecification, but this possibility was pointed out by Kiparsky (p.c.) as a solution to the problem of affricates in Marathi raised in Joshi (1988)). An anonymous reviewer has suggested to me that (4) relates to the proposal in Archangeli (1988) whereby nonredundant specifications are freely combined (subject to constraint and default rules) to derive segmental inventories. According to Archangeli, the set of "possible segments" is derived from a "free combination" of elements in a feature inventory (1988: 194). Thus, she claims that the segment inventory /i, e, a, o, u/ is the result of combining the elements [−high], [+low] and [+back] in all the logically possible ways. This claim is inaccurate, since, as she herself notes, what yields a five vowel inventory instead of the six vowel inventory /i, e, æ, a. o,u/ is the rule [+low] → [+back] which guarantees that both {[+low], [+back]} and {[+low]} yield the segment /a/. In the absence of this rule, the more general default rule [ ] → [−back] would yield /æ/ from {[+low]} unspecified for backness. Thus, the segment inventory is not derived by a free combination of elements, but by the application of default rules to the combination. In a theory that employs the device in (4), the default rule [+low] → [+back] will be replaced by the constraint *[+low, −back], and the free combination of the elements [+high], [−high], [[+low], [−low], [+back] and [−back] subject to the constraint will yield the five segment inventory.

[6] A structure changing rule is capable of changing structure, but it is not necessary that its application always involve a structural change.

in (4), subject to the constraints. What, then, is the motivation for combining (1) with structure building rules in radical underspecification? Why should we demand that all distributional regularities be stated in terms of rules rather than constraints? In order to answer this question, it is necessary to see how distributional regularities persist in alternation.

2.2. *Relation between Distribution and Alternation in Phonology*

2.2.1. *Preservation of Distributional Patterns in Alternation*

The main preoccupation in phonological theory since the beginnings of generative phonology has been the characterization of regularities of distribution and alternation. Distribution is the systematic correlation between a property and the environment in which it occurs, such as feature values within the structure of a segment, or segments within a syllable or morpheme (co-occurrence). Alternation is the systematic correlation between two properties in related forms (co-variance).

It is well known that distribution and alternation are closely connected. An advantage of structure changing operations is that regularities of distribution can often be made to follow from the statement of alternations. Thus, English disallows two nasals word finally (e.g. *[bemn], *[benn] are not possible words in English). It also exhibits an alternation between medial [mn] and word final [m] (e.g. *hymn/hymnal*). If we formulate this alternation as a rule that obligatorily deletes the second nasal, the absence of word final nasal clusters automatically follows.

As I see it, an important motivation for underspecification is the mirror image of this idea, namely, that statements expressing regularities of distribution can simplify the statements expressing alternation. Though this motivation has not been explicitly formulated in this fashion in the literature, I believe it is implicit in many analyses employing underspecification. To illustrate, consider the widespread generalization that back nonlow vowels are rounded and the rest unrounded. Suppose we state this segment internal distributional regularity as (5):

$$(5) \qquad [-\text{cons}] \rightarrow_{sc} \begin{cases} [+\text{round}]/[\underline{\quad}, +\text{back}, -\text{low}] & \text{(a)} \\ [-\text{round}] & \text{(b)} \end{cases}$$

To see how (5) simplifies the statement of phonological alternation, consider the alternations in *goose/geese* ([uw]/[iy]), *mouse/mice* ([aw]/[ay]), and *tell/told* ([e]/[ow]). To account for these alternations, we may postulate the following rules:

(6)a. $V \rightarrow_{sc} [-back, -round] / \underset{PLUR}{\_\_\_\_}$

b. $V \rightarrow_{sc} [+back, +round] / \underset{PAST}{\_\_\_\_}$

The specification of rounding in (6) is redundant, as it repeats the generalizations already captured in (5). This relation between distribution and alternation was first noted in SPE, which proposed a "linking convention", by which the rules which stated the segment internal distributional regularities ("marking conventions" in SPE) applied to the output of the rules which stated the regularities of alternation ("phonological rules" in SPE) (pp. 420–1). The linking conventions (or unordered "everywhere rules") apply whenever their structural description is met, and allow us to simplify (6) to (7), thereby eliminating the duplication involved in the specification of rounding:

(7)a. $V \rightarrow_{sc} [-back] / \underset{PLUR}{\_\_\_\_}$

b. $V \rightarrow_{sc} [+back] / \underset{PAST}{\_\_\_\_}$

The details of rounding will now be taken care of by rule (5). Rule (7a) changes the */o/* of *goose* ([+back, −low, −high, +round]) to the intermediate [−**back**, −low, −high, +round], which then changes to [−back, −low, −high, −**round**] by rule (5b), yielding [iy].

Illustrated above is the generalization that patterns of alternation tend to conform to distibutional restrictions. Given this effect of distribution on alternation, *formal statements of phonological alternation can be simplified by factoring out the effects of distribution on alternation.*[7]

SPE assumes that the rules in (5a, b) are structure changing operations. Theories of underspecification achieve this effect in terms of structure building rules by leaving rounding underlyingly unspecified and formulating (5) as a structure building rule. (5) then inserts the appropriate values of [round] in the outputs of (7) as follows:

(8)	*goose*	*geese*	
	[+ back, −low]	[+back, −low]	underlying
	——	[−back,−low]	ablaut
	[+back, −low, +round]	[−back, −low, −round]	(5b, str. bldg)

[7] Since the rules of (5) are assumed to be universal conventions, the grammar of a language that has back high unrounded vowels will have to carry the special stipulation that (5a) does not apply in this language, which explains why i → ɨ is less natural than i → u.

Analyses of this kind have been taken as evidence for eliminating predictable information from underlying representations, and therefore for the use of structure building rules. This conclusion, however, is unjustified since the SPE linking rules which are structure changing operations achieve this parsimony equally efficiently. In fact, linking rules have been brought back to current phonology by Myers (1989), who argues that the effect of language specific distributional constraints on phonological alternation is best captured by linking conventions of the type used in SPE.

An equally efficient alternative is that of constraints and repair. Suppose we restate the rules in (5) as the constraints in (5′), where "$\rightarrow_c$" denotes an entailment:

(5′) [−cons, +back, −low] $\rightarrow_c$ [+round] (a)
[−cons] $\rightarrow_c$ [−round] (b)

As in the case of (5), the statement in (5′a) is more specific, and by the Elsewhere Condition, overrides the more general statement in (5′b). The repairs effected by (5′) can be illustrated as the following alternative derivation for (8);

(8′)	*goose*	*geese*	
	[+back, −low, +round]	[+back, −low, +round]	underlying
	——	[−back, −low, +round]	ablaut
	[+back, −low, +round]	[−back, −low, −round]−	repair by (5b′)

The use of constraints and repair has been advocated by various researchers including Singh (1984), Calabrese (1987), Paradis (1988), Goldsmith (1989) and Mohanan (1989)). Given that (a) underspecification and default rules, (b) structure changing linking rules, and (c) constraints and structure changing repair, are alternative implementations of the same idea (phonological alternations conform to distribution regularities), arguments in favor of structure building rules are at best incomplete without a systematic comparison with its alternatives in linking or repair. Worse still, given that these are implementational variants, the use of both underspecification and repair within the same theory, as is currently practiced, constitutes unnecessary duplication. We must either choose one of these formalisms in favor of the other, or provide explicit principles which determine the choice between them for specific purposes.

To illustrate better how underspecification theories capture the preservation of distributional regularities in patterns of alternation, and point out what it would take to argue in favor of underspecification with structure

building rules, let us consider Archangeli and Pulleyblank's (1989) analysis of Yoruba [ATR] harmony. Yoruba has seven vowels in its inventory: the [+ATR] vowels [i, e, o, u] and the [−ATR] vowels [ẹ, ọ, a]. The segment internal distributional facts of [ATR] in Yoruba are as follows:

A. Both [−ATR] and [+ATR] can occur in mid vowels.
B. Only [+ATR] can occur in high vowels.
C. Only [−ATR] can occur in low vowels.

The morpheme internal distributional facts are as follows:

D. [+ATR] mid vowels cannot precede [−ATR] mid vowels (*[eẹ], *[eọ], *[oọ], *[oẹ])
E. [−ATR] mid vowels cannot precede [+ATR] mid vowels (*[ẹe], *[ẹo], *[ọo], *[ọe])
F. [+ATR] mid vowels cannot precede [a], but may follow [a] (*[ea], *[oa], [ae], [ao])
G. [−ATR] mid vowels can both precede and follow /a/ ([ẹa], [ọa], [aẹ], [aọ])
F. Both [−ATR] and [+ATR] mid vowels can precede final high vowels but only [+ATR] can precede non-final high vowels. They can both follow high vowels. ([eu], [ue], [ẹu], [uẹ], [euV], but *[ẹuV])

These observations hold not only morpheme internally, but also across morphemes in affixation.[8] When two morphemes combine, the first one changes to conform to these regularities. In terms of fully specified representations, the pattern described above can be restated as follows:

(i) Both values of [ATR] spread right-to-left.
(ii) [ATR] does not spread from final high vowels.
(iii) Neither low nor high vowels undergo [ATR] spreading.

A & P account for the restriction against nonhigh sequences of [+ATR][−ATR] by assuming that both high vowels and */a/* are underlyingly unspecified for [ATR].[9] They use both constraints and default rules, stating the relation between the feature values in low vowels as a default rule (9a) and that in high vowels as a constraint (9c):

[8] Harmony seems to apply within some compounds, but not all (Archangeli and Pulleyblank (1989: 190)).

[9] The morpheme internal restriction [−ATR, −low][+ATR] vowels is accounted for in A & P by assuming that (i) only [−ATR] is available underlyingly, and (ii) [−ATR] is specified for the morpheme as a whole, rather than for each segment. We will return to these assumptions later.

(9)a. [+low] $\rightarrow_{sb}$ [−ATR]

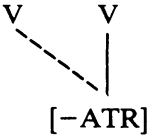
b. [ ] $\rightarrow_{sb}$ [+ATR]

c. A[−ATR] specification can be linked only to a vowel that is [−high].

One would have thought that the predictability of the value of [ATR] in high and low vowels would be uniformly captured either as rules ([+low] → [−ATR], [+high] → [+ATR]) or as constraints, either positive ("If [+low] then [−ATR]", "If [+high], then [+ATR]") or negative (* [+low, +ATR]), [*[+high, −ATR]). Observe that (9c) is a notational variant of the negative constraint *[+high, −ATR]. The sole purpose of this arbitrary choice is to express the asymmetry in the behaviour of the predictable value of [ATR] in high and low vowels. In both high and low vowels, the value of [ATR] is predictable. The presence of predictable [ATR] in high vowels has the effect of ruling them out as both the undergoer and trigger of harmony. In contrast, all that the presence of predictable [ATR] in the low vowels does is to make it incapable of undergoing harmony, while allowing it to trigger harmony. As we will see, this asymmetry can be expressed without such roundabout machinery.

Given (9a–c), A & P account for the harmony facts by the following rules:

(9)d. Associate [−ATR] to the rightmost eligible vowel.[10]

e. 

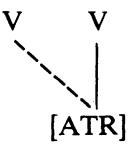
(structure building)

In addition, as I have shown earlier, A & P require the stipulation in (9f), in order to rule out [+low, +ATR] underlyingly:

(9)f. [+ATR] is not available underlyingly.

In order to make sure that the redundant [−ATR] on the low vowel spreads to the mid vowels, this analysis must crucially order the default rule in (9a) prior to the spreading rule in (9e). This ordering is the result of a universal principle that requires the application of default rules inserting feature values prior to the application of rules which refer to those values. However, in order to derive this result, it is important to specify the negative value in the formulation of (9e), rather than formulating it in a simpler fashion as (9e′):

[10] "Eligible" means: "subject to the constraint in (9c)".

(9)e′. 

(structure building)

Formulated as (9e′), both (9a) and (9b) must precede the application of the spreading rule. If so, the structure building spreading rule will be inapplicable in the grammar. Therefore the sole purpose of formulating the rule as (9e) rather than as (9e′) is to force the application of (9a) prior to (9e), allowing the redundant [−ATR] in the low vowel to trigger the harmony.

The fact that final high vowels do not trigger harmony is accounted for in the A & P analysis by making the following assumptions;

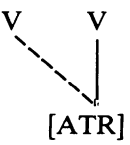
(9)g. [−ATR] is morphemic.
h. *[−ATR][−ATR]

(9h) does not have to be stipulated in the grammar, as it follows from OCP. The combination of (9g) and (9h) has the effect of disallowing [−ATR] mid vowels before non-final high vowels ([elubọ] 'yam flour', but *[ẹlubọ]). If there is only one [−ATR] in the morpheme, it will associate to the final mid vowel, but will not spread to the first vowel across the high vowel. The only way of having a [−ATR] mid vowel would be to have another [−ATR] in the morpheme, which is disallowed by (9h).

A & P argue against contrastive underspecification at length, but, as in the case of other discussions of underspecification, the alternatives of structure changing rules or constraints-and-repair are not considered. Suppose we employ the SPE linking convention, advocated in Myers (1989). The segment structure regularities would be stated as the following linking rules:

(10)a. [+low] $\rightarrow_{sc}$ [−ATR]
b. [+high] $\rightarrow_{sc}$ [+ATR]

The spreading rule (9e) would be interpreted as a structure changing rule, with the additional specification that the trigger is a non-high vowel, stated as (10c):

(10)c. 

(structure changing)

In order to prevent the spreading of [+ATR] from final high vowels, we assume:

(10)d. Final syllables with [+high] vowels are extraprosodic.

Pulleyblank (p.c.) has pointed out to me that nasal high vowels, unlike oral high vowels, cannot follow [−ATR] mid vowels, even when the high vowels are final. This fact has no account under the A & P analysis. If we adopt the strategy in (10d), we can account for the illformedness of final [−ATR][+ATR, +high, +nasal] sequences by revising (10d) as: final syllables with [+high, −nasal] vowels are extraprosodic.

In order to account for the opacity of high vowels to the spreading rule, A & P need to stipulate the redundant constraint in (9c), a variant of the negative constraint that [−ATR] cannot be linked to a vowel that is [+high]. Given (10b) as an everywhere, structure changing linking rule, this duplication of the default rule is unnecessary. Rule (10c) will apply to a high vowel, but the output [+high, −ATR] will immediately be changed to [+high, +ATR], preventing further application of (10c).

A & P account for the morpheme internal restriction against sequences of [−ATR, −low] [+ATR] vowels by crucially relying on (9g). Given the sequences of mid vowels within a morpheme, and the possibility of [−ATR] on the morpheme, there are only two possible outputs: either the morpheme contains [−ATR], in which case the sequence surfaces as a sequence of mid [−ATR] vowels, or the morpheme doesn't contain [−ATR], in which case default rule (9b) inserts [+ATR] in every vowel in the sequence. Instead of stipulating that [−ATR] is a property of the morpheme, the account in (10) stipulates that both values of [ATR] spread in affixation. The effect of [+ATR] not spreading to the low vowel follows from the application of (10a): as soon as the output of spreading becomes [+low, +ATR], rule (10a) changes it back to [+low, −ATR]. Thus, the linking rules (10a) and (10b) correctly account for the fact that neither the low vowel nor the high vowel undergoes assimilation.

What lies behind the A & P analysis of Yoruba is the insight that (i) all the segment internal distributional regularities in Yoruba are preserved in phonological alternation, and (ii) when two morphemes are put together, the result conforms to the morpheme internal regularities. This conformity is complete in affixation, and partial in compounding. The formal expression of this insight, however, does not require the device of underspecification and structure building rules. In fact, the structure changing mechanism of linking rules yields a simpler analysis, as can be seen from the following comparison of the two analyses of [ATR] harmony in Yoruba:

	A&P analysis		*Alternative analysis*
(9)a.	[+low] $\rightarrow_{sb}$ [−ATR]	(10)a.	[+low] $\rightarrow_{sc}$ [−ATR]
b.	[ ] $\rightarrow_{sb}$ [+ATR]		
c.	*[−ATR, 1high]	b.	[+high] $\rightarrow_{sc}$ [+ATR]
d.	Link [−ATR] to rightmost V		
e.	Spread [−ATR] to left (str. bdg)	c.	Spread [ATR] to left (str. chng)
f.	[+ATR] is not available underlyingly		
g.	[ATR] values are morphemic	d.	Final [+high] is extraprosidic.

Clearly, the analysis in (10) is much simpler, demonstrating that linking rules should be investigated as a serious alternative to underspecification and default rules. An equally plausible candidate is repair strategies combined with constraints. The reader may reformulate (10a–c) as positive constraints (as we did in the case of rounding in *goose* ~ *geese* alternation), and see for herself that constraints-and-repair yield a solution as simple as (10a–c).[11]

In sum, we make the following observations. If we allow (segment internal and morpheme internal) distributional restrictions to interact with phonological alternations, part of the changes involved in alternation can be derived from the formal statement of distribution. Underspecification-and-structure-building-rules simplifies the statement of phonological alternation, but I have shown that structure changing linking rules, or constraints-and-repair, will yield equally simple or better results. Whether or not we subscribe to assumption (1) is irrelevant if we use either of the structure changing devices. Therefore the alleged advantages of underspecification-and-structure-building-rules remain undemonstrated.

For more than three decades, the assumption that underlying representations may not contain predictable information (1) has been accepted as an unquestioned dogma in generative phonology. In the preceding sections, we tried to discover a motivation for this assumption, and found none. It is clear that all regularities of distribution and alternation must be captured in the grammar, but why should this requirement entail that there exist a level of representation that contains only idiosyncratic information? The real impetus for accepting assumption (1) during the

[11] For a detailed discussion of how a constraint based model works, see Goldsmith (1989) and Lakoff (1989).

initial stages of generative phonology was the questionable assumption that speakers of a language do not memorise predictable information. If we reject this assumption, there is no reason for accepting (1).

We also found that the special mechanism of structure building rules, unlike linking rules or constraints, is incapable of accounting for segment internal (or cross segmental) distribution of feature values. Supplementing structure building rules with constraints in order to take care of distributional gaps has the effect of making structure building rules redundant. Therefore structure building rules should be eliminated from segmental phonology. As we shall see, if structure building rules are disallowed, radical underspecifiation will have to be abandoned.

2.2.2. *Preservation of Morpheme Structure Regularities*

In the preceding discussion, we focussed on the preservation of segment structure regularities. The Yoruba example illustrates the effect of both segment structure and morpheme structure regularities. A striking instance of the preservation of morpheme structure regularities is Pali assimilation, reported in Hankamer and Aissen (1974). They observe that in Pali, the only consonant sequences found both morpheme-internally and across morphemes are: (i) nasal + homorganic stop, (ii) stop + hormorganic aspirate, (iii) geminate consonants. This restriction is found not only morpheme internally, but across morphemes as well. When two non-identical consonants come together through the concatenation of morphemes, either the sequence is broken up by epenthesis, or one of the consonants assimilates to the other. In the case of nasal-stop sequences, the nasal assimilates in place to the stop; in other cases, the assimilation is complete: the more sonorous consonant assimilates to the less sonorous consonant, yielding geminates.

As pointed out in Prince (1984), the distributional restriction that all intervocalic consonant sequences must be partial or full geminates is found in a wide variety of languages, dubbed "Prince-languages" by Goldsmith (1989). A satisfactory analysis of the Pali facts must express the following generalizations: firstly, because the distributional restriction is common across languages, the mechanism that derives it must also be common to the other Prince-languages. Secondly, the facts of distribution within morphemes and the facts of alternation across the morphemes must be stated in a unified fashion. Third, it should express the "conspiracy" effect (Kisseberth (1970)), namely, the generalization that nasal assimilation and total assimilation are both strategies to preserve a general constraint on intervocalic consonant sequences.

In order to express these generalizations, one may explore the constraint-repair mechanism as follows. Assume, following Goldsmith (1989), that the coda in Prince-languages can "license" only a limited set of features, [+nasal] in the case of Pali. This means that the other features of the coda must be licensed by being linked to the onset of the following segment. For example, in the [m] in intervocalic [m – p], the feature [+nasal] is sanctioned by the coda, while the place features are sanctioned by the onset of the following syllable. In [p – p] on the other hand, all features are sanctioned by the onset of the second syllable. In sequences such as [m – t], the coda of the first syllable cannot sanction the place features of the nasal, and as a result, the two consonants are obliged to share a single place node, which will be the repair that makes the representation conform to the wellformedness condition.[12] The directionality of assimilation will presumably be determined by universal principles; in nasal + plosive, it is the nasal that assimilates in place to the plosive, not the plosive to the sonorant (see K. P. Mohanan (1989)). Turning to sequences other than nasal + plosive, we note that place assimilation is not sufficient to satisfy the wellformedness condition of licensing, and therefore total assimilation takes place. If the two segments have the same manner of articulation, the first assimilates to the second. The directionality of assimilation in this case appears to be language particular if they have different manners of articulation: as Hankamer and Aissen (1974) point out, the more sonorous assimilates to the less sonorous.[13,14]

Crucial to the above analysis is the idea that structure changing operations can be triggered as repair strategies when a phonological representation violates a wellformedness condition (Kisseberth (1970), Shibatani (1973), Somerstein (1974), Singh (1984), Calabrese (1986), Paradis (1988), Goldsmith (1989), K. P. Mohanan (1989), etc.). This idea is also explored as a way of understanding the effects of OCP on phonological alternation, and simplifying the formal statement of alternation (Yip (1988)). It is unclear how this strategy can be translated into the mechanism of underspecification and default rules. First, given that labial and coronal nasals

[12] Whether the statement of the constraint will automatically determine the nature of the repair (e.g. the minimal changes required to satisfy the constraint) or whether additional stipulations are required to choose the particular repair in question is not an issue I will pursue here. For discussion on this topic, see K. P. Mohanan (1989).

[13] E.g. *pac* + *ya* → *pacca* pass. pac- 'to cook'
udir + *ya* → *udiyya* pass. *udir-* 'to begin'.

[14] See Cho (1988) for the proposal that assimilation in sequences other than nasal + plosive sequences is the result of an independently required rule that creates ambisyllabic consonants. This proposal fails to explain why ambisyllabicity fails to appear just in nasal + plosive sequences. It also fails to bring out the Prince-languageness of Pali.

are distinctive in the language, default rules and structure building assimilation cannot prevent the morpheme internal sequence /m t/. Even if we employ an additional Alpha-constraint that forbids a nasal from having an independent place node when followed by a plosive, it fails to account for the facts of alternation across morphemes which clearly require a structure changing spreading rule.[15]

If it is the case that underspecification-and-structure-building-rules cannot provide a satisfactory analysis of the data for which constraints-and-repair has an elegant analysis, then we must admit repair as a legitimate mechanism in the theory. Given that constraints-and-repair is an implementational variant of underspecification-and-structure-building, we must eliminate the latter in favor of the former.

2.3. *Structure Preservation*

The observation made in the preceding sections was that segment internal or cross segmental regularities of distribution are often preserved in phonological alternation. We may refer to this phenomenon as STRUCTURE PRESERVATION. In the literature in phonology, however, the term "structure preservation" refers, not to a phenomenon, but to a formal condition which says that if the potential output of a rule violates a constraint on any representation in the lexicon, then the rule cannot apply in the lexicon (SPC in Kiparsky (1985)). What this condition allows us to capture is the effect of a distributional restriction blocking the application of a rule. What SPC aims to capture is the phenomenon of the preservation of a distributional regularity through blocking. However, the formulation of structure preservation as a condition on rule application obscures an important generalization: the phenomenon of a distributional restriction making the output of a rule conform to it (either through structure building rules or through repair strategies) is also an instance of the preservation of distributional regularities in alternation.

In order to avoid this problem, I will use the term C(ONFORMING)-TYPE structure preservation to refer to making the output of processes conform to the distributional regularities, and B(LOCKING)-TYPE structure preservation to refer to blocking the processes that create outputs that violate

[15] An anonymous reviewer suggests that the Pali facts can be accounted for by combining the idea of delinking with underspecification. If the coda contains a segment that cannot be licenced, its features are automatically delinked. This analysis does not explain how the onset assimilates to the coda when the coda is less sonorous, (e.g. *lag* + *na* → *lagga* gerundive *lag*-'attach'; *gam* + *ya* → *gamma* 'gerundive *gam*-'go).

the distributional regularities. Underspecification-and-structure-building-rules provides one way of capturing c-type structure preservation; constraints-and-repair provides an alternative way of capturing it. SPC offers a way of capturing b-type structure preservation.

As an example of b-type structure preservation, consider Kiparsky's (1985) analysis of devoicing in Russian. The crucial facts are as follows. Russian has a rule which devoices consonants in the final position (e.g. *sad* + *a* → *sa[d]a* 'garden' (gen. sg.); *sad* → *sa[t]* (nom. sg.)). It also has a rule that assimilates all consonants in a sequence to the voicing of the rightmost consonant, a rule that is fed by final devoicing[16] (e.g. *mcensk ## by* → *mcen[zg b]y* 'if Mcensk'; *mozg* → *mo[sk]* 'brain'). Sonorants, however, are transparent to voicing assimilation in that the devoicing applies across sonorants without fully devoicing the sonorants themselves (e.g. *iz ## mcensk* + *a* → *i[s mc]enska* 'from Mcensk'). The solution that Kiparsky proposes for this behaviour of sonorants crucially appeals to the distributional restriction that [+son] and [−voice] cannot co-occur in the same segment. This constraint prevents sonorants from undergoing both final devoicing and voicing assimilation, an effect of structure preservation, which may be stated as follows:

(11) A (b-type) Structure Preserving module blocks the application of phonological rules the output of which violates any of the constraints holding in that module.

Given the constraint against voiceless sonorants, (11) disallows sonorants from undergoing the spreading of [−voice] to them in the lexical module. In the post lexical module, however, spreading applies across sonorants.[17]

The examples of structure preservation discussed above are those of language specific distributional constraints being preserved in phonological alternation. An example of the preservation of a universal constraint is OCP, which appears to have both an "active" function (c-type structure preservation) of making illformed representations conform to the constraint and a "passive" function (b-type structure preservation) of preventing the application of a rule the output of which would violate the

[16] These generalizations are prose statements of the rules given in Kiparsky (1985: 108).

[17] Even though the [m] to the left of [c] in *i[s mc]enska* is still voiced, Kiparsky assumes that [−voice] spreads post lexically to [m] and then to the obstruent to its left. According to him, the spreading of [−voice] to the sonorant yields a partly voiceless segment, while the spreading to an obstruent yields a fully voiceless segment.

constraint (Leben (1973, 1978), McCarthy (1986), Odden (1986), Yip (1988)).

Kiparsky's analysis of the predictability of voicing in sonorants employs the structure building rule in (3a), rather than the constraint in (3b) or (3c):

(3)a. $[+\text{son}] \rightarrow_{sb} [+\text{voice}]$[18]

b. $[+\text{son}] \rightarrow_{c} [+\text{voice}]$

c. *[+son, −voice]

As pointed out earlier, the rule in (3a) does not prevent the presence of [+son, −voice] in underlying representations; nor does it block the application of rules that spread [−voice] to [+son]. In contrast, the constraint in (3b) or (3c) will do both. Therefore, Kiparsky is forced to postulate the Alpha-constraint in (3d).

(3)d. *[+son, αvoice]

For the reasons mentioned earlier, the use of both (3a) and (3d) constitutes an unnecessary duplication. Given that (3d) is a combination of *[+son, −voice] and *[+son, +voice], what Kiparsky's solution does is to use both (3a) and (3c) within the same theory. In short, if we want to appeal to structure preservation (b-type), we must abandon the device of structure building rules in favor of constraints. In a theory that employs constraints, structure building rules are redundant. This result has important consequences for radical underspecifiation, which crucially depends upon structure building rules. To summarise and restate the argument, suppose we adopted underspecification and constraints in order to account for structure preservation. Such a theory cannot assume that one of the values of a feature is left unspecified (2a), as structure building ("complement") rules like [ ] → [−back] and [ ] → [+cor] cannot be stated as constraints.[19] Therefore, if we want to maintain structure preservation, we must abandon the device of structure building rules for the statement of distributional regularities.

[18] This rule is formulated in Kiparsky (1985: 108) as [αson] → [αvoice], collapsing the filling in of [+voice] in sonorants with the filling in of [−voice] in obstruents.

[19] A possible solution would be to use constraints for predictable information (1) and default rules for inserting unmarked information (2).

3. Totally Redundancy Free Underlying Representations

In the preceding section, we focussed on the rule system in underspecification theories. I argued against the combination of (1) and structure building rules, showing that (1) is unmotivated, and that structure building rules are inadequate. I will now argue that (1) cannot in fact be maintained, as underlying representations cannot be entirely free of predictable information.

Demanding that all predictable information be eliminated from underlying representations leads to a problem in situations where two types of information are mutually dependent. A classic case is the dependency between syllable structure and segment structure, a problem which has been posed in Levin (1985) and Borowsky (1986). Given information about the feature composition of the segments in a string, we can predict its syllable structure. For example, given a string of the form /sedilin/ in English, we know that it must have exactly three syllables. Therefore a theory that incorporates (1) must assume that syllable structure information that can be computed from distinctive feature information is not present in underlying representations. It is also necessary to assume that the values of all the distinctive features on the basis of which syllables are built are specified prior to syllable building. This includes features that participate in the sonority scale ([sonorant], [consonantal], [nasal], [continuant] and so on), and other features such as [voice] and [coronal], leaving very little to be underspecified.[20] But syllable structure information allows us to predict the feature composition of segments. Given an English morpheme that begins with three consonants, we can predict that the first segment must be [s], the second segment must be [p], [t], or [k], and the third segment must be [l], [r], or [w]. We assume that this regularitiy is best stated in terms of wellformed onsets rather than wellformed morphemes. If so, then a theory that incorporates (1) must assume that the distinctive feature information that can be computed from syllable structure information is not present underlyingly.

This situation creates problems of the following type: for a morpheme like *straw*, the minimally redundant information is that it has four melodic units of the form/[+cons][+cons, +cor][+cons][+back, +low]/. The rest can be computed from the syllable structure principles: the only way to

[20] An anonymous reviewer has objected to this statement saying that syllabification does not require both plus and minus values. The issue of using both values has to do with assumption (2a); what I am addressing here is assumption (1) which requires all predictable information to be eliminated from underlying representations.

syllabify the string is to assign the last melodic unit to the rime, and the first three to the onset. Given the principles of syllable structure in English, we know that the first unit in the onset must be /s/, the second one must be a voiceless stop (and hence /t/), and the third can now be filled only by /r/. However, in order to build a syllable on the string, one needs to appeal to principles like "Only a [+son] segment can be a syllable nucleus in English" (or its converse, "A [−son] segment cannot be a syllable nucleus in English.") Such principles cannot apply to the redundancy free underlying representations /[+cons][+cons, +cor][+cons][+back, +low]/, since it does not contain the specification of [son].

The dilemma we are facing is: given syllable structure information, we can predict segment structure information, and given segment structure information, we can predict syllable structure information. Which type of information and how much do we leave unspecified? In other words, is there an optimal way of omitting information in underlying representations such that it satisfies (1), without being contradictory? The challenge that this problem raises for assumption (1) has often been overlooked in the literature. Perhaps there are answers to these questions consistent with (1), but it is necessary for underspecification theories to show they can be solved.[21]

4. Dominant and Non-dominant Feature Values

4.1. *Allowing Only One Value in a Given Environment*

Having demonstrated the problems in the implementation of assumption (1), we now turn to the proposal to allow only one value of a feature (in a given environment) ((2a.i/(2a.ii)) and the assumption that this value is the marked one (2b). If we accept (2a), the contrast between voiced and voiceless obstruents can be expressed by using the feature specifications [−son, +voice] for voiced obstruents, and [−son] for voiceless ones, and interpreting the absence of voice specification in the latter as [−voice], using the following structure building rule:

(12) $[-\text{son}] \rightarrow_{sb} [-\text{voice}]$

This rule will insert [−voice] where voicing is unspecified (as in the first

[21] See Cairns (1988) for a discussion of the minimally redundant segmental and syllable structure information. Cairns proposes that both syllable structure information and segmental information must be partially present in underlying representations. Since he does not provide the rules which would insert the redundant values of features, his proposals are difficult to evaluate.

segment of *pit*), without affecting the already specified values of voice (as in the first segment of *bit*).

We have already seen that the option of structure building rules conflicts with appeals to structure preservation (b-type) effects. If we adopt constraints and free filling in of features in order to express segment internal distributional regularities, the option of expressing the unmarked value of a feature in terms of the absence of specifiation is not open to us, as nothing prevents the free filling in of feature values from filling in the unspecified value of an obstruent segment as [+voice] rather than as [−voice]. Therefore we must either reject the assumption in (2a), or abandon structure preservation (b-type).

The theory that subscribes to CSRA faces a more serious problem when it comes to spelling out the vague reference to "environment" in (2a.i). Suppose we interpret the "environment" of a feature to include *all* the segmental, prosodic, and morphological environments in which the feature appears. Under this interpretation, the only instance of two values of a feature being in identical environment is when they occur in a minimal pair. If the /b/ in *bit* is specified as [+voice], (2a.i) would prevent the specification of the /p/ in *pit* as [−voice], but nothing prevents the specification of /p/ in *please* as [−voice], since /b/ does not happen to occur in the underlying representations in English in the environment _ *lease*. Similarly, the /b/ and /p/ in *bad* and *pad* can be specified as [+voice] and [−voice] respectively because they do not occur in the same environment: one of them is an adjective, and the other is not. This interpretation of "environment" allows the free use of both values except where minimal pairs with identical morpho-syntactic properties are involved. On the other hand, if we interpret "environment" to refer to *any* segmental, prosodic or morphological environment, it would be impossible for a feature to have two different values in two different forms, since the two forms will always have some environment in common. For example, the last segment in *Malthus* and the first segment of *ship* occur in the same environment because they are both adjacent to a [−cons]; the first segment of *aroma* and the last segment of *molest* occur in the same environment because both them occur in morphemes that contain nasals, and so on. In short, if a segment specified as [+F1] occurs in a morpheme that also has a segment specified as [+F2], condition (2a.i) would rule out the specification of a segment as [−F1] in all morphemes which have a segment specified as [+F2]. If so, the effect of condition (2a.i) would be to allow only one value for a given feature irrespective of environment (2a.ii).[22]

[22] The only other interpretation of "environment" that I can think of is the sum total of all the structural descriptions referred to in all the phonological *rules* of a language.

4.2. *Markedness and Context Sensitive Radical Underspecification*

The marking conventions of SPE expressed the relative markedness of segments using the symbols **m** for marked and **u** for unmarked. Thus, the representations [u voice, −son] and [m voice, −son] would be interpreted by the marking conventions as [−voice, −son] and [+voice, −son] respectively. Instead of the notation of [uF] and [mF], the radical underspecification theories that subscribe to (2b) use the notation of the absence and presence of a value for [F] (Kiparsky (1982, 1985)). In Radical Underspecification theories that do not subscribe to (2b) (Archangeli (1984, 1988)) nothing prevents the contrast between /p/ and /b/ being represented as [−son, −voice] vs. [−son] in some languages, and the same contrast being represented as [−son] vs. [−son, +voice] in other languages. Clearly, the former theory is more restrictive.

For CSRA to be an empirical claim, the theory must satisfy two conditions. First, it must provide a universal statement about which values of features are unmarked in a given context, independently of language internal descriptive requirements. Second, it must provide a basis for empirically validating the claim that a given value of a feature F is unmarked.

To take the first condition, the choice between plus and minus in the value of [voice] in obstruents must be based not on the contingencies of a particular language, but on a universal statement (e.g. the unmarked value of [voice] in obstruents is universally minus). If we allow the free use of plus and minus in obstruents in different languages, the claim that it is the unmarked value that is unspecified (2b) has no empirical substance. This requirement does not apply to CFRA that rejects (2b). Thus, as Archangeli (1988) points out, what has been claimed to be the maximally underspecified segment is not identical across languages. While Archangeli and Pulleyblank (1989) argue that the maximally underspecified vowel in Yoruba is /i/, Abaglo and Archangli (1989) argue that the maximally underspecified vowel in Genge is /e/, and Vago (1988) claims that it is /a/ is Pasiego. If the same theory sanctions all these analyses, it couldn't be the case that such a theory subscribes to (2b), as what is *unmarked* (in the sense in which the word is used in SPE and subsequent works) cannot vary from language to language, even though "neutral vowel" and "neutral consonant" can differ from language to language. In such a theory (i.e., one that does not subscribe to (2b)), there is no reason why it cannot be the case that the maximally underspecified vowel in some language is the front rounded high vowel, or the maximally underspecified consonant is the coronal implosive or a labial plosive.

Now, many analyses using underspecification have made claims about the special nature of coronals in phenomena such as assimilation, neu-

tralization and transparency (e.g. Avery & Rice (1988), Paradis & Prunet (1988), Cho (1988)). If underspecification theories are to make any crosslinguistic predictions about, say, which segment is more likely to undergo assimilation (e.g. /n/ assimilates, but not /m/), then it is clear that these claims must be based on universal statements about which features should be underspecified. A theory that allows the free choice of /i/, /e/, /a/, etc. as the maximally underspecified vowel, also allows the free choice of coronal, velar or labial, or uvular as the maximally underspecified consonant. Such a theory cannot make cross linguistic predictions such as "In no language can the high front rounded vowel be the epenthetic vowel", "In no language can the uvular consonant but not the coronal consonant undergo place assimilation". Therefore the claims about underspecification capturing crosslinguistic patterns in the special status of coronals are inconsistent with the free choice of vowels for underspecifiation, unless substantive statements are made in UG about the class of features whose default values are not universally determined.

To take the second condition, for the claim in (2b) to be meaningful, one must also provide a way of validating the claim that segment X is unmarked in relation to segment Y. Following the traditional wisdom, I take it that the empirical substance of such a claim can be stated as the following crosslinguistic prediction: If property P_i is unmarked in relation to property P_j then P_i will be more frequent than P_j. We also expect, though not invariantly so, that there can be languages with P_i without P_j, but languages with P_j without P_i would not occur. Thus, the statement that voiced aspirated stops are marked with respect to voiced unaspirated stops predicts that there can be languages with voiced unaspirated stops without voiced aspirated stops, but the reverse is not possible.[23] If this characterization of "marked" is accepted, then a theory that subscribes to (2a, b) is committed to deciding what must be underspecified on the basis of crosslinguistic facts.

4.3. *Underspecification and Assimilation*

What is the motivation for formally expressing dominant and non-dominant feature values as specified and unspecified? What are the claims behind using the same formal notation to represent both predictability of feature values and asymmetry of feature values, rather than, say, expressing pre-

[23] It is likely that this is not the empirical substance behind the use of the word "unmarked" in radical underspecification. If so, it is necessary that the meaning of "unmarked" should be clearly spelt out.

dictable information as unspecified information and expressing feature asymmetries with, for instance, the notation in SPE?

It is quite common to find place assimilations in which coronals assimilate to non-coronals without non-coronals assimilating to coronals. English, for example, allows syllable final [mp], [nt] and [mt], but not syllable final *[np], which indicates that [−cor] is dominant in place assimilation in English. In terms of the notion of dominant and non-dominant feature values alluded to in Section 1.2, this means that [−cor] is dominant, while [+cor] is non-dominant. Let us indicate dominant feature values in upper case letters:

(13)a. /n/:[+NASAL, +coronal]
b. /m/:[+NASAL, −CORONAL].

The intuitions that we are trying to capture may be stated as (14):

(14)a. Segments with non-dominant feature values often fail to *trigger* spreading.

b. Segments with dominant feature values often fail to *undergo* spreading.

Instead of using upper case for dominant values of features, radical underspecification uses the notation of null specification for non-dominant ones:

(15)a. /n/:[+nasal] b. /m/:[+nasal, −coronal].

A consequence of representing dominant and non-dominant feature values as in (15) is the following prediction:

(16)a. During the stages in the derivation where the non-dominant values are still represented as null,
(i) segments with non-dominant feature values cannot be *triggers* of spreading.
(ii) segments with dominant feature values cannot be *undergoers* of spreading.

b. After the point when the non-dominant feature values are specified, they cannot exhibit any asymmetric behaviour.

At subsequent stages in the derivation where the null values are replaced by pluses and minuses and structure changing rules apply, the asymmetry in (16) no longer holds. Thus, the claim implicit in the use of underspecification for the representation of "non-dominant" as "null specification" is that it derives the generalizations in (14).

In addition to providing a representation for the distinction between dominant and non-dominant feature values which derives (14), context sensitive radical underspecification also makes the following claim:

(17) Dominant values are the marked values.

It follows from (16) and (17) that if there are asymmetries of spreading, it is always the segment with the marked value that triggers spreading and the segment with the unmarked value that undergoes spreading. As stated earlier, examples of assimilation in which coronals assimilate to noncoronals are abundant in natural languages, while examples of noncoronals assimilating to coronals are relatively rare. Within context sensitive radical underspecification, this is accounted for by assuming that (i) coronals are unmarked and therefore universally unspecified for place, and (ii) structure changing rules are more complex than structure building rules.[24] If most assimilatory rules are structure building rules (ii), it would follow from assumption (i) that most assimilation rules can change a coronal (unspecified) to a noncoronal (specified), but not the reverse.

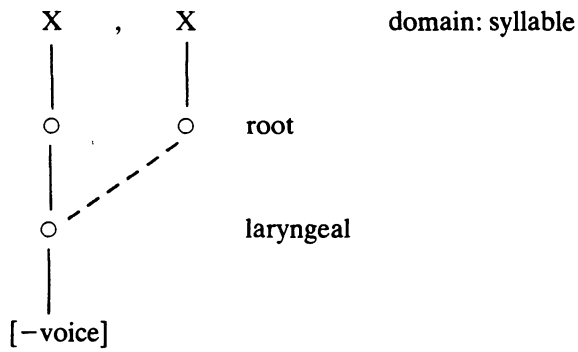
Now, it is important to realize that, as in the case of structure preservation, the combination of (16) and (17) (marked values do not asymmetrically assimilate to the unmarked values) expresses a cross linguistic tendency, not an absolute restriction. Thus, the voicing assimilation of obstruents in English changes voiced obstruents (marked) to voiceless obstruents (unmarked) when preceded by a voiceless consonant within the same syllable, as exemplified by well known alternations such as *dogs/cats* [z]/[s] and *raved/laughed* [d/t]. Further, this assimilation can also be regressive, as in alternations like *wide/width* [d/t], *five/fifth* [*v*/*f*], and *berieve/bereft* [v/f]. The generalization, as argued in Halle and Mohanan (1985), is that an obstruent assimilates in voicing to the adjacent tautosyllabic voiceless segment. This formulation has the advantage of automatically taking care of the distributional facts of syllable structure in English, namely, that adjacent obstruents in the same syllable in English must agree in voice (Shibatani (1973)): as is well known, English does not allow onsets like *[sb], *[sd], *[sg], *[zp], *[zd], and [*zk], and codas like *[bt], *[gt], *[zp], *[zt], *[zk], *[vt], *[pd], *[kd], *[sb], *[sg], and *[fd], even though the onsets [sp], [st], [sk] and the codas [pt], [kt], [sp], [st], [sk] and [ft] are permitted. This distribution follows from the bidirectional

[24] As argued in note 2, this is a dubious claim.

assimilation independently required for the facts of alternation.[25] Halle and Mohanan (1985) formulate the rule as (18a), but it can in fact be simplified as "spread [−voice] to the adjacent tautosyllabic segment", formally stated as (18b), without stipulating that it applies only to obstruents:[26]

(18)a. [−son] → [−voice]% ___ [−voice]

b.



The comma between the two segments indicates that the relative order is not relevant. Pairs like *deal/dealt*, and *dream/dreamt* show that sonorants do not undergo voicing assimilation.[27] However, this does not have to be stipulated in the rule. As in the Russian example discussed in Section 2.3, if we assume that (18b) is structure preserving (b-type), sonorants will not undergo (18b), since the structure [+son, −voice] is disallowed by segment structure constraints. Assuming that the voicing assimilation in pairs like *John* [z] *here/Jack* [s] *here* is accounted for by the same rule, we have to

[25] Voicing assimilation is not always restricted to the syllable internal environment in English. Thus, even though the heterosyllabic sequences [sb] and [bs] are allowed, [fd] and [vt] are not. This restriction is responsible for the heterosyllabic assimilation is *fifty* (/vt/ → [ft]). Similarly, Charles Ferguson (p.c.) points out that voicing assimilation applies optionally across syllables in his speech, in examples like *absolute* ([ps]) and *asbestos* ([sp]).

[26] Cho (1990) argues against collapsing the regressive devoicing in *bereft* with the progressive devoicing in *cats*, following Mascaro (1988) who points out that (i) there are dialects of English in which the devoicing systematically fails to apply to final /d/ followed by the suffix *-th* (e.g. *width*), and (ii) there are lexical exceptions like *svelt*. Abandoning the general regularity on the basis of a few exceptions is undesirable, since such an account fails to account for the distributional restrictions on onsets and codas in English. It also fails to extend to the data cited in note 25.

[27] Kiparsky (1985), who claims that structure preservation does not hold in the postlexical module, assumes that the partial devoicing in the sonorants in words like *cry* [kray], *please* [pliyz], etc. is due to the postlexical application of the same rule that lexically devoices the /v/ in *bereft*. This assumption cannot be correct as the sonorants in *dreamt* and *dealt* do not undergo partial devoicing. Furthermore, 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*[s] *here*, but only partial devoicing of the sonorant in *cry*.

conclude that (18b) applies postlexically as well. The failure of the rule to apply postlexically to sonorants shows that the preservation of the structural constraint *[+son, −voice] holds postlexically as well. Here, then, is an instance of a structure changing post lexical rule application which is also structure preserving.[28,29]

Even though there exist instances where assimilation spreads an unmarked feature value to a marked one, the statement in (17) is undoubtedly a strong tendency. However, the claim that this patterning of phonological alternations can be formally expressed in terms of underspecification is not true. Consider the case of homorganic assimilation of nasal and oral stops across words in English. The coronal assimilates to the following labial and velar plosives in colloquial speech, but in the same style of speech the noncoronal does not assimilate:

(19)a. ten [ten]; ten pounds [tempawndz]; ten kings [teŋkiŋz]

b. some [səm]; some time *[səntaym]; some kings *[səŋkiŋz][30]

c. king [kiŋ]; king Tom *[kintam]; king Baber *[kimbabar]

d. hot cakes [hakkeyks], cup cakes *[k ∧ kkeyks]

Examples of this kind show markedness effects in the directionality of assimilation in the postlexical module. In a theory that represents nondominant values as null, and derives (14) from these representations by formulating assimilation as structure building spreading, we will have to

[28] Observe that the claim that voicing is universally a "privative" or single valued feature, and therefore voicelessness cannot spread (Mester and Itô (1989)) is also contradicted by (18b). Instead of using a rule that spreads [−voice], Mester and Itô propose a universal constraint that forbids adjacent obstruents in the same syllable to disagree in voice, and the delinking of [voice] in sequences that violate the constraint (p. 281–2). This idea is pursued in Cho (1990) as well. Now, it is indeed necessary to assume that voicing agreement in obstruents should be specified in UG (see also Mohanan (1989)), but privative underspecification cannot formally express this regularity, since the formulation of the constraint requires reference to voicelessness (*[−voice], [+voice]). If the **p** in the sequence **pd** is unspecified for voicing, then the constraint will have to prohibit the occurrence of [voice] when adjacent to a segment unspecified for voice. This solution violates the standard assumptions of underspecicfiation which prevent rules and constaints from referring to unspecified entities in phonological representations. Furthermore, since voiced sonorants are also unspecified for voice, the most general formulation of the constraint that corresponds to (18b) will treat **md** on par with **pd**, and incorrectly rule out **md** as well.

[29] This analysis of voicing assimilation in English supports the position that b-type structure preservation is simply a consequence of allowing the domains of structural constraints to be specified on different modules of the grammar (T. Mohanan (1989)), and is not a property of a (lexical) module as such, contra Kiparsky (1982, 1985).

[30] An anonymous reviewer has pointed out that this generalization is more complex: unstressed forms appear to assimilate in the same styles of speech in which stressed ones do not (e.g. *some dried raisins* [səndrayd]).

account for the facts in (19) by assuming that alveolars are unspecified for place in English even postlexically, unlike labials and velars. This assumption, however, conflicts with the observation that a number of phonological regularities at stratum 1 in English require that alveolars be specified for place. These include (i) the syllable structure restriction which prevents a sequence of two noncontinuant coronals in the onset (*[dlet], *[tlet]), (ii) spirantization which applies to alveolar stops, but not labial and velar stops (*divide* [divayd] vs. *divisive* [diviziv], *resident* [rezident] vs. *residency* [rezidensi]), and (iii) s-voicing (*resume* [rizuwm] vs. *consume* [kənsuwm], but *refer* [rəfər]/*rəvər]). If alveolars are unspecified for place, then none of these regularities can apply to alveolars.

If alveolar consonants in English are specified for their place of articulation in the lexical module, prior to the post lexical assimilation, then the assimilation in (19) must be a structure changing operation. If so, its conformity to the principle in (14) cannot be derived from the combination of underspecification and structure building rules.

The problem I am raising here is the following. By formally representing the distinction between the non-dominant and dominant feature values as unspecified vs. specified, radical underspecification claims that from the point in the derivation where the unspecified value is specified, the distinction between non-dominant and dominant will cease to be operative. Given that the unspecified value must be supplied prior to the application of a rule that refers to the unspecified value in its structural description, it follows that beyond the point where a rule crucially refers to a non-dominant value, the asymmetry between dominant and non-dominant values will be inoperative (16b). The facts of English assimilation constitute a counterexample to this prediction. The derivation in the lexical module crucially requires reference to the non-dominant feature value ([+cor]), and yet this value continues as non-dominant in the derivation in the post lexical module. The representation of "non-dominant" as "unspecified", therefore, makes incorrect predictions.[31]

Another failure of the strategy of deriving (14) by representing "nondominant" as "unspecified" is found in the facts of morpheme internal assimilation in English. Even though /m/ does not assimilate across words, it does so within morphemes, thereby preventing *[mk] and *(mč] as

[31] The reverse problem appears in the post lexical rule of vowel assimilation in Yoruba. Across words, the last vowel of a word completely assimilates to the following vowel in the next stem, unless the stem initial vowel is /i/. Pulleyblank attributes this special behaviour of /i/ to its being completely unspecified. However, as Clements (1989) has argued, there are reasons to believe that /i/ is specified at level 1 in Yoruba. If so, the effect of the least dominant failing to trigger assimilation cannot be expressed in terms of underspecification.

morpheme internal codas. Yet, [m] does not assimilate to the following [t], as shown by *exempt*, *preempt*, etc.[32] The generalizations involved in morpheme internal and post lexical assimilations in English can be stated as follows:

A. Morpheme internal:	*trigger*	*undergoer*	
	non-dominant	dominant	*does not assimilate*
	dominant	dominant	*assimilates*
	dominant	non-dominant	*assimilates*
B. Post lexical	*trigger*	*undergoer*	
	non-dominant	dominant	*does not assimilate*
	dominant	dominant	*does not assimilate*
	dominant	non-dominant	*assimilates*

These facts are consistent with the statements in (14), but they cannot be derived from the formalism of underspecification and structure building rules. The particular problem is that of deriving the morpheme internal asymmetry of the dominant and nondominant triggers with respect to dominant undergoers. If the dominant undergoers are represented as specified, the prediction is that a structure building rule cannot apply to them, and that a structure changing rule will apply to them, whatever be the nature of the trigger. Therefore it is not true that we can deduce (14) from the combination of structure building rules and representations like (15).

Finally, let us observe that the mechanism of structure changing spreading cannot be eliminated in favor of the mechanism of structure building spreading, even though it has been claimed that apparent structure changing spreading can be reduced to a combination of independent rules of structure changing deletion and structure building spreading (Mascaro (1988), Cho (1988)). The rule of postlexical vowel assimilation in Yoruba in which all word final vowels assimilate to the following word initial vowel (except /i/) (Pulleyblank (1988)) cannot be dealt with in terms of independent deletion and structure building spreading: there is no independent rule in Yoruba that deletes the melodic substance of word final vowels.

The Malayalam rule of homorganic nasal assimilation in which both labial and coronal nasals assimilate to the following plosive word internally and across words (Mohanan and Mohanan (1984), K. P. Mohanan (1989))

[32] Paul Kiparsky has pointed out to me that the same facts hold in German, which allows [mt], but not [mk] and [mc].

is yet another counterexample to the claim. One possibility is to account for the Malayalam facts by stipulating a rule that deletes the place node of the nasal just when followed by a plosive (e.g. m k → N k → ŋk). However, if every counterexample to the claim that there are no structure changing spreading rules can be dealt with by stipulating unmotivated neutralization, then the claim is empirically vacuous. Furthermore, this solution also makes the incorrect prediction that there would be languages in which there is neutralization but no spreading *in the assimilatory environment*. In such a language, polymorphemic sequences like /mk/ would become [nk], though word final /m/ and sequences like /ms/, /mn/, and /ml/ will be unaffected. Therefore the solution of treating homorganic nasal assimilation in Malayalam as reduction-and-spreading is not open to us. Similar remarks apply to the rule of nasal spread in Malayalam, which converts a voiced plosive after a nasal into a nasal. As shown in Mohanan and Mohanan (1984) and Mohanan (1986), the rule of homorganic nasal assimilation, which precedes nasal spread, requires that the trigger be a plosive. Therefore, plosives must be specified as [−son, −cont] prior to nasal spread. Yet, nasal spread applies to these segments, converting them to [+son, +nasal]. As far as I can see, these facts cannot be analysed in terms of structure building spreading rules. If we have to allow structure changing spreading anyway in the theory, the addition of structure building spreading makes phonological theory unnecessarily rich.

4.4. *Underspecification and Neutralization*

Yet another empirical claim behind the formalism of underspecifying non-dominant values can be spelt out as (20):

(20) The output of neutralization rules is the non-dominant value.

Once again, combining (20) with (17) derives the result that the output of neutralization rules is the unmarked value. In Korean, for example, the contrast amongst different laryngeals is neutralized to the voiceless unaspirated in the syllable final position. Within radical underspecifiation, this fact can be accounted for by a rule that erases information on the laryngeal node, without specifying the direction of the change (Cho (1988)). Given an empty laryngeal node, the rule that inserts unmarked information would specify it as voiceless unaspirated.

Combining (20) with (17), we derive the prediction that *the output of neutralization rules is the unmarked value*. It is clear that (20) cannot be an absolute universal. Harris (1984), for example, reports that neutralization in Spanish results in the coronal nasal in some dialects and the velar

nasal in others. Given that the velar nasal is more marked than the coronal nasal, some dialects of Spanish violate the combination of (17) and (20).[33] If neutralization of the place of articulation is formulated as deletion of the place node, it cannot be the case that the value of this node is determined by a default rule that inserts the value of coronal. Putting together (16) and (20), we also predict that *the segment that undergoes assimilation is also the segment that contrasts neutralize to*. Whether or not this prediction is correct in an absolute sense remains to be investigated.

4.5. *Underspecification and Epenthesis*

One of the main arguments for radical underspecification has been that it provides a formal mechanism to state the facts of epenthesis (Archangeli (1984)). The claim can be stated as follows:

(21) The output of epenthesis is the non-dominant value.

Once again, combining (21) with (17) derives the result that the output of epenthesis is the unmarked value. Now, it is well known that the epenthetic vowel exhibits a considerable range of variation, from [i], [u], [ə] to [a]. Many Indian languages, for example, insert an epenthetic vowel to break up clusters, word finally, or after a syllabic /r/. Though the vowel inventory in these languages is roughly the same, the epenthetic vowel in Malayalam is [ə] ([gḷaasə] 'glass', [rəṣi] /rsi/ 'sage'), in Telugu it is [u] ([glaasu] 'glass', [ruṣi] 'sage'), and in Hindi it is [i] ([gilaas] 'glass', [riṣi] 'sage'). Given that markedness is a crosslinguistic constant, it makes no sense to say that [i] is unmarked in one language, while [u] is unmarked in another. I take it that the correlation between the unmarked value and epenthesis then is incorrect, at least with respect to vowels. Abandoning this claim is in fact implicit in Archangeli (1984) and subsequent work in which assumption (17) is dropped, although Kiparsky (1982, 1985) and other theories that subscribe to (2b) incorrectly predict cross linguistic invariance in the feature values of the output of epenthesis.

Given (16), (20) and (21), we would expect the following correlation between assimilation, neutralization and epenthesis: *the segment that undergoes assimilation asymmetrically is (i) the segment that contrasts neutralize to, and (ii) the segment that is inserted in epenthesis*. Once again, this prediction has to be carefully investigated.

[33] Harris reports (p.c.) that chances are that some of the final segments alleged to be the velar nasal may in fact be a nasalized vowel, though the velar nasal is not ruled out in other dialects.

Granted that coronals are more likely than noncoronals to undergo assimilation and be the epenthetic consonant, we must also recognize that coronals are more likely than noncoronals to undergo deletion and lenition.[34] In most dialects of American English, for example, /t/ undergoes lenition in unstressed syllables (in words like *writer*). In some dialects, /p/ also undergoes lenition in unstressed syllables (in words like *rapid*). However, there are no dialects in which /p/, but not /t/, undergoes lenition. Why should this be so? Perhaps the answer to this question is that segments with non-dominant feature values are more prone to assimilation, deletion, and lenition than those with dominant values. Whatever it is that makes coronals special with respect to assimilation makes them special with respect to lenition and deletion as well. Yet, asymmetry of coronals with respect to lenition and deletion cannot be expressed in terms of underspecification. If we devise some machinery other than underspecification to account for lenition and deletion, that machinery may account for assimilation as well.

4.6. *The Representation of Barriers to Spreading*

One of the motivations for radical underspecification has been the asymmetry of some feature values in allowing or disallowing the propagation of harmony across them. It has been claimed, for example, that coronals typically allow harmony to apply across them (e.g. Paradis and Prunet (1988)), while non-coronals block further propagation of harmony, acting as "barriers" to spreading.[35] Now, the representation of both non-dominant and predictable as unspecified makes the following claim:

(22) Predictable information cannot be a barrier to spreading rules.

This claim conflicts with the facts in Yoruba. Recall that the low vowel triggers [ATR] harmony and the high vowels block it, even though the value of [ATR] is predictable and hence unspecified in these vowels. In order to make these vowels non-transparent, A & P assume that the value of [ATR] in low vowels is inserted prior to spreading, and a constraint against associating [−ATR] with [+high] blocks the spreading rule. The

[34] I am grateful to an annoymous reviewer who raised this question.

[35] Once again, universal claims about the transparency of coronals are valid only within a theory of CSRA in which the decisions about which member of a distinctive pair is left unspecified is made on the basis of universal statements, and does not allow the universal statements to be overriden by language particular statements. If either /i/ or /e/ can be the maximally underspecified vowel, then the theory does not rule out the choice of a labial plosive or an implosive as the maximally underspecified consonant.

mechanism implicit in the account of coronal transparency in Fula and the transparency of voicing in sonorants in Russian (Kiparsky (1985)) should allow the spreading of [−ATR] across high vowels in Yoruba. Given the freedom to block such spreading by inserting default values prior to spreading, the theory does not predict that unspecified values are always transparent. The only prediction that we can draw from it is that *only* unspecified values can be transparent. If the theory also allows stipulations on the target and the trigger, the theory's predictive power is further compromised, because one can always restate the non-application of a spreading to a particular segment by making stipulations on the target.

A brief survey of the attested asymmetries of triggers, barriers, and undergoers of phonological rules fails to reveal any general patterns.:

A. In Russian predictable [+voice] in [+son] is not a trigger, undergoer, or barrier for the spreading of [voice] (Kiparsky (1985)).

B. In Yoruba predictable [+ATR] in [+high] is not a trigger or undergoer, but is a barrier for the spreading of [ATR] (Archangeli and Pulleyblank (1989)).

C. In Yoruba, predictable [−ATR] in [+low] is a trigger, but is not an undergoer for the spreading of [ATR] (Archangeli and Pulleyblank (1989).

D. In Warlpiri predictable [−round] in [+low] is not a trigger or undergoer, but is a barrier, in the spreading of [round] (Nash (1979), van der Hulst and Smith (1985), Kiparsky (1989)).

E. In Yoruba, unpredictable [+high, −back] on [−cons] (the default values of /i/) is not a trigger for vowel spreading (Pulleyblank (1988)).

F. In Warlpiri, unpredictable [−lab] on [+cons] is not a barrier for the spreading of [+round] (Nash (1979), van der Hulst and Smith (1985), Kiparsky (1989)).

G. In Fula, unpredictable [+cor] on [+cons] is not a barrier for vowel spreading (Paradis and Prunet (1989)).

H. In Telugu, unpredictable [−cor] on [+cons] is not a barrier for the spreading of [+round] (Wilkinson (1974), Kiparsky (1989)).

There is no discernible crosslinguistic correlation between predictability of information and the three types of asymmetry effects, and yet all the facts in A–H have been interpreted as evidence for underspecification. For example, transparency of both coronals and noncoronals has been attested in the radical underspecification literature (F–H); and yet, for some reason, coronal transparency has been singled out as evidence for radical underspecification!

Underspecification theories express the inability of a segment S to trigger spreading by omitting the values of the spreading features in the

underlying representation of S. They formally express the inability of a segment S to undergo spreading by specifying the values of the spreading features in the underlying representation of S. The prediction that derives from this formalism is that *the segment that fails to trigger spreading is the only segment that can undergo spreading, and vice versa.*[36] This prediction, however, is false, as shown by the facts of Yoruba, in which

(i) the low vowel triggers the spreading of [ATR], but fails to undergo it;
(ii) high vowels do not trigger or undergo the spreading of [ATR] although they are not specified for [ATR]; and
(iii) /i/ fails to trigger regressive vowel assimilation, but all vowels undergo it.

A–H above also show that the following claims are false; (a) a segment must be an undergoer but cannot be a trigger or barrier for a spreading rule if the spreading feature is predictable in that segment, (b) a segment cannot be an undergoer but must be a trigger and barrier for a spreading rule if the spreading feature is unpredictable in that segment. We have already shown that there is no crosslinguistic correlation between markedness and asymmetry effects. One might be able to use underspecification as a descriptive tool to stipulate certain transparency effects, but it doesn't explain anything, since it does not make any crosslinguistic predictions.[37]

Finally, consider what this account of asymmetry predicts for geminate inalterability. If we assume that segments which are maximally underspecified for place features lack the place node, the adjacent coronals /nt/ in a language that has homorganic nasal assimilation will not undergo the spreading rule, since neither of them have a place node to spread.[38] If so, their place specifications will be inserted by the default rules separately for each segment. As a result, [nt] will not constitute a partial geminate, since the two segments do not share a place node, and hence will fail to exhibit the effects of geminate inalterability. As far as I know, there is no evidence to support this prediction.

[36] An anonymous reviewer objects to this statement, saying that it is not true that all underspecification theories express failure to undergo spreading by specifying the values of the spreading feature. Given this position, I fail to see what they predict.

[37] Observe, in passing, the inconsistencies between the treatments of locality of spreading in Russian vs. Yoruba: In Russian, the locality condition on spreading (Archangeli & Pulleyblank (1986)) does not prevent the spreading of [voice] across a [+son] segment; in contrast, it prevents the spreading of [ATR] across /a/ in Yoruba.

[38] If we assume that coronals do have a place node (but the feature values are not filled in) a structure building rule cannot spread the place node to the coronal.

5. Lexical Exceptionality and Underspecification

We have seen that the formal device of underspecification has been used in phonological theory to express the distinction between predictable and unpredictable information, as well as that between marked and unmarked information. It is important that we distinguish these two uses of the device from a third use, namely, to express lexical exceptionality. Given that a structure building rule that assigns a value for the feature [F] will not apply to a segment that is specified for the value of [F], we can use the specifications [+F] or [−F] to prevent the application of the rule to the segment. To take an example, consider the analysis of the well known [t]/[s] alternation in Finnish attributed to Kiparsky in Borowsky (1986). Finnish has a rule that changes *t* to *s* when followed by *i*. Thus, /halut + i/ 'wanted' and /vete/ 'water' nom. are realized as [halusi] and [vesi]. However, underived forms like [äiti] 'mother', [itikka] 'mosquito' do not undergo this rule. This lexical exceptionality is expressed through the device of underspecification as follows. First, the rule of [t]/[s] alternation is formulated as a structure building rule, applying to segments unspecified for the feature [cont], but not to those specified as [−cont]. Second, "Those *t*'s which alternate with *s*'s . . . are represented [0 continuant] underlyingly. That is: /haluT/, /veTe/ etc. Unalternating *t*'s are underlyingly specified [−continuant] – thus: /äiti/, /itikka/ etc. (where *t* = [−cont]). Underlying *s* in other environments is distinguished by being [+cont] – e.g. /kasa/ . . . Exceptions to the rule in derived environments are also found, e.g., *souta* ~ *souti* and not **sousi*. This is simply captured by specifying the *t* here as [−cont] . . ." (Borowsky (1986: 51–52).

This analysis violates the condition that the two values of the same feature cannot be specified in the same environment (2a), unless the term "environment" refers only to the structural description of the rule of spirantization itself. If "environment" is defined by the rules of the grammar, we will be forced to scan all the rules of a grammar to guarantee that (2a) is not violated. Whether such a proposal is feasible or not, I will let the reader judge.

In analyses of this kind, underspecification is used to distinguish between alternating and non-alternating forms. Specification of a feature value serves as a diacritic that expresses lexical exceptionalty.[39] Unless phonological theory disallows lexical exceptionality features and claims that all instances of lexical exceptionality are amenable to analyses in terms of the specification of the information involved in the alternation, the use

[39] Another instance is the analysis of Ruki in Kiparsky (1982).

of underspecification to stipulate the distinction between alternating and nonalternating forms has no special advantage over the stipulation of lexical exceptionality. Also, this device cannot be extended to alternations which clearly involve structure changing operations, such as the absence of trisyllabic shortening in exceptions like *obesity* in English. Therefore the alleged advantages of using feature specifications as diacritics for lexical exceptionality is only illusory.

6. Concluding Remarks

At the heart of debates on underspecification are assumptions about the nature of the representations and the nature of the rule system. Radical (as well as many contrastive) theories of underspecification assume that underlying representations cannot contain predictable information (1) and that this information is supplied by structure building rules. In addition, context sensitive radical underspecification assumes that underlying representations cannot contain both values of a given feature in any given environment (2a.i), and that the value that is specified is the marked one (2b). Context free radical underspecification assumes that underlying representations in any given language cannot contain both values of a given feature (2a.ii), and rejects the assumption that the choice of the specified value is determined on the basis of universal assumptions about markedness.

I have argued that assumption (1) is unmotivated: the apparent advantages of (1) in expressing the relationship between distribution and alternation can be captured equally efficiently, and in some cases more efficiently, by the repair mechanism, and the independently required constraints on representations. I have also argued that (1) cannot even be maintained.

The motivation for eliminating one of the values of features (2) in radical underspecification is to express the asymmetric behaviour of dominant and nondominant feature values in assimilation, neutralization, and epenthesis. I have shown the formalism fails to express this asymmetry, and that many of its predictions are simply false.

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Received 20 March 1989
Revised 23 May 1990

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