

Deriving the Feature-Filling/ Feature-Changing Contrast: An Application to Hungarian Vowel Harmony

Charles Reiss

The article explores an alternative to the interpretive procedure adopted in *SPE* and proposes a unified interpretive procedure for all languages. The proposal solves long-standing problems by making it unnecessary to refer to a third value of binary features [\emptyset F], to introduce negation into lexical representations (e.g., [NOT + rd]), or to introduce a *feature filling/feature changing* diacritic on rules. The article provides a metric for comparing extensionally equivalent rule systems and argues that the most concise formulation is not always the correct one, by appealing to crosslinguistic evidence. The proposal is illustrated by application to the target/trigger relations in Hungarian vowel harmony.

Keywords: underspecification, Hungarian vowel harmony, subsumption, structural descriptions, phonological rules, conciseness

Unfortunately, within linguistics it has not been generally recognized how important such formal, theoretical work is; instead there is a feeling that too much concern for theoretical detail is a waste of time. . . . [T]he attitude that formal, theoretical work is bound to be both ad-hoc and sterile is, I am convinced, fundamentally mistaken . . .

Morris Halle, "Confessio Grammatici"

1 Distinctness and the Interpretation of Structural Descriptions

In practice, as inspection of any introductory phonology book will show, it has been implicitly assumed in generative phonology that a rule will apply to any representation that contains a superset of the information contained in the rule's structural description (SD). In other words, if the SD of a rule R subsumes a representation Q, then Q is an input to R. Rules apply to natural classes of segments, and a natural class is represented by a representation that subsumes the representation of each of its members.

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It turns out, however, that this is *not* the interpretive procedure developed in Chomsky and Halle 1968 (hereafter, *SPE*), the foundational work in the field.

(1) *Interpretive procedure from SPE (p. 337)*

A rule of the form $A \rightarrow B / X \text{ — } Y$ applies to any string $Z = \dots X'A'Y' \dots$, where X' , A' , Y' are not distinct from X , A , Y , respectively; and it converts Z to $Z' = \dots X'B'Y' \dots$, where B' contains all specified features of B in addition to all features of A' not specified in B .

Distinctness is defined as follows:¹

(2) *Distinctness in SPE (p. 336)*

Two units U_1 and U_2 are distinct if and only if there is at least one feature F such that U_1 is specified $[\alpha F]$ and U_2 is specified $[\beta F]$ where α is plus and β is minus . . .

The (typically implicit) appeal to subsumption in general phonological practice derives from the assumption of a logical equivalence between subsumption and nondistinctness, the idea that if x is nondistinct from y , then either x subsumes y or y subsumes x . This equivalence does not hold, however, except under the working assumption of the *SPE* era that representations are fully specified for all features. It *is* true that if either x subsumes y or y subsumes x , then x and y are nondistinct, but a simple example can illustrate that the converse is not valid if we allow for partially specified feature matrices in lexical entries.

Let $x = [+round, -back]$ and let $y = [+round, +high]$. The representations x and y do not disagree with respect to any features and are thus nondistinct, but one clearly does not subsume the other. And we clearly do not expect, say, that x would satisfy an SD specified as y .

As a further example, consider that by strict application of the *SPE* interpretive procedure, an underspecified vowel that had only the feature $[-round]$ would satisfy the SD of a rule like (3), since the representation $[-round]$ is not distinct from the representation $[-nasal]$.

(3) $[-nasal] \rightarrow [-voiced]$

This is surely an undesirable result.

Nondistinct representations are, in the general case, what is called “consistent” in unification-based frameworks—that is, they have no incompatible feature values. But nondistinctness, or consistency, does not reduce to subsumption.² The preceding discussion should make it clear that the interpretation of SDs in generative phonology warrants reexamination.

¹ I have omitted reference to nonbinary feature values.

² I have found the same point made by Bayer and Johnson (1995:sec. 2) in a discussion of Lambek Categorical Grammar: “Interestingly, in cases where features are fully specified, these subsumption and consistency requirements are equivalent.” However, I do not think that the relevance of this observation to the application of phonological rules has been noted.

2 Feature-Counting Evaluation Metrics

Perhaps all that is needed is to reject the *SPE* interpretive procedure in favor of one appealing to subsumption, since this is what the practice has been for the last several decades. Under this view, any representation subsumed by (containing a superset of the information contained in) a rule's SD is taken to be a licit input to the rule. This interpretive procedure has the desirable effect of allowing rules to apply to more than just single representations—they can apply to a natural class of representations whose description is subsumed by the rule's SD.

This interpretive procedure entails that a rule that changed feature values—say, from +F to –F for some feature F—would apply vacuously to representations that are already –F before the application of the rule.³ For example, a straightforward statement of Polish coda devoicing might be written as follows:

(4) [+ cons, – son] → [– voiced] in coda

This rule applies nonvacuously to [+ voiced] inputs that are [+ cons, – son]; in other words, it makes them [– voiced]. However, according to the subsumption-based convention of rule interpretation, the rule also applies, albeit vacuously, to [– voiced] inputs that are [+ cons, – son]. To reiterate, both [+ voiced] and [– voiced] can satisfy the SD to be inputs to the rule.

This interpretation of SDs is related to the *SPE* feature-counting evaluation metric, the overarching goal of which is to minimize redundancy in the grammar, as seen in the Conciseness Condition formulated by Kenstowicz and Kisseberth (1979).

(5) *The Conciseness Condition (one component of the SPE evaluation metric, from Kenstowicz and Kisseberth 1979:336)*

If there is more than one possible grammar that can be constructed for a given body of data, choose the grammar that is most concise in terms of the number of feature specifications.

With hindsight, it is now apparent that the Conciseness Condition is flawed by virtue of its parochialness—in choosing a model of grammar, the analyst should take into account the models necessary to generate other languages as well as the one in question, and not just choose the most concise grammar that can generate a given corpus. Thus, we can see that the Conciseness Condition as stated here is in direct conflict with the search for Universal Grammar (UG), the grammar of S_0 , the initial state of the language faculty.⁴

³ I adopt without argument a binary-valued feature system. The article is compatible with theories that allow various kinds of underspecification.

⁴ An important question is whether the correct formulation of a rule is necessarily the most concise one that is consistent with the data and with the crosslinguistic (universal) demands discussed here. I argue in Reiss 2002 that learnability considerations provide yet another reason to favor less concise rules than are traditionally posited.

(6) *Choosing among extensionally equivalent grammars (Chomsky 1986:38)*

Because evidence from Japanese can evidently bear on the correctness of a theory of S_0 , it can have indirect—but very powerful—bearing on the choice of the grammar that attempts to characterize the I-language attained by a speaker of English.

In other words, evidence from one language should bear on the best analysis of other languages. If two hypotheses, A and B, concerning UG are empirically adequate to provide an explanatory account of English, but only one of the two—say, A—is adequate to provide an explanatory account of Japanese, then we should select A as the best available hypothesis for a theory of S_0 that can lead to acquisition of *both languages*.

The traditional interpretation of SDs such as (4) is not the only logical possibility. It could have been argued that a rule like Polish devoicing should be formulated so as not to apply vacuously, as in (7).

(7) [+cons, –son, +voiced] → [–voiced] in coda

It seems that the decision to adopt the Conciseness Condition, and thus the rule format of (4), rather than (7), was motivated by the influence that engineering approaches to information theory had on the pioneers of generative phonology, an influence that has been described as leading to a dead end (Morris Halle, 1975:532 and personal communication). Formulation (4) was seen as the more efficient, and thus better, engineering solution since it was more concise than (7).⁵

In this article, I explore another logical possibility for the interpretation of SDs and show that it solves long-standing problems in phonological theory: the question of how to allow rules to target unmarked or unspecified feature values and the intimately related issue of the distinction between feature-filling and feature-changing rules. I then apply the solution to the generation of the alternations seen in Hungarian vowel harmony.

3 Subsumption and Structural Descriptions: A Problem

The SD in (4) subsumes various possible input representations. Crucially, all inputs must be specified for at least the features [+cons, –son]. To further understand the nature of the set of representations that can serve as inputs to the rule, we need to focus on features that are *absent* from the rule's SD. The traditional understanding of (4) depends on two distinct interpretations of the absence of a specification:

(8) a. Absence of a feature value implies that the feature is *irrelevant* to the application of the rule.

⁵ The belief that the mind organizes language in a maximally efficient manner may have also motivated the Conciseness Condition. However, it could also have been argued that avoiding vacuous application would have constituted a more efficient solution. Anderson's (1985:327) remarks on the topic are also telling: "Early concern for evaluation procedures . . . turned out to be something of a dead end. . . . [T]he appeal of feature counting went away . . . not with a bang, but with a whimper."

- b. Absence of a feature value implies that the feature does not need to be mentioned in the rule, because the rule neutralizes different values for the feature.

The absence of reference to features for place of articulation in the input of (4), for example, is interpreted as in (8a) to mean that the rule applies *regardless* of the place of articulation of the input consonant. In other words, features such as [coronal] and [labial] do not appear in the rule because they are irrelevant to its application: Polish devoicing applies to obstruents at all places of articulation.

Assuming that Polish alternating stops are underlyingly [+voiced],⁶ the rule applies vacuously to underlyingly [–voiced] stops and it changes underlyingly [+voiced] stops to [–voiced]. Thus, the rule's SD contains no reference to [voiced] since the rule neutralizes the distinction between [+voiced] and [–voiced]. This is interpretation (8b).

So, some features are absent from the SD because the rule does not affect them or depend on them in any way (8a), and others are absent because the rule neutralizes their two possible values (8b). To reiterate, any representation that is subsumed by the SD of the rule satisfies that SD. Thus, (4) can apply to the following inputs:

- (9) a. representations in which the absent features are irrelevant to rule application *and*
 b. representations in which the absent features are neutralized by the rule.

In contrast to the standard view of Polish-type patterns, consider a pattern that only became known much later in the history of generative phonology, one that requires rules that fill in values on necessarily underspecified segments.

In Turkish, for example, Inkelas (1996; Inkelas and Orgun 1995) argues that there is necessarily a three-way contrast in voicing. Some stem-final stops show a *t/d* alternation (10a), with [t] appearing in codas and [d] appearing in onsets. Inkelas convincingly argues for an underlying segment that has all the features of a coronal stop, but is unspecified for [voiced]. She denotes this feature bundle as /D/. She states that the segment is assigned the value [–voiced] in codas and [+voiced] elsewhere. Other stem-final stops consistently surface as [t] and thus are posited to be /t/ underlyingly (10b), and still others consistently surface as [d] and thus are posited to be /d/ underlyingly (10c).

(10) *Turkish voicing alternations*⁷

- a. Alternating: [∅voiced] (unmarked for [voiced]) /D/
kanat 'wing', *kanatlar* 'wing-pl', *kanadım* 'wing-1sg.poss'
- b. Nonalternating voiceless: [–voiced] /t/
sanat 'art', *sanatlar* 'art-pl', *sanatım* 'art-1sg.poss'

⁶ I will do so without argument here. The reader will notice that if Polish alternating stops are instead unmarked for voicing, the problem is to voice them in the appropriate contexts without targeting the nonalternating voiceless ones.

⁷ These data have been challenged in discussion on the grounds that some Turkish speakers do not pronounce the (10c) forms with a voiced obstruent in coda position. The irrelevance of such an objection is apparent, as long as the data represent a possible language. Since Orgun is a native speaker, I accept the data as given. The presence of inflectional

- c. Nonalternating voiced: [+voiced] /d/
etüd ‘étude’, *etüdler* ‘étude-pl’, *etüdüm* ‘étude-1sg.poss’

The rule responsible for making /D/ surface as [t] in codas would be identical to (4), but would have to be interpreted differently, since it crucially cannot apply to underlying /d/. In other words, the representation of /D/ subsumes that of /d/ (and also that of /t/), but the rule that affects /D/ does not affect /d/. It is necessary to interpret the absence of [voiced] in the SD as in (11c), which completes the list of interpretations of absent features under discussion.

- (11) a. Absence of a feature value implies that the feature is *irrelevant* to the application of the rule (= (9a)).
 b. Absence of a feature value implies that the feature does not need to be mentioned in the rule, because the rule neutralizes different values for the feature (= (9b)).
 c. Absence of a feature value implies that the feature *must* be absent from a potential input representation for the rule to apply.

Without an intelligent homunculus, a mental grammar needs a solution to the problem of correctly selecting the relevant interpretation of an SD.

4 Earlier Approaches

One way out of this dilemma would be to allow the grammar to refer to [\emptyset voiced] as a possible specification.

- (12) [+cons, –son, \emptyset voiced] → [–voiced] in coda

Below, I provide a principled argument against allowing [\emptyset voiced] as a possible specification. Traditionally, this move has been avoided by most researchers on the intuitive grounds that it represents an overly powerful enrichment of the representational apparatus of phonology.

Instead, however, the notational apparatus of rules has been enriched. Typically, a rule label—*feature filling* or, equivalently, *structure filling*—is used, as in (13), to ensure that such a rule is not (over)applied to fully specified segments and can only apply to provide feature values to underspecified segments. In the absence of such a label, the correct interpretation is left to the intelligence of the reader.

morphology suggests that the forms should be treated as Turkish and not as French (the language they were borrowed from). I refer the reader to the cited works for further data showing that this Turkish case is not isolated; Inkelas discusses several cases with the same logical structure. She further shows that these data cannot be handled by labeling certain morphemes as “exceptions.” For instance, she provides examples of a single morpheme with both an obstruent that alternates in voicing and one that is consistently voiced (even in coda position): *ed̞ɟlat* ‘ancestor’, *ed̞ɟlatlar* ‘ancestor-pl’, *ed̞ɟladu* ‘ancestor-acc’. This example shows that failure to devoice obstruents in coda position cannot be a property of individual morphemes, since the stem-medial /d̞ɟ/ remains voiced although it is always in coda position, whereas the stem-final /d/ alternates. Instead, the two segments must be representationally distinct: the former is [+voiced] and the latter is underspecified for voicing.

(13) *Feature filling*: [+ cons, – son] → [– voiced] in coda

This is the solution proposed by Inkelas and Orgun (1995:777). I reproduce their rules in (14).

(14) *Feature-filling rules from Inkelas and Orgun 1995:777*

- a. DEVOICING: Coda plosive → [– voiced] (structure-filling)
- b. VOICING: Onset plosive → [+ voiced] (structure-filling)

Their rule (14a) is basically equivalent to (13), and they propose a second feature-filling rule (14b) to provide the alternating stops with [+ voiced] in onsets.

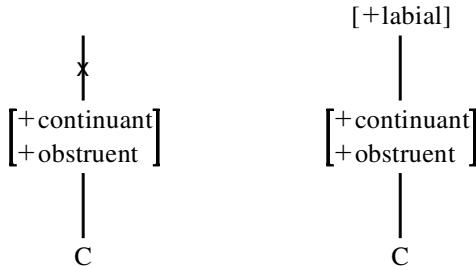
Another example of the *feature filling* label is provided by McCarthy (1994:210), who formulates a rule spreading [pharyngeal] from a consonant to a following vowel. In addition to an autosegmental representation of spreading, McCarthy includes the following in the rule statement: “Condition: Feature-filling.” He notes that the “intent of the condition restricting [the spreading] to feature-filling is to block the rule from lowering any vowel other than the featureless vowel schwa.” Because it is featureless, consisting of just enough features to identify it as a vowel, the representation of schwa will subsume that of every other vowel—less specification entails greater generality.

Kiparsky’s (1985) discussion of coronal underspecification briefly notes the problem treated here, stating that it is necessary “to work out some way of referring to unmarked segments” (p. 98) when representations are not fully specified. However, his manner of distinguishing underspecified segments is not satisfactory since he introduces a new diacritic into representations just in places where, for example, [+ coronal] (or a Coronal class node) would be specified. Kiparsky proposes that (15a) be the representation of a coronal fricative such as /s/, where the x on the line to the missing node means ‘There is no specification on the tier of place features’. How do we know (or, more importantly, how does the grammar ‘know’?) that the x doesn’t denote underspecification for some other feature?

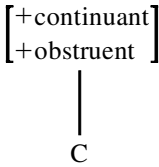
(15) *Representations of /s/ and /f/ (Kiparsky 1985)*

a. /s/

b. /f/



Kiparsky represents a noncoronal voiceless fricative such as /f/ as in (15b), where the root node is associated to a labial place node. The natural class including both these voiceless fricatives /s/ and /f/ would presumably be represented by Kiparsky as in (16), unspecified for features on the place tier.

(16) *Representation of all fricatives in Kiparsky's (1985) system*

Obviously, Kiparsky's system of representing /s/ in (15a) is the equivalent of specifying [+coronal], since the representation of /s/ contains information not present in (16) and can hardly be called underspecified.⁸

Similar use of a diacritic denoting the absence of an association to a given node can be found in Archangeli 1988, where a "melody unit or anchor" Z can be linked to a feature F via normal association lines between Z and F, obligatorily unlinked to F if Z is enclosed in a circle, or ambiguously linked or unlinked to F in the absence of an association line or circle.

(17) *Linkage notation (adapted from Archangeli 1988); Z is a "melody unit or anchor"*

- a. \textcircled{Z} unlinked to F
 b. Z linked to F
 |
 F
 c. Z ambiguously linked or unlinked to F

This notation presents a problem similar to the one facing Kiparsky's (1985) system, since the meaning of the circle around the Z in a given rule is 'unlinked to the feature F that the rule will provide'. Thus, this notation of "underspecification" requires reference to the very feature whose mention it is meant to avoid.

In the next section, I develop a unified interpretive procedure for SDs that vitiates the need for explicit *feature filling* or *feature changing* diacritics, as well as the need to refer to features that are absent from a representation—I do not use [ØF] as a possible specification.

5 The Unified Interpretive Procedure

For a given rule R_a , we can refer to its structural description as SD_a , its structural change as SC_a , and its environment as Env_a , giving us the simple rule schema in (18).

⁸ Kiparsky's suggestion leads to other problems as well: does the line in (15a) block spreading?

(18) *Rule schema*⁹

$$R_a: SD_a \rightarrow SC_a \text{ in } Env_a$$

We will employ Greek letter variables in the usual way: $\alpha \in \{+, -\}$.

I also assume that something like Chomsky's (1967) Principle 6 is valid: "Two successive lines of a derivation can differ by at most one feature specification."¹⁰ This principle helps restrict the notion of possible phonological rule, and thus it is desirable to conform to it. For our purposes, this principle means that SC_a will always contain a single feature specification, $+F$, $-F$, or αF . We can now formulate the unified interpretive procedure (UIP) for structural descriptions, substituting αF for SC_a .

(19) *Unified interpretive procedure for structural descriptions*

A representation Q is an input to a rule R_a

$$SD_a \rightarrow \alpha F \text{ in } Env_a$$

if and only if SD_a subsumes Q and one of the following holds:

- a. $-\alpha F \in SD_a$ (SD_a and thus each Q that satisfies SD_a is specified $-\alpha F$) *or*
- b. $-\alpha F \notin Q$ (no Q that satisfies SD_a is specified $-\alpha F$, and thus SD_a is not specified $-\alpha F$, either).

First consider (19a). Since (19a) requires that SD_a be specified $-\alpha F$, it follows that every representation Q subsumed by SD_a be thus specified. Since SD_a must subsume every input to the rule, each input must also be specified $-\alpha F$. A representation Q that satisfies this condition will undergo feature changing to αF .

Now consider (19b). The requirement of (19b) is that Q not be specified $-\alpha F$, so it can be either specified αF or *not specified at all* for feature F . Since Q is required not to be specified $-\alpha F$, any Q that satisfies this condition will not be subsumed by an SD_a that is $-\alpha F$. In other words, if Q is not $-\alpha F$, and Q is an input to R_a , then SD_a is also not $-\alpha F$. (We thus see that (19a) and (19b) are mutually exclusive: they cannot be satisfied simultaneously.) If condition (19b) is fulfilled, the rule will either fill in the value αF or vacuously "change" αF to αF .

The two conditions thus require either (a) Q is $-\alpha F$ or (b) Q is not $-\alpha F$. (Further conditions are imposed by Env_a , of course.) The existence of underspecification means that *not $-\alpha F$* does not mean ' αF ', but instead means 'either αF or unspecified for F '.

Thus, if SC_a is $-F$, and SD_a is specified $+F$, then an input to R_a must contain $+F$ in order to satisfy SD_a by condition (a). However, if SC_a is $-F$ but SD_a is not specified $+F$, then an

⁹ More discussion is required for deletion, insertion, and metathesis rules. These problems are addressed in work in progress. Also, the environment Env is, strictly speaking, part of the SD , but I will treat them separately for the sake of clarity.

¹⁰ This notion can be adapted for more recent theories of representation. I do not make use of, for example, feature geometry in this article, and I have argued elsewhere (Reiss, to appear a,b) that feature geometry is not a necessary or desirable part of phonological theory.

input to R_a may not contain $+F$. It may be specified $-F$ (R_a will apply vacuously in this case) or it may be unspecified for F (R_a will fill in $-F$ in this case) and thus satisfy SD_a by condition (b).

Similarly, we can switch all the signs. If SC_a is specified $+F$ and SD_a is specified $-F$, then an input to R_a must contain $-F$ in order to satisfy SD_a by condition (a). However, if SC_a is specified $+F$, but SD_a is not specified $-F$, then an input to R_a may not contain $-F$, but it may be specified $+F$ (R_a will apply vacuously in this case) or it may be unspecified for F (R_a will fill in $+F$ in this case) and thus satisfy SD_a by condition (b).

So, (19a) corresponds to traditional feature-changing rules and (19b) to traditional feature-filling rules. However, the UIP precludes the necessity of referring to unmarked values such as [\emptyset voiced]. The crucial advance we have made is this: instead of having “to work out some way of referring to unmarked segments,” we have a way to ensure that they are treated as a class with representations that are vacuously affected by rules.

In a language like Polish, which has a two-way voiced/voiceless contrast in obstruents, we might be tempted to retain the traditional formulation of the devoicing rule and the traditional interpretation of SDs. We would still generate Polish-type output. However, a truly explanatory approach to phonology allows us to see that Turkish can tell us something about Polish: the correct formulation of the rule must be something closer to (7) than to (4). Since we are interested in UG, we are interested in a single interpretive procedure for all grammars. This was the point of the quotation from Chomsky 1986 in (6).

In the particular case of the representation of Polish devoicing, UG should be assumed to use the same interpretive procedure as is used in Turkish. More concise rules can be written for just the Polish data, but they would not be rules of human phonology, if the UIP is correct. Since the interpretive procedure for all languages is assumed to be identical, but the patterns to be accounted for are different, the rules themselves must differ as well. Polish uses (7), whereas Turkish uses (4).

In other words, the traditional account of Polish devoicing using the subsumption-based interpretive procedure would be extensionally equivalent to the account proposed here (using (7) and the UIP), but we now can choose between them in a principled fashion. Again, this is the type of argumentation suggested by (6).

A further implication of the UIP is that we now derive the intuitively valid result that rules do not treat representations that are $+F$ and representations that are $-F$ as a natural class to the exclusion of representations that are unmarked for F . With respect to the Turkish data discussed above, this means that, for example, $/t/$ and $/D/$ constitute a natural class (they are *not* [$+voiced$]), and $/d/$ and $/D/$ do so as well (they are *not* [$-voiced$]), but $/t/$ and $/d/$ do not, to the exclusion of $/D/$.

For the sake of explicitness, let me reiterate the difference between the simple subsumption-based interpretation of SDs and that given by the UIP. A rule like (4) should apply to [$+voiced$] stops according to the traditional interpretive procedure. The SD of (4) is given as [$+cons, -son$], and since the representations of, say, $/t/$, $/D/$, and $/d/$ are subsumed by [$+cons, -son$], the rule

should apply to all three. But this would not let us distinguish /d/ from /D/, which we need to do for Turkish.

However, using the UIP, a rule like (4), where the SC is [−voiced], cannot apply to [+voiced] representations like /d/.

- (19a) is not satisfied since [+voiced] is not in the SD of the rule as stated.
- By (19b), any Q that is an input to the rule cannot be specified as [+voiced].

Since neither condition is satisfied, the rule cannot apply to [+voiced] representations. However, both /t/ and /D/ satisfy condition (19a), since /t/ is [−voiced], and the rule applies vacuously; and /D/ satisfies condition (19b), since /D/ is *not* [−voiced], and thus the rule fills in this value. This would work perfectly for our model of Turkish.

Consider now the rule in (7), repeated here:

(20) [+cons, −son, +voiced] → [−voiced] in coda

Since the SD of the rule contains [+voiced], the rule can obviously apply to [+voiced] representations. It cannot apply to representations that are either specified [−voiced] or unspecified for [voiced]—the SD does not subsume such representations. This would work perfectly for our model of Polish.

6 Discussion

A reviewer of an abstract of this article objected to the UIP on the grounds that it is an extremely powerful device, since it is meant to be relevant to all rules in all languages. This objection reflects a misunderstanding of the notion of power in theory construction. In fact, a single interpretive procedure that holds for all rules in all languages provides a *less* powerful (and thus better) model than one that allows various devices on an ad hoc rule-by-rule and language-by-language basis. The objection can thus be dismissed.

Note that the result of the UIP in (19) can also be derived by allowing the use of logical negation in phonological representations. For example, if Turkish /t/ and /D/ were both specified [NOT +voiced], then the rule that fills in [−voiced] on /D/ in codas could refer to this specification.

(21) [+cons, −son, NOT +voiced] → [−voiced] in coda

Allowing negation in representations to have scope over a single-valued feature such as [+voiced] will not obviously create problems. However, allowing negation to have scope over sets of valued features would wreak havoc with the notion of natural class. It would allow us to treat the complement set of each natural class as a natural class. For example, the segments described by the set NOT[+voiced, +labial] would include both [d] and [p], but not [b].

What the UIP does is introduce logical negation into the interpretation of rules without enriching the set of primitives that can appear in lexical representations. The UIP does redefine the notion of natural class, in fact, but in a very restricted fashion: “[αF]” and “unspecified for

F' constitute a natural class to the exclusion of "[$-\alpha$ F]" in the sense that the difference between otherwise identical members of a natural class "NOT[$-\alpha$ F]" is neutralized by the rule. Under this view, natural classes are defined, not by a feature matrix that subsumes a set of phonological representations, but by a set of phonological representations that are accepted as inputs to a rule, given the UIP. In other words, natural classes are derived from the nature of rule application, rather than constituting a primitive notion of phonological theory. I think this is a desirable result.

We can now return to the rejection of the use of \emptyset as a coefficient value for features. Obviously, we could introduce this value, allowing the set of values to range over $\{+, -, \emptyset\}$. However, this move would have implications for the behavior of natural classes that appear to be undesirable. If phonological rules could refer to [\emptyset F] in SDs, then it would be possible to apply rules to segments so specified without affecting other segments. For example, it would be possible to affect Turkish /D/ to the exclusion of both /d/ and /t/—say, by rounding it before round vowels.

(22) *A hypothetical rule*

[\emptyset voiced] \rightarrow [+labial] before [+labial]

My intuition is that we will not find such processes; but introducing \emptyset as a feature value allows such possibilities since [\emptyset voiced] describes a natural class to the exclusion of /d/ and /t/. In contrast, such a process cannot be modeled using the UIP approach. Underspecified segments can never be referred to without referring to the segments with which they neutralize on the surface.

Either the introduction of negation into the set of lexical representational primitives (e.g., [NOT +voiced]) or the use of \emptyset as a possible feature coefficient ([\emptyset voiced]) can be used to correctly model data with the logical structure of the Turkish stop alternations. However, I have provided arguments that introducing logical negation into the *interpretive procedure for rules* is empirically preferable to both of these alternatives. Let us turn now to discussion of a more complex rule type.

7 Rules Containing Variables

In the previous discussion, α was used as a metalanguage variable to refer to either "+" or "-" within rules. In this section, I show that the UIP applies without modification also in cases where α denotes a variable within the rules themselves.

If SC_a contains the variable α F, then a representation Q will serve as input to R_a if SD_a subsumes Q and either (a) Q and SD_a are specified $-\alpha$ F (to satisfy (19a)) or (b) Q and SD_a are not specified $-\alpha$ F (to satisfy (19b)). Since α ranges over + and -, $-\alpha$ also ranges over + and -. This means that if SC_a is specified α F, and SD_a is *not* specified $-\alpha$ F, then inputs to R_a cannot be specified either +F or -F (19b). Thus, R_a must be feature filling: its inputs must be unspecified for F.

Immediately we see that this forces us to revise a type of rule that is commonly invoked: the type that involves feature-changing assimilation to either -F or +F. For example, the voicing assimilation seen in Russian prepositions in (23a) is represented in standard generative phonology

as in (23b) (Halle and Clements 1983). We see that /t/ voices to [d] and that /z/ devoices to [s], when preceding a voiced or voiceless obstruent, respectively.

(23) *Traditional statement of Russian voicing assimilation (to be rejected in accordance with (19))*

a.	‘from’	‘without’	‘next to’
‘rose’	at rózi	bʲiz rózi	u rózi
‘Ala’ (name)	at áli	bʲiz áli	u áli
‘cow’	at karóvi	bʲis karóvi	u karóvi
‘beard’	ad baradǫ	bʲiz baradǫ	u baradǫ
‘sister’	at sʲistrǫ	bʲis sʲistrǫ	u sʲistrǫ
b.	[+ cons, – son] → [αvoiced] / ____ [– son, αvoiced]		

According to the UIP (19), the presence of [αvoiced] in the SC and the lack of reference to [voiced] in the SD force the interpretation that inputs lack [–αvoiced]. Since $\alpha \in \{+, -\}$, this rules out any value for [voiced] in the input. Thus, in accordance with the UIP, this rule would only be licit as a feature-filling rule, applying to consonants that lacked a value for [voiced].

Assuming, as is traditional, that Russian obstruents are all specified as either [+voiced] or [–voiced] underlyingly, the analysis could, in accordance with the UIP, be split into two rules:

(24) *Two-valued assimilation*

- a. [+voiced, + cons, – son] → [–voiced] / ____ [–voiced]
 b. [–voiced, + cons, – son] → [+voiced] / ____ [+voiced]

Rule (24a) would apply only to [+voiced] stops. Rule (24b) would apply only to [–voiced] stops.

However, it now becomes apparent that we can collapse the two processes and still honor the UIP.

(25) [+ cons, – son, – αvoiced] → [αvoiced] / ____ [– son, αvoiced]

The rule, like Polish (and Russian) coda devoicing, is thus purely feature changing: whenever there is feature changing, there is no vacuous application. If we compare (25) with (23b), we see that once again the UIP drives us to accept a less concise representation of the rule. The new formulation contains three mentions of α , as compared with two in the original.¹¹

¹¹ Of course, it is common to represent such a process as a rule autosegmentally spreading the [voiced] specification from an obstruent to the one preceding it. Elsewhere (Reiss, to appear a,b), I argue that much of autosegmental phonology must be replaced by an algebraic notation using variables and indices. The more powerful algebraic notation is necessary, since phonological quantification appears to require the use of quantifiers in order to express nonidentity conditions. In other words, some version of the old-fashioned alpha notation may be the best way to express such processes.

I will now apply the UIP to the generation of a more complex body of data, the trigger-target relations found in Hungarian vowel harmony.

8 Regular Patterns in Hungarian Vowel Harmony

In the following discussion, I treat only the fully productive patterns of Hungarian vowel harmony in regular stems. For example, I leave aside the representational issues associated with front vowel stems that take back vowel suffixes, rule iterativity, and the treatment of transparent vowels. There are four main patterns of harmonic alternations, which I first present with the orthographic vowels, since the orthography has typically guided (excessively, I believe) other treatments of these facts. I turn in section 9 to the phonetic values of the vowels, showing some of the deficiencies of relying too heavily on the orthography, and in section 10 to the lexical representation of alternating and nonalternating vowels. In section 11, I develop a set of rules for generating the surface forms from the proposed lexical representations, and in section 12, I provide schematic derivations.

Nothing crucial relies on deriving all of these alternations from rules that correspond to “structure-filling” rules; however, the complex patterns and the relative familiarity of the data make Hungarian vowel harmony an attractive testing ground for a new proposal.

8.1 Harmony involving *a/e*

Suffixes such as inessive *-ban/-ben* surface as *-ban* after back vowels and *-ben* after front vowels: *dobban* ‘in a drum’, *szemben* ‘in an eye’. These suffixes are never rounded and thus surface with the unrounded front variant also after a front round vowel: *tökben* ‘in a pumpkin’.

8.2 Harmony involving *á/é*

There are also alternations involving the so-called long versions of *a/e*, as in the translative suffix *-vá/-vé* (the *v* assimilates to a preceding consonant): *dobbá* ‘(turn) into a drum’, *szemmé* ‘(turn) into an eye’, *tökké* ‘(turn) into a pumpkin’.

8.3 Harmony involving *u/ü, ú/ú, and ó/ó*

The other alternations with two forms always have round vowels. They agree with the backness of the preceding vowel. Some consistently have a short high round vowel: *angolul* ‘in English’, *törökül* ‘in Turkish’, *lengyelül* ‘in Polish’. Others have the long counterparts of these high vowels: *lábú* ‘-legged’, *fejű* ‘-headed’. Finally, one set consistently has a long mid round vowel: *dobtól* ‘from a drum’, *szemtől* ‘from an eye’, *töktől* ‘from a pumpkin’. Thus, the height of the preceding vowel never affects the harmonic vowel: *tűztől* ‘from a fire’.

8.4 Harmony involving *e/ö/o*

Finally, we must consider harmony patterns with three alternants. These are restricted to a single pattern involving mid vowels: *e/ö/o*. This pattern is seen in the superessive suffix *-en/-ön/-on*:

szemen ‘on an eye’, *tökön* ‘on a pumpkin’, *dobon* ‘on a drum’.¹² The vowel of this suffix is present underlyingly, and it can be accounted for straightforwardly.

However, there are other vowels that participate in a vowel-zero alternation and may be analyzed as epenthetic. These vowels generally show the same three-way *e/ø/o* contrast. Such is the case of the accusative suffix: *szemet* ‘eye-acc’, *tököt* ‘pumpkin-acc’, *dobot* ‘drum-acc’. These “unstable” vowels also surface as *a/e* after so-called lowering stems. I leave a discussion of such stems aside for the purposes of this article.

9 Vowel Phonetics

In the preceding section, I referred to the vowels using standard orthography and occasional reference to their phonetic features. In this section, I provide the IPA symbols that represent the vowels in standard pronunciation, along with a featural representation. The umlaut marks front round vowels. The lengthened umlaut marks long front round vowels, and an acute accent marks all the other long vowels. Thus, one of the two orthographic marks of length is always present on a phonetically long vowel, and never present (aside from a few frozen spellings) on a short vowel. However, the phonetically long vowels do not always differ from their “short” counterparts in length alone; they may also differ featurally, with respect to height, rounding, or tenseness.

The IPA symbols and featural descriptions I have assigned are based on examination of a variety of sources, most importantly consultation with native-speaker linguists Péter Siptár and Sylvia Blaho.

Many discussions of Hungarian vowels abstract away from predictable and nondistinctive features. For example, Siptár (1994:175) says of the *á* vowel that the height (extra low, in comparison with *a/e*, which are often treated as low) and backness (fairly central) are “a matter of phonetic implementation since in the (morpho)phonological pattern of Hungarian [this vowel] behaves as a low back vowel (*e.g.* with respect to vowel harmony, long/short alternations, *etc.*).” I will assume a minimal amount of underspecification (following Inkelas 1996) and thus include such features. Assuming an inventory of binary vowel features that consists of {hi, lo, bk, rd, ATR}, I prefer to remain faithful to the phonetic facts wherever possible and to show how doing so helps us to account for a complex set of interactions. Note that all the high vowels are [+ATR]. For the mid front unrounded vowels, the short one is lax ([−ATR]), the long one tense ([+ATR]). However, the other four mid vowels, all the round ones, are all tense. Finally, note that orthographic *a* represents [ɔ], a mid back round lax vowel, whereas *á* is low and unrounded and tense.

¹² The superessive does also surface as just *-n* when the stem ends in a vowel, as in *kapu-n* ‘on a gate’. I assume this results from a straightforward vowel deletion rule.

(26) *Surface vowels of Hungarian*

Orthography	IPA	Features	Length
i	[i]	[+ hi, - lo, - bk, - rd, + ATR]	short
í	[i:]	[+ hi, - lo, - bk, - rd, + ATR]	long
ü	[y]	[+ hi, - lo, - bk, + rd, + ATR]	short
ű	[y:]	[+ hi, - lo, - bk, + rd, + ATR]	long
e	[ɛ]	[- hi, - lo, - bk, - rd, - ATR]	short
é	[ɛ:]	[- hi, - lo, - bk, - rd, + ATR]	long
ö	[ø]	[- hi, - lo, - bk, + rd, + ATR]	short
ő	[ø:]	[- hi, - lo, - bk, + rd, + ATR]	long
u	[u]	[+ hi, - lo, + bk, + rd, + ATR]	short
ú	[u:]	[+ hi, - lo, + bk, + rd, + ATR]	long
o	[o]	[- hi, - lo, + bk, + rd, + ATR]	short
ó	[o:]	[- hi, - lo, + bk, + rd, + ATR]	long
a	[ɔ]	[- hi, - lo, + bk, + rd, - ATR]	short
á	[a:]	[- hi, + lo, + bk, - rd, + ATR]	long

Most analyses of Hungarian abstract away from all of these surface distinctions—for example, treating *a* as an unrounded vowel for the purposes of harmony. In the following discussion, I take a different course.

10 Vowels in Underlying Representation

Following work by Inkelas (1996) and others, I assume that learners posit underspecification only when alternations in the data force them to do so. In other words, it is logically possible that Polish has the alternation /t/ versus /D/, rather than /t/ versus /d/, but we assume that /D/ is posited only if /t/ and /d/ are “already assigned.” The child’s default parse is that underlying segments are identical to surface segments, and this default is rejected only if alternations force a new analysis,¹³ as in Turkish. Polish does not present the child with data that will force such a change. Since the transparent parse works, the learner sticks with it and does not consider other extensionally equivalent grammars.¹⁴

(27) *Inkelas (1996:1) on underspecification*

[U]nderlying representation is determined solely by optimization with respect to the grammar, not by imposing any type of constraints directly on underlying representa-

¹³ See Hale and Reiss 1998 for arguments concerning the transparency of the child’s initial parse.

¹⁴ An additional source of underspecification may arise in order to capture distributional patterns, but the point here is that there is no obvious need to minimize the amount of information stored in lexical representations, since this represents a longer learning path; see Hale and Reiss, to appear, for discussion.

tion. . . . [This] results in the use of underspecification only when there are alternant surface forms . . .

Inkelas specifically rejects philosophical arguments for underspecification.

- (28) “Grammar-blind” approaches to underspecification rejected by Inkelas (1996, and references cited there)
- a. Markedness (universal, language-specific, or contextual): Unmarked material is underspecified.
 - b. Redundancy: Redundant feature values (determined on the basis of the segment inventory) are underspecified.
 - c. Predictability: Predictable material is underspecified.

According to Inkelas, “The only motivation for underspecification is to capture alternations in the optimal way” (1996:2). The underspecification posited for the harmonic vowels of Hungarian will be guided by this principle.

10.1 Nonalternating Vowels

In the case of nonalternating vowels, I assume that they enter and exit the phonology with the same featural representations. There are no redundancy rules, for example. Thus, both nonalternating and alternating high vowels are [+ATR] in the lexicon, and they surface as [+ATR]. The fact that [+ATR] is predictable from [+hi] is not encoded in the grammar.

10.1.1 Stem Vowels Aside from a few length alternations and vowel-zero alternations that will not concern us, all stem (and prefix) vowels in Hungarian have a constant value.¹⁵ All of the vowels in (26) appear in stems, and many in prefixes. I assume that they all have the underlying and surface featural representations given above.

10.1.2 Suffix Vowels Vowel harmony in Hungarian only affects suffixes. However, not all suffixes are subject to harmony. The following suffixes are among those that do not alternate: *-ig* ‘until’, *-ként* ‘as’, *-kor* ‘at a time’: *hatkor* ‘at six o’clock’, *hétkor* ‘at seven o’clock’.

10.2 Alternating Vowels

I now propose underlying representations for the alternating harmonic vowels. I will assume that each of the alternations mentioned in section 8 can be captured via a partially underspecified representation and a set of phonological rules that *fill in* some feature values; no feature-changing

¹⁵ Of course, a full evaluation of my proposal will ultimately require accounting for the length alternations as well. I leave this for future research.

rules are needed. Length is mentioned in the prose, but not represented featurally, since I assume it is represented through multiple linking to a timing tier.¹⁶

10.2.1 The Lexical Form of the a/e Vowel Suffixes such as the inessive *-ban/-ben*, illative *-bal/-be*, and sublative *-ral/-re* are all stored with the following feature values for their alternating vowel, *a* or *e*: [−hi, −lo, −ATR]. This should not be controversial, since such suffixes do in fact alternate with respect to [bk] and [rd] (*a* is [+rd]). The specification [−lo] is maintained, since both realizations of the vowel, [ɔ, ɛ], are mid vowels.

10.2.2 The Lexical Form of the á/é Vowel The vowels *á* and *é* are never high or round, but they alternate between mid front and low back. I assume that both forms are [+ATR], although this may be debatable. Accordingly, the underlying form is [−hi, −rd, +ATR].

10.2.3 The Lexical Form of the Consistently Round Vowels The alternations among the consistently round vowels can all be generated by the same rule—the only alternating feature is [bk].

The *ú/ü* alternation is between front and back vowels that are consistently high, round, and tense. These vowels are represented as [+hi, −lo, +rd, +ATR], with no specification for [bk]. This feature is filled in by context.

The *ú/ű* alternation is between long vowels that are consistently high, round, and tense. These vowels are represented as [+hi, −lo, +rd, +ATR].

The *ó/ő* alternation is between long vowels that are consistently mid, round, and tense. These vowels are represented as [−hi, −lo, +rd, +ATR].

10.2.4 The Lexical Form of the e/ö/o Vowel The most complex alternation to deal with is the one that shows three surface forms, *e/ö/o*. As mentioned above, the presence of a vocalic feature bundle is underlying in some cases of three-way alternations and epenthetic in others. Of course, in the latter case, it is misleading to refer to the vowel's lexical representation. However, I will assume that both underlying and epenthetic three-form suffixes enter the phonology as [−hi, −lo]. ‘Feature-filling’ rules provide the values for [bk], [rd], and [ATR].

10.3 Personal Pronoun Forms

Corresponding to the case endings discussed above are a set of stems that inflect for person. For example, the inessive *-ban/-ben* corresponds to *bennem, benned, benne, bennünk, bennetek, bennük* ‘in me, in you, . . .’. The stem appears with the front vowel [ɛ], with which the person endings harmonize. Similarly, the delative *-róll/-ről* corresponds to *rólam, rólad, róla, rólunk, rólatok, róluk* ‘from off of me, from off of you, . . .’, all with back vowel suffixes. It is thus tempting to see these case stems as providing evidence for the underlying vowel quality of the case suffixes.

¹⁶ Although I rejected some uses of autosegmental phonology in footnote 11, here I am appealing to an autosegmental representation of length. This will have to be dealt with.

However, in several categories, the case stem and case suffix do *not* match phonologically. The superessive ending *-en/-ön/-on* corresponds to the case stem in *rajtam, rajtad, rajta, rajtunk, rajtatok, rajtuk* ‘on me, on you, . . .’. The elative *-ból/-ből* corresponds to the case stem in *belőlem, belőled, belőle, belőlünk, belőletek, belőlük* ‘from in me, from in you, . . .’. Thus, I will assume that the case endings and the case stems are listed independently in the lexicon. In other words, contra Ringen and Vago (1998), I conclude that there is a set of suffixes such as */-bVn/* with underspecified, alternating vowels, and a set of stems such as */bɛn-/* with fully specified, nonalternating vowels. In some instances (e.g., inessive */-bVn/* and */bɛn-/*), the forms are clearly related etymologically, whereas in others (e.g., elative */-bVl/* and */belől-/* or superessive */-Vn/* and */rajt-/*), the relationship is opaque. The case stems contain fully specified vowels that trigger harmony in the personal suffixes; the case endings harmonize with the stems they attach to. There is no need to posit feature-changing processes in those instances where the case stem and case suffix just happen to look alike.

11 The Rules

In this article, I am concerned only with capturing the interactions between triggers and targets of harmony. Therefore, I will not address the issues of transparent vowels or of roots with surface front vowels that trigger back harmony. I will also not propose an explicit mechanism for harmony in terms of syllable structure or higher-level structures. I will adopt a simplified view in which harmony occurs between a vowel and the vowel that precedes it. The following seven rules are posited with crucial ordering noted. All seven are what would be called feature-filling or structure-filling rules in other accounts.¹⁷ This does not need to be stated for each rule, since it follows from the UIP.

$R_1: V \rightarrow [\alpha bk] / [\alpha bk] \text{ ____}$

This rule applies first. According to the UIP, it can only apply to vowels that have no specification for [bk]. Thus, it applies to all of the alternating vowels and none of the nonalternating ones.

$R_2: [-lo, +bk] \rightarrow [+rd]$

In accordance with the UIP, this rule applies to $[-lo, +bk]$ vowels that are *not* $[-rd]$. The rule applies vacuously to already round vowels that are also $[-lo, +bk]$, and in feature-filling fashion to $[-lo, +bk]$ vowels that are unspecified for [rd]. Since R_2 applies to vowels that became $[+bk]$ via R_1 , R_2 must follow R_1 . For example, a vowel that enters the phonology as $[-hi, -lo]$ could become $[+bk]$ by R_1 if it follows a back vowel, and then $[+rd]$ by R_2 . It would then receive an [ATR] value from R_6 , and at this point it would be fully specified for all the vowel features.

¹⁷ Some also happen to be what are traditionally called fill-in rules—rules that supply default values only with reference to context within the segment itself.

$R_3: [+bk, -rd] \rightarrow [+lo]$

This rule ensures that *á* is realized as a low vowel, the only one in the language. Crucially, the vowel of the *á/é* alternation is underlyingly specified as $[-rd]$. The rule refers to $[+bk]$, and since all the alternating vowels are underlyingly unspecified for $[bk]$, R_3 must follow R_1 .

$R_4: [-hi, -bk, -ATR] \rightarrow [-rd]$

This rule ensures that the *e* of the *e/a* alternation surfaces as unrounded. It cannot effect this feature insertion for the *e* of the *e/ö/o* alternation, since the latter is not specified as $[-ATR]$ until R_6 applies.

$R_5: V \rightarrow [\alpha rd] / [\alpha rd] \text{ —}$

By the UIP, this rule cannot apply to any vowel that is already specified for rounding. It turns out that it only affects the front vowels of the *e/ö/o* alternation. All other vowels that receive rounding by rule get $[+rd]$ from R_2 or R_4 . Thus, R_5 follows these two.

$R_6: [-hi, -lo, \alpha rd] \rightarrow [\alpha ATR]$

This rule supplies mid vowels that are unspecified for $[ATR]$ with an $[ATR]$ value that agrees with their rounding value. The UIP requires that inputs to this rule not have an $[ATR]$ value; thus, there is no chance that long *é* will be affected by this rule. This rule applies after R_2 and also after R_5 , since these fill in the values of $[rd]$ required for the rule to apply.

$R_7: [-hi, -bk] \rightarrow [-lo]$

This provides the $[-lo]$ value to the front member of the *á/é* alternation. Since the SD refers to $[bk]$, R_7 must follow R_1 . The rule will apply vacuously to a derived $[-hi, -bk, -lo]$ *e*, as well.

12 Derivations

The following tables provide derivations of each of the alternations. Input and output are given with orthographic vowels. The only features of the trigger of harmony that are relevant are $[bk]$ and $[rd]$, so it is not necessary to provide all trigger-target pairs. For example, the vowel *u* triggers the same harmony patterns as *o*. I have provided schematic derivations for four trigger vowels representing each of the four possible combinations of these features: $[+bk, -rd]$, $[+bk, +rd]$, $[-bk, -rd]$, and $[-bk, +rd]$.

In the first table, (29), I have annotated the cases where the rule does not affect the input, whereas in the subsequent tables I merely note *NA* for *not affected*. If a box is marked *NS* (*no subsumption*), it means that the SD of the rule does not subsume the potential input representation. For example, R_3 does not apply to any forms in table (29), since the structural description of R_3 does not subsume any of the input representations in this table. Thus, such cases conform to standard practice: the rule does not apply because it does not match the SD.

However, some cells are marked *UIP* to show that the current rule's SD would be met under traditional assumptions, but it is not met under the UIP. For example, R_5 does not apply to any

forms in (29) since all the inputs are specified for [rd] by this point in the derivation, and R₅ must be feature filling by the UIP.

Finally, some cells are marked VAC; here, the SD is satisfied under the UIP, but the effect of the rule is not visible (it applies vacuously). This is the case for R₇ in the second and fourth data columns in (29), where it applies vacuously to vowels that are already [-hi, -lo, -bk]. The only rules that affect the output are R₁ (for all forms in this table), R₂ (forms preceded by a back vowel trigger), and R₄ (forms preceded by a front vowel trigger).

(29) *Generating the a/e alternation*

	á__	e__	o__	ö__
In.	$\begin{bmatrix} -hi \\ +lo \\ +bk \\ -rd \\ +ATR \end{bmatrix}$	$\begin{bmatrix} -hi \\ -lo \\ -bk \\ -rd \\ -ATR \end{bmatrix}$	$\begin{bmatrix} -hi \\ -lo \\ +bk \\ +rd \\ +ATR \end{bmatrix}$	$\begin{bmatrix} -hi \\ -lo \\ -bk \\ +rd \\ +ATR \end{bmatrix}$
R ₁	$\begin{bmatrix} -hi \\ -lo \\ +bk \\ -ATR \end{bmatrix}$	$\begin{bmatrix} -hi \\ -lo \\ -bk \\ -ATR \end{bmatrix}$	$\begin{bmatrix} -hi \\ -lo \\ +bk \\ -ATR \end{bmatrix}$	$\begin{bmatrix} -hi \\ -lo \\ -bk \\ -ATR \end{bmatrix}$
R ₂	$\begin{bmatrix} -hi \\ -lo \\ +bk \\ +rd \\ -ATR \end{bmatrix}$	NS	$\begin{bmatrix} -hi \\ -lo \\ +bk \\ +rd \\ -ATR \end{bmatrix}$	NS
R ₃	NS	NS	NS	NS
R ₄	NS	$\begin{bmatrix} -hi \\ -lo \\ -bk \\ -rd \\ -ATR \end{bmatrix}$	NS	$\begin{bmatrix} -hi \\ -lo \\ -bk \\ -rd \\ -ATR \end{bmatrix}$
R ₅	UIP	UIP	UIP	UIP
R ₆	UIP	UIP	UIP	UIP
R ₇	NS	VAC	NS	VAC
Out.	á-a	e-e	o-a	ö-e

Table (30) shows the derivation of the *á/é* alternation. We see that rules R₁ and R₃ affect the forms triggered by preceding back vowels, whereas rules R₁ and R₇ affect the forms triggered by preceding front vowels.

The next two tables, (31) and (32), show the derivation of front/back alternations of consistently round vowels. In both cases, the only relevant rule is R₁. Since the long high round vowels *ú, ũ* behave in completely parallel fashion to the short ones *u, ü*, I show only the latter.

In table (33), rules R₁ and R₆ affect all forms. R₂ only affects forms triggered by back vowels, and R₃ only affects forms triggered by front vowels. The input vowel is merely specified [-hi, -lo], but a three-way *e/ö/o* alternation is generated.

(30) *Generating the á/é alternation*

In.	$\begin{matrix} \text{á} _ \\ \left[\begin{array}{l} -\text{hi} \\ +\text{lo} \\ +\text{bk} \\ -\text{rd} \\ +\text{ATR} \end{array} \right] \end{matrix}$	$\begin{matrix} \text{e} _ \\ \left[\begin{array}{l} -\text{hi} \\ -\text{lo} \\ -\text{bk} \\ -\text{rd} \\ -\text{ATR} \end{array} \right] \end{matrix}$	$\begin{matrix} \text{o} _ \\ \left[\begin{array}{l} -\text{hi} \\ -\text{lo} \\ +\text{bk} \\ +\text{rd} \\ +\text{ATR} \end{array} \right] \end{matrix}$	$\begin{matrix} \text{ö} _ \\ \left[\begin{array}{l} -\text{hi} \\ -\text{lo} \\ -\text{bk} \\ +\text{rd} \\ +\text{ATR} \end{array} \right] \end{matrix}$
R ₁	$\left[\begin{array}{l} -\text{hi} \\ -\text{rd} \\ +\text{bk} \\ +\text{ATR} \end{array} \right]$	$\left[\begin{array}{l} -\text{hi} \\ -\text{rd} \\ -\text{bk} \\ +\text{ATR} \end{array} \right]$	$\left[\begin{array}{l} -\text{hi} \\ -\text{rd} \\ +\text{bk} \\ +\text{ATR} \end{array} \right]$	$\left[\begin{array}{l} -\text{hi} \\ -\text{rd} \\ -\text{bk} \\ +\text{ATR} \end{array} \right]$
R ₂	NA	NA	NA	NA
R ₃	$\left[\begin{array}{l} -\text{hi} \\ +\text{lo} \\ -\text{rd} \\ +\text{bk} \\ +\text{ATR} \end{array} \right]$	NA	$\left[\begin{array}{l} -\text{hi} \\ +\text{lo} \\ -\text{rd} \\ +\text{bk} \\ +\text{ATR} \end{array} \right]$	NA
R ₄	NA	NA	NA	NA
R ₅	NA	NA	NA	NA
R ₆	NA	NA	NA	NA
R ₇	NA	$\left[\begin{array}{l} -\text{hi} \\ -\text{lo} \\ -\text{rd} \\ -\text{bk} \\ +\text{ATR} \end{array} \right]$	NA	$\left[\begin{array}{l} -\text{hi} \\ -\text{lo} \\ -\text{rd} \\ -\text{bk} \\ +\text{ATR} \end{array} \right]$
Out.	á-á	e-é	o-á	ö-é

(31) *Generating the u/ü alternation*

In.	$\begin{matrix} \text{á} _ \\ \left[\begin{array}{l} -\text{hi} \\ +\text{lo} \\ +\text{bk} \\ -\text{rd} \\ +\text{ATR} \end{array} \right] \end{matrix}$	$\begin{matrix} \text{e} _ \\ \left[\begin{array}{l} -\text{hi} \\ -\text{lo} \\ -\text{bk} \\ -\text{rd} \\ +\text{ATR} \end{array} \right] \end{matrix}$	$\begin{matrix} \text{o} _ \\ \left[\begin{array}{l} -\text{hi} \\ -\text{lo} \\ +\text{bk} \\ +\text{rd} \\ +\text{ATR} \end{array} \right] \end{matrix}$	$\begin{matrix} \text{ö} _ \\ \left[\begin{array}{l} -\text{hi} \\ -\text{lo} \\ -\text{bk} \\ +\text{rd} \\ +\text{ATR} \end{array} \right] \end{matrix}$
R ₁	$\left[\begin{array}{l} +\text{hi} \\ -\text{lo} \\ +\text{bk} \\ +\text{rd} \\ +\text{ATR} \end{array} \right]$	$\left[\begin{array}{l} +\text{hi} \\ -\text{lo} \\ -\text{bk} \\ +\text{rd} \\ +\text{ATR} \end{array} \right]$	$\left[\begin{array}{l} +\text{hi} \\ -\text{lo} \\ +\text{bk} \\ +\text{rd} \\ +\text{ATR} \end{array} \right]$	$\left[\begin{array}{l} +\text{hi} \\ -\text{lo} \\ -\text{bk} \\ +\text{rd} \\ +\text{ATR} \end{array} \right]$
R ₂	NA	NA	NA	NA
R ₃	NA	NA	NA	NA
R ₄	NA	NA	NA	NA
R ₅	NA	NA	NA	NA
R ₆	NA	NA	NA	NA
R ₇	NA	NA	NA	NA
Out.	á-u	e-ü	o-u	ö-ü

(32) *Generating the á/ǒ alternation*

In.	$\begin{matrix} \acute{a}_ \\ \begin{bmatrix} -hi \\ +lo \\ +bk \\ -rd \\ +ATR \end{bmatrix} \end{matrix}$	$\begin{matrix} e_ \\ \begin{bmatrix} -hi \\ -lo \\ -bk \\ -rd \\ -ATR \end{bmatrix} \end{matrix}$	$\begin{matrix} o_ \\ \begin{bmatrix} -hi \\ -lo \\ +bk \\ +rd \\ +ATR \end{bmatrix} \end{matrix}$	$\begin{matrix} \ddot{o}_ \\ \begin{bmatrix} -hi \\ -lo \\ -bk \\ +rd \\ +ATR \end{bmatrix} \end{matrix}$
R ₁	$\begin{bmatrix} -hi \\ -lo \\ +bk \\ +rd \\ +ATR \end{bmatrix}$	$\begin{bmatrix} -hi \\ -lo \\ -bk \\ +rd \\ +ATR \end{bmatrix}$	$\begin{bmatrix} -hi \\ -lo \\ +bk \\ +rd \\ +ATR \end{bmatrix}$	$\begin{bmatrix} -hi \\ -lo \\ -bk \\ +rd \\ +ATR \end{bmatrix}$
R ₂	NA	NA	NA	NA
R ₃	NA	NA	NA	NA
R ₄	NA	NA	NA	NA
R ₅	NA	NA	NA	NA
R ₆	NA	NA	NA	NA
R ₇	NA	NA	NA	NA
Out.	<i>á-ǒ</i>	<i>e-ǒ</i>	<i>o-ǒ</i>	<i>ö-ǒ</i>

(33) *Generating the e/ǒlo alternation*

In.	$\begin{matrix} \acute{a}_ \\ \begin{bmatrix} -hi \\ +lo \\ +bk \\ -rd \\ +ATR \end{bmatrix} \end{matrix}$	$\begin{matrix} e_ \\ \begin{bmatrix} -hi \\ -lo \\ -bk \\ -rd \\ -ATR \end{bmatrix} \end{matrix}$	$\begin{matrix} o_ \\ \begin{bmatrix} -hi \\ -lo \\ +bk \\ +rd \\ +ATR \end{bmatrix} \end{matrix}$	$\begin{matrix} \ddot{o}_ \\ \begin{bmatrix} -hi \\ -lo \\ -bk \\ +rd \\ +ATR \end{bmatrix} \end{matrix}$
R ₁	$\begin{bmatrix} -hi \\ -lo \\ +bk \end{bmatrix}$	$\begin{bmatrix} -hi \\ -lo \\ -bk \end{bmatrix}$	$\begin{bmatrix} -hi \\ -lo \\ +bk \end{bmatrix}$	$\begin{bmatrix} -hi \\ -lo \\ -bk \end{bmatrix}$
R ₂	$\begin{bmatrix} -hi \\ -lo \\ +bk \\ +rd \end{bmatrix}$	NA	$\begin{bmatrix} -hi \\ -lo \\ +bk \\ +rd \end{bmatrix}$	NA
R ₃	NA	NA	NA	NA
R ₄	NA	NA	NA	NA
R ₅	NA	$\begin{bmatrix} -hi \\ -lo \\ -bk \\ -rd \end{bmatrix}$	NA	$\begin{bmatrix} -hi \\ -lo \\ -bk \\ +rd \end{bmatrix}$
R ₆	$\begin{bmatrix} -hi \\ -lo \\ +bk \\ +rd \\ +ATR \end{bmatrix}$	$\begin{bmatrix} -hi \\ -lo \\ -bk \\ -rd \\ -ATR \end{bmatrix}$	$\begin{bmatrix} -hi \\ -lo \\ +bk \\ +rd \\ +ATR \end{bmatrix}$	$\begin{bmatrix} -hi \\ -lo \\ -bk \\ +rd \\ +ATR \end{bmatrix}$
R ₇	NA	NA	NA	NA
Out.	<i>á-o</i>	<i>e-e</i>	<i>o-o</i>	<i>ö-ö</i>

We thus see that a complex set of vowel-vowel interactions can be derived using a set of simple rules, appropriately applied in accordance with the UIP. As mentioned in passing, other problems clearly remain to be solved in the domain of Hungarian vowels, and it will be interesting to see if the present proposal can shed new light on these classic problems. While there is no logical necessity to derive these patterns exclusively with the equivalent of feature-filling rules, doing so allows us to simplify the account of vowel harmony in a straightforward fashion, a topic we now turn to.

13 Mixed Stems

When Hungarian vowel harmony is generated in this way, it is unnecessary to explain why harmony does not occur between stems in a compound (e.g., *balta + nyél* ‘hatchet handle’) or between a prefix and a stem (e.g., *meg + lát* ‘catch sight of’), despite the standard view on this matter as expressed by authors like Spencer (1996:178) and Siptár and Törkenczy (2000:chap. 6). These authors attribute the failure of harmony to apply in such cases to the assignment of prefixes and first compound members to separate phonological words from the stem that follows them. While such a division may be reasonable on other grounds, vowel harmony, or rather its failure to apply, provides no evidence for a phonological word break between such constituents. Under the model presented here, all prefix and stem vowels are fully specified¹⁸ and the proposed vowel harmony rules affect only underspecified vowels, when interpreted using the UIP.

14 Conclusions

We have seen that the goal of conciseness, or maximal generality, in rule formulation was inconsistent with the search for UG. Rules were formulated in order to generate a given corpus of data, not with the aim of modeling a single human phonological component. It is desirable to have a single interpretive procedure for determining whether a representation satisfies the SD of a rule and thus serves as an input to the rule. This single procedure should work for all rules in all languages. In this article, I have explored a logical alternative to the interpretive procedure adopted in *SPE* and argued that this unified interpretive procedure solves long-standing problems by making it unnecessary to refer to a third value of binary features [ØF], introduce negation into lexical representations (e.g., [NOT +rd]), or introduce a *feature filling/feature changing* diacritic on rules.

I have argued that a small set of rules, provided with the UIP, can generate a set of data as complex as the target-trigger relations of Hungarian vowel harmony. The UIP provides a principled distinction between feature-filling and feature-changing rules, one that is read mechanically off the rule’s representation. We do not need labels (or a clever homunculus) to tell us if a rule is feature filling or feature changing, and we do not need diacritics in representations to refer to

¹⁸ Aside from some epenthetic, “unstable” vowels, which receive their full specification from within their stem.

features that are not present. If the purely feature-filling analysis of Hungarian presented here¹⁹ is in fact valid, then we have shown that this conclusion leads to an overall simplification in our understanding of Hungarian phonology: there is less evidence for positing phonological domains within words to account for the lack of harmony in mixed stems and compounds. Not surprisingly, rather than being ‘ad-hoc and sterile,’ attention to theoretical detail can lead to improved analyses.

One might wonder whether the UIP is just a notational variant of the rule labels *feature filling* and *feature changing*, since it appears to replace these two labels with a disjunctive condition on rule application. There is a good argument that it is not. Labels could be used with great latitude, in principle. For example, using the mechanism of rule labeling, a rule could be stated that filled in values for [rd] only on segments *lacking* specification for [hi]. The notion of a rule label does not preclude this possibility, though I believe it is not attested, and the UIP tells us why it is not: feature-filling and feature-changing differences derive from the UIP. The UIP uses the SC of a rule to determine which features must be absent from a representation for it to serve as an input to that same rule. In other words, the UIP explains why just the feature that appears in the SC is the one for which a rule can require obligatory absence.

The UIP allows representations in the lexicon to be nondistinct, and it even makes it possible for one representation to subsume another, since it allows the two to be treated differently by the grammar in a principled fashion. Specifically, a rule can affect a representation A, yet fail to affect another representation B, even when A is more general than (subsumes) B. As the references to earlier work by Inkelas and Orgun, Kiparsky, Archangeli, and McCarthy demonstrate, this has been a long-standing problem in phonological theory.

By developing a workable (albeit incomplete) underspecification analysis for Hungarian, we are working toward a simpler model of Hungarian phonology, in general. If the contrast between suffix alternations and prefix constancy, for example, does not call for a stratal phonology, the question arises how general this result is—both for Hungarian and for universal phonology. Can the UIP as formulated here be used to simplify other analyses that in the past drew on the arsenal of traditional generative phonology, such as the Derived Environment Condition, the Strict Cycle Condition, Structure Preservation, and the Elsewhere Condition? This important issue will provide fertile terrain for future research.

At this point, we can compare the introductory quotation from Morris Halle with a competing view of the proper goals of phonology:

We urge a re-assessment of this essentially formalist position. If phonology is separated from the principles of well-formedness (the ‘laws’) that drive it, the resulting loss of constraint and theoretical depth will mark a major defeat for the enterprise. (Prince and Smolensky 1993:198; see also p. 3)

This article is an attempt to support Halle’s view. We should develop the necessary formal tools to express phonological processes, and we should understand how our notation works, whether it is constraint or rule based. I find this to be a more interesting and pressing problem, one that

¹⁹ Or another feature-filling analysis.

can lead to greater “theoretical depth,” than a taxonomic encoding of dubious “principles of well-formedness.”

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Concordia University
Linguistics Program
1455 de Maisonneuve W.
Montréal H3G 1M8
Québec, Canada
reiss@alcor.concordia.ca