Markedness, Harmony, and Phonological Invisibility *

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To what extent can Optimality Theory (‘OT’, Prince and Smolensky 1993/2004; Prince and Smolensky 1997) provide theoretical phonology a satisfactory formalization of markedness theory (Trubetzkoy 1939/1969, Jakobson 1962)? Through a case study of the unmarkedness of coronal place of articulation (Paradis and Prunet 1991), it is argued that OT makes possible formal markedness-based explanations of both broad universal generalizations — provided the theory incorporates conjunctive constraint interaction. The phonological invisibility of unmarked elements is an inevitable consequence of the computational structure of OT; stipulating the representational absence — underspecification — of the unmarked is both unnecessary and undesirable.

The core of the formalization of markedness laid out in Prince and Smolensky 1993/2004: Chapter 9 is extremely simple.¹ Let a dimension of variation of linguistic representations be encoded by a binary feature \( \varphi \) with values \( \{\pm \varphi\} \). If the universally marked (dispreferred, lower-Harmony) pole is, say, \([+\varphi]\), then the universal ranking (1a) holds.

(1) Universal markedness hierarchy. Marked pole: \([+\varphi]\)

a. \( \star [+\varphi] \gg_{\text{UG}} \star [-\varphi] \)

b. \( \star [+\varphi] \in \text{Con}, \quad \star [-\varphi] \notin \text{Con} \)

* The material in this article was presented in a talk entitled “Harmony, markedness and phonological activity” at the first Rutgers Optimality Workshop (ROW–1) in October 1993. An expanded version of this paper may be found in Smolensky and Legendre to appear.
¹ For general introductions to markedness theory, see Battistella 1990, 1996.

(1a) states that, whereas universal grammar by default allows all possible rankings of its constraints, in the case of the particular constraints • [+φ] and • [−φ], only the ranking of (1a) is permitted in a possible human grammar.\(^2\) This typological restriction is denoted by the subscript in the symbol ‘\(\Rightarrow_{UG}\)’. • [+φ] is a constraint in the MARKEDNESS family, violated by each occurrence of the feature value [+φ] in a representation. Sometimes it is convenient to work with a simplification of (1a), according to which the universal constraint set Con contains the constraint • [+φ] but simply does not contain any constraint • [−φ]: (1b).

As one means of evaluating the adequacy of OT’s approach to formalizing markedness, in this article, I compare OT with an important rule-based approach to markedness, underspecification theory. Analyzing the case of coronal place unmarkedness, I show how the general types of language-internal markedness effects achieved through underspecification theory are inevitable consequences of OT’s computational architecture, eliminating the additional stipulation of underspecified representations (and the problems they entail). This will require adding to the basic theory a general formal device, local conjunction of constraints.

Underspecification theory depends upon a derivational computational architecture. Our interest in underspecification here is as a means of formalizing aspects of the notion of markedness; thus it is the ‘radical’ version of underspecification theory that is most relevant (Kiparsky 1982; Archangeli 1984). In this theory, the preferred or unmarked value of a feature (in a given context) is unspecified in the underlying form — underlying representations are literally not ‘marked’ with this feature value. During the course of the derivation, this absent feature value typically gets inserted; after its insertion, it behaves essentially like any other feature, but prior to insertion it clearly cannot: it is phonologically inert, neither undergoing nor triggering phonological processes.

Underspecification is a problematic device in OT; I will mention only two of the reasons here. First, OT’s fundamental principle, Richness of the Base

\(^2\) See de Lacy 2002 for arguments that such markedness rankings can be “ignored, but never reversed”.
(Prince and Smolensky 1993/2004: Chapter 9), bans any systematic restrictions on the input: work done previously by special input properties (such as lack of specification for unmarked values) must in OT be done by the grammar itself. Second, even if inputs could be guaranteed to be unspecified for certain features, these features typically must be present in the output, so these features’ distinguishing status — absence — could not obtain at the one point where such special status could be phonologically relevant in OT: the output. The input is only visible to faithfulness constraints, which demand only that it be matched by the output. As their name may suggest, it is markedness constraints which distinguish between marked and unmarked feature values, and these constraints ‘see’ only the output.

But the markedness constraints of OT provide a formalization of markedness directly; the general architecture of OT should provide the power to capture markedness generalizations, and no additional device — in particular, underspecification — should be needed. As a markedness device, underspecification would be at best conceptually redundant in OT. A primary goal of this article is to understand how OT’s inherent markedness theory accounts for the ‘inertness’ of unmarked features, previously analyzed in terms of their absence at early stages of derivation.

1. The Problem

In most languages, all nasal consonants in the inventory are voiced. Thus it is reasonable to ask whether a segment specified [+nasal] must in addition be specified [+voice]. Since [+voice] is the unmarked value of voicing in the context of the feature [+nasal], this question can be generalized: must a feature be specified in a representation if it bears the unmarked value (in its context)?

There is a profound motivation for the unspecification of unmarked values. As Itô, Mester and Padgett put it:

(2) Inertness of the unmarked (Itô, Mester and Padgett 1995: 571)

“It is commonly observed that redundant phonological features in language are inert, neither triggering phonological rules nor interfering with the workings of contrastive features. … This distinction between ‘active’ contrastive and ‘inactive’ redundant features is expressed in the
theory through the notion of (under)specification of features in phonology.”

Redundant features, and more generally, unmarked feature values, tend to be phonologically inert, as if invisible to the phonology; this follows with perspicacious elegance from the assumption that such features are simply not present in the representations on which phonology acts. This assumption is the basis of radical underspecification theory (Kiparsky 1982: 53ff; Archangeli 1984, 1988; Mester and Itô 1989). Underspecification theory is a formalization of markedness theory: it interprets ‘unmarked’ as a literal description of linguistic representations, which are not marked so as to indicate the value of the unspecified feature.\(^3\)

Thus the very loose generalization I seek to explain in this paper is (3).

\(^3\) This conception was already explicit in Trubetzkoy 1939/1969 (all emphasis original):

The signifier of the system of language consists of a number of elements whose essential function is to distinguish themselves from each other. Each word must distinguish itself by some element from all other words of the same system of language. The system of language, however, possesses only a limited number of such differential means, and since their number is smaller than the number of words, the words must consist of combinations of discriminative elements (“marks” in K. Bühler’s terminology.) [p. 10]

Privative oppositions are oppositions in which one member is characterized by the presence, the other by the absence, of a mark. For example: “voiced”/"voiceless,” “nasalized”/"nonnasalized,” “rounded”/"unrounded.” The opposition member that is characterized by the presence of the mark is called “marked,” the member characterized by its absence “unmarked.” This type of opposition is extremely important for phonology. [p. 75]

In cases of this type one of the opposition members occurs in the position of neutralization, and its choice is in no way related to the nature of the position of neutralization. However, due to the fact that one of the opposition members occurs in that position as the representative of the respective archiphoneme, its specific features become nonrelevant, while the specific features of its partner receive full phonological relevance: the former opposition member that is permitted in the position of neutralization is unmarked from the standpoint of the respective phonemic system, while the opposing member is marked. [p. 81]
(3) Activity Generalization (absolute version): Unmarked $\Rightarrow$ Inactive
Unmarked elements are phonologically inactive.

If OT's notion of Harmony provides an adequate formalization of markedness, such a generalization should follow from general OT principles without the need for further assumptions. Underspecification in OT would be a second way of encoding unmarkedness; such a redundant device should not be needed to derive the Activity Generalization (3). If underspecification were necessary to derive (3), it would be possible to have an OT phonology without underspecification in which the Activity Generalization would be violated.

But we will see that this is impossible: there is no way to have an OT theory that violates the Activity Generalization, even if representations are fully specified. In this sense, the Activity Generalization is an integral, inevitable property of OT. In contrast, it is only by stipulation of underspecification that rule-based theory can derive the Activity Generalization; it is logically possible to have a rule-based theory lacking underspecification which would as a result violate the Activity Generalization.

As mentioned earlier, there are several reasons internal to OT for avoiding (dependence upon) underspecified representations. Outputs underspecified for $\phi$ cannot truly be evaluated by OT constraints sensitive to the value of $\phi$. And dependence upon inputs being systematically unspecified for $\phi$ is ruled out by Richness of the Base: in OT, it is not possible to restrict inputs in this way. Inputs specified for $\phi$ cannot be prevented from entering the grammar; it is up to the grammar to ensure that the Activity Generalization holds, and so this result cannot be a consequence of input underspecification.

Independent of OT, there are several reasons to seek alternatives to underspecification (e.g., Mohanan 1991; McCarthy and Taub 1992; Steriade 1995; Bakovic 2000). As McCarthy and Taub put it, underspecification analyses rely on a “now you see it, now you don’t” shell game with unmarked features. With respect to certain processes, these features are inactive, so at the stage of derivation when the relevant rules apply, the unmarked feature must be unspecified. With respect to other processes, these same features may be active, and so these features must be present when these other rules apply. Orchestration the appearance of unmarked values to achieve this poses significant descriptive and explanatory problems.
A second problem McCarthy and Taub 1992 raise is that, while inactivity of unmarked features could conceivably be due to their non-existence, this distinguishing property of unmarked values is not consistent with another hallmark of unmarkedness, greater diversity. Specifically with respect to the markedness of oral Places of Articulation, the unmarked Place suggested by inactivity is [coronal]; but it is just at this Place that the greatest diversity of other featural contrasts is to be found. As formalized in feature geometry, this diversity means that the [coronal] node has many dependents relative to the nodes for marked Places, exactly the opposite of what would be expected if the distinguishing property of [coronal] is its reduced degree of presence. Independent of feature geometry, it remains a problem that non-existence does not seem to be a formal property that can unify two central characteristics of the unmarkedness of [coronal]: that it is inactive, and that it licenses a diversity of other features.

The problems associated with underspecification, both those that are internal to OT and those that are not, disappear if unmarked elements (e.g. [coronal]) are present in representations, but their higher Harmony, relative to their more marked counterparts, accounts both for their inactivity and their enhanced licensing power.

McCarthy and Taub 1992 point out that the English processes to which coronals seem "invisible" range from the derivationally very early to the derivationally very late. And the same is true of English processes to which coronals must be "visible." A diagnostic used (see the next point in the text) is whether plain coronals (simple alveolars) pattern differently from complex coronals (like θ and f); the former are unspecified in radical underspecification theory, but the latter cannot be, since they have features which are dependents of the [coronal] node. Processes to which plain but not complex coronals are invisible must be ordered prior to the default rule filling in [coronal], while processes to which all coronals are visible must of course be ordered after the default rule. McCarthy and Taub observe that it is quite unlikely that such an ordering of processes is possible given the other ordering requirements imposed by English phonology, and that in any event "such an ordering will sometimes be quite arbitrary" (p. 365).
2. The Proposed Solution

The main claim of the paper is simply this.

(4) More harmonic ⇒ Less active

The working hypothesis is that “less marked” can be formalized in OT as more harmonic — preferred — according to markedness constraints, and that universal markedness relationships such as “[−φ] is less marked than [+φ]” are encoded in UG via universally fixed rankings

(5) * [+φ] ≫ _UG_ * [−φ]

(or by the presence of * [+φ] and the absence of * [−φ] in the universal constraint set Con, as discussed in (1)).

Let an input element x be said to “undergo a process” if it has no faithful output correspondent, and to “trigger a process” if its presence entails that constraints will force other input elements to undergo the process. Let x be phonologically “active” if it undergoes or triggers a process. Then the claim is:

(6) Less marked elements are less active.

If a more harmonic element surfaces unfaithfully or induces another element to surface unfaithfully, then a less harmonic element will also.\(^5\)

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\(^5\) To illustrate the triggering case, consider a language E (like English: see Section 4.3) in which consonant clusters can only have one non-coronal consonant. Suppose the grammar imposes this by deleting segments: if an input contains, say, /pv/ then p is deleted. /ps/ surfaces faithfully however since only p is non-coronal. Now consider another language M (like the Polynesian language Maori; e.g., Hale 1973: 417), a language lacking clusters altogether, and suppose again that repair is by deletion. Then in M, /pv/ → [v], as in E. But in M, /ps/ → [s]: even the presence of s triggers deletion of p. The less Place-marked s is sufficiently “visible” to the cluster-simplification “process” to trigger it; and so certainly is the more-marked v. In E, however, v but not s is visible to the process. In both languages, the more-marked v is
This must be understood in a very broad, liberal sense, commensurate with the empirical generalization (3) that it is intended to explain. It is too broadly stated to be a literal theorem, and indeed it is far from a crisp result. Rather than attempting to substantiate this broad claim as such, I will instead consider several classes of "phonological processes" for which the generalization holds. In many of these cases, underspecification can also provide an account.

The essence of the argument is encapsulated in (7).

(7) Key Idea (Absolute version): No marks $\Rightarrow$ Invisible

In OT, outputs are evaluated and selected solely on the basis of the constraints they violate, or the marks (•'s) they are assessed by these constraints. Hence a phonological element can be "invisible" to the phonology even when present, if it does not incur any marks — i.e., if is literally ‘unmarked’.

Underspecification theory takes “unmarked” literally, with “marked” understood in the sense of “specified”. OT takes “unmarked” literally too, but with “marked” understood as “bearing the • marking a constraint violation”. The constraints relevant in (7) are MARKEDNESS constraints, naturally.

The absolute version of the main idea (7) states that an element which generates no mark is phonologically invisible; an element which incurs a mark is potentially visible. The same idea also applies in a more subtle way that fully exploits the Harmony scale of OT.

(8) Key Idea (Relative version): Lower marks $\Rightarrow$ Less active

In OT, the lower a constraint is ranked, the less active it is in the phonology. A mark assessed by a low-ranking constraint functions almost like no mark at all. Thus if structure $u$ incurs lower-ranked marks than structure $m$, then $u$ will interact with fewer constraints than $m$.

more visible than less-marked $s$ to the process; in $E$, $s$ is sufficiently invisible to prevent deletion, while in $M$ it is not. For the proposed analysis of this type of pattern, see Section 4.3.
The sense of ‘active’ used here is formally defined in Prince and Smolensky 1993/2004: 82 (110): a constraint is active in a grammar if it actually rules out candidates during the Harmony evaluation process defining optimality.

3. The Challenge: The Coronal Syndrome

In the remainder of the paper I will focus on particular types of phonological processes relevant to the markedness of oral Places of Articulation. The unmarked status of [coronal] Place is documented in the important collection Paradis and Prunet 1991 (henceforth, ‘P&P91’). In their argument for underspecification theory, Paradis and Prunet issue the challenge (9); the current project may be seen in part as an attempt to provide an OT response to this challenge. I have inserted the numbers of the subsections below which address the particular phenomena listed by Paradis and Prunet.

(9) The challenge (Paradis and Prunet 1991: 21)

“Mohanan 1989, in an overview of underspecification theories, suggests that (at least some of) the phenomena attributed to underspecification could be handled by a theory of markedness … It is not clear how such an approach would handle any of the various arguments presented here for the special status of coronals:

the coda and cluster conditions, [Sections 4.3, 4.4]

assimilation, [Section 4.5]

neutralization, [Section 4.4]

transparency, [Section 5.3]

deletion, [Section 4.2]

epenthesis, [Section 4.1]

substitution, the frequency of coronal harmonies, etc.

It is even less clear how it could connect all of these properties together.”

So our first question is, which of these effects can be explained (and thereby “connected”) via the key idea (8): ‘Lower marks ⇒ Less active’? Second, is it possible to go further and connect the effects in (9) with other markedness phenomena, such as those listed in (10)?
(10) Further markedness phenomena
   a. coronal diversity [Section 5.2]
   b. universal markedness patterns delimiting segmental inventories (presence/absence) [Section 5]
   c. constrastiveness of features in segmental inventories [Section 5.1]
   d. markedness effects within segmental inventories (e.g., markedness conditions on targets of feature spread) [Section 5.4]

At the root of all the OT explanations is the single universal fixed ranking expressing the unmarked status of coronal (henceforth [cor]) relative to other oral places, such as labial, [lab];

(11) Segmental Place Markedness Hierarchy
   • [lab] ≫_{UG} • [cor]

This is to be seen as an instance of the general schema (1). It was proposed in Prince and Smolensky 1993/2004: Chapter 9. As in that work, here [lab] will stand in for [dorsal], as well as denoting labial Place; [dorsal] is treated formally just like [lab] in the theory.\(^6\)

4. “Invisibility” Phenomena

4.1. Epenthesis
Paradis and Prunet claim (Paradis and Prunet 1991: 21) that coronal underspecification correctly predicts that oral epenthetic consonants will have coronal Place. (Concerning the empirical status of this generalization, see Lombardi 2002.)

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\(^6\) Lombardi 2002 argues that the hierarchy should be further extended to include • [coronal] ≫_{UG} • [pharyngeal].
(12) Epenthesis of coronals

<table>
<thead>
<tr>
<th></th>
<th>/an/ →</th>
<th>Epenthesis Onset</th>
<th>Place Markedness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ONSET</td>
<td>PARSE</td>
</tr>
<tr>
<td>a.</td>
<td>an</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Ø</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>p&lt;sub&gt;3&lt;/sub&gt;an</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>d.</td>
<td>t&lt;sub&gt;3&lt;/sub&gt;an</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

Consider a simple hypothetical input such as /an/. The ranking shown in tableau (12) leads to epenthesis of an onset consonant. Because ONSET dominates a FAITHFULNESS constraint, it will be enforced by some kind of unfaithfulness; thus candidate a is not optimal. Because PARSE dominates FILL, the optimal type of unfaithfulness is a FILL violation, i.e., over-parsing or ‘epenthesis’; the maximally under-parsed Null Parse b, denoted ⟨an⟩ here, is non-optimal. This leaves only over-parsed candidates like c and d containing an epenthetic onset segment (boxed). FILL Ons is violated by the epenthized onset.

I assume that candidate outputs include completely specified segments, including a value for Place. This Place is not filled by underlying material, so it violates FILL<sub>PL</sub>. The two Places under consideration are [cor] and [lab], so in addition to the FILL violations, the epenthetic segment will violate either * [lab] or * [cor], the relevant * STRUCTURE constraints. By the coronal unmarkedness condition (11), the latter violation is universally more harmonic than the former, thus labial candidates like c are suboptimal, and the optimal candidate will have an epenthized coronal, like candidate d. (Other constraints, encoding the unmarked values of other features, will determine just which coronal consonant is optimal.)

In tableau (12), where the Place markedness constraints are ranked relative to the other constraints influences whether epenthesis occurs (e.g., if both are ranked higher than PARSE, the null parse c will be optimal). But it is only the ranking of the Place constraints relative to each other — universally fixed — that influences the choice among epenthetic segments. All marks of candidates
c and d cancel except those assessed by the Place constraints (highlighted with the heavy boxes); so wherever they are ranked, the Place markedness constraints ensure that the coronal d is more harmonic than the labial c.

The conclusion is that the universal markedness subhierarchy * [lab] \( \succ \) * [cor] entails that, ceteris paribus, epenthetic consonants are coronals. Epenthetic material should be as ‘invisible’ as possible: not in the sense of having an absent Place value, but in having an absent Place mark — or, since this is impossible, coming as closest as possible to no Place mark, by having the lowest-ranked Place mark possible: * [cor].

4.2. Deletion

Paradis and Prunet claim that coronal underspecification explains the invisibility of coronals to deletion in Japanese (P&P: 2, citing Grignon 1984: 324). An idealization of the intended situation might be the behavior of s in the verbal paradigm:\(^\text{7}\):

\[
(13) \text{Cor invisibility to deletion} \\
\begin{align*}
\text{a.} & \quad \sim C_1 + C_2 V/ \rightarrow \sim V. \quad C_2 V/ \quad \text{if } C_1 = \text{Lab} \\
\text{b.} & \quad \rightarrow \sim V C_1 . \quad C_2 V/ \quad \text{if } C_1 = \text{Cor} \\
\text{c.} & \quad \sim V C_1 + C_2 V/ \rightarrow \sim V C_1 . \quad V/ \quad \text{if } C_1 = \text{Cor or Lab}
\end{align*}
\]

Tableau (16) shows how the markedness hierarchy * [lab] \( \succ \) * [cor] can explain why an unsyllabifiable labial consonant will delete, but a coronal will not (its survival requires V-epenthesis).

The “deletion process” pertains to the first two inputs in (16), when the

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\(^7\) Thanks to Junko Itô and Armin Mester (personal communication) for suggesting this piece of the Japanese grammar; they are in no way responsible for my idealization or use of it, of course. With the gerundive suffix \(-\text{tel}\), the non-coronal place of stem-final consonants does not surface in /tob/ \( \rightarrow \) tonde ‘fly’, /kaw/ \( \rightarrow \) katte ‘buy’, /tok/ \( \rightarrow \) toite ‘solve’. The coronal place of stem-final /s/ is however preserved by epenthesis of i, /hanas/ \( \rightarrow \) hanasite ‘speak’. (Itô and Mester suggest that the special status of /s/ results from its sibilance, not shared by other coronals which do not trigger epenthesis: /tor/ \( \rightarrow \) totte ‘take’, /sin/ \( \rightarrow \) sinde ‘die’; Itô and Mester 1986: 58-59; cf. Iwasaki 2002: 61ff.)
initial C is unsyllabifiable (due to restrictions on coda consonants). Ignoring Place markedness, the basic syllable structure constraints are ranked so that such a stranded C is parsed by epenthizing a following V rather than by deleting the C: \( \text{FILL}^{\text{Nuc}} \) is lower-ranked than \( \text{PARSE} \). The application of the "deletion process" corresponds to outputs with \( \ast \text{PARSE} \) marks. The labial consonant undergoes this process — is "visible" to it — because

\[
(14) \quad \ast \left[ \text{lab} \right] \gg \text{PARSE}
\]

In contrast, the coronal consonant is "invisible" to this process because

\[
(15) \quad \text{PARSE} \gg \ast \left[ \text{cor} \right].
\]

It is the \( \ast \left[ \text{lab} \right] \) mark that makes the labial visible; the \( \ast \left[ \text{cor} \right] \) is low-ranked, and it might as well not be there at all. The faithfulness constraint violated by the "deletion process", \( \text{PARSE} \), essentially sets a threshold by its place in the ranking: marks higher than this threshold make the consonants that incur them "visible" to the process, whereas marks lower than the threshold function like no marks at all - the consonants that incur these marks are "invisible" to this process. The \( \text{PARSE} \) violation incurred by "deleting" segment \( X \) can be optimal if the faithful structure (containing \( X \)) incurs a mark worse than \( \ast \text{PARSE} \): otherwise \( X \) is "invisible". Since \( \ast \left[ \text{lab} \right] \gg_{\text{UG}} \ast \left[ \text{cor} \right] \) it is possible for \( \ast \left[ \text{lab} \right] \) to be "visible" without \( \ast \left[ \text{cor} \right] \) being "visible", but not vice versa.\(^8\)

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\(^8\) Note that if \( \text{PARSE} \) and \( \text{FILL}^{\text{Nuc}} \) are interchanged, it is still not the case that \( \ast \left[ \text{cor} \right] \) is more visible than \( \left[ \text{lab} \right] \) to deletion: both types of consonants delete. It is the relative ranking of \( \ast \left[ \text{lab} \right] \) and \( \ast \left[ \text{cor} \right] \) that is critical to their contrast, not the ranking of \( \text{PARSE} \) and \( \text{FILL}^{\text{Nuc}} \). The generalization is that if coronals delete, so must labials.
Cor invisibility to deletion

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
<th>$\Sigma^C V$</th>
<th>$C_{[lab]} \rightarrow \emptyset$</th>
<th>$C_{[cor]} \rightarrow C_{[cor]}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_{[lab]} + C_2 V$</td>
<td>$\diamond C_{[cor]} V$</td>
<td>* lab</td>
<td>PARSE</td>
<td>* cor</td>
</tr>
<tr>
<td>$C_{[lab]} \ convin C_2 V$</td>
<td>$\diamond C_{[cor]} V$</td>
<td>*</td>
<td>PARSE</td>
<td>*</td>
</tr>
<tr>
<td>$C_{[cor]} + C_2 V$</td>
<td>$\diamond C_{[cor]} V$</td>
<td>*</td>
<td>PARSE</td>
<td>*</td>
</tr>
</tbody>
</table>
| $C_{[lab]} + V$ | $\diamond C_{[lab]} V$ | * | ONSET | *
| $C_{[cor]} V$ | * ONSET | * | FILL$^\text{ons}$ |
| $C_{[cor]} + V$ | $\diamond C_{[cor]} V$ | * | ONSET | * |

The crucial contrast between [lab] and [cor] place is the difference between (14) and (15); this particular contrast is possible because

(17) * [lab] $\gg$ * [cor].

4.3. Cluster Conditions and Local Conjunction

In addition to the relative ‘invisibility’ of coronals to phonological processes, underspecification of [cor] can account for the relative ‘invisibility’ of coronals to certain conditions (inviolable constraints) of the sort that have often been overlaid on rule-based architectures. The instance Paradis and Prunet refer to in (9) is the following type of cluster condition (see also Prince 1984 concerning such constraints on melodic sequences, independent of syllable structure).

(18) Coronal invisibility in cluster conditions
"In monomorphic words, English clusters never include more than one non-coronal ...\text{\textit{Cluster condition: Adjacent consonants are limited to at most one Place specification.}}" (Yip 1991: 62)

To handle multiple segments, the Universal Place Hierarchy must be scaled up to achieve something like the Sequential Markedness Principle of Clements 1990: 313, which asserts essentially that if A is more marked than B, then the sequence XAY is more marked than the sequence XBY. Using the ‘less harmonic than’ symbol \(<\) to denote “more marked than”,\textsuperscript{9} this principle takes the form (19).

\text{(19) Sequential Markedness Principle}
A \(<\) B \(\Rightarrow\) XAY \(<\) XBY

E.g., if the Place of A is less harmonic (more marked) than the Place of B, then a cluster containing A is less harmonic (more marked) than one containing B, all else equal.

To achieve this, it is necessary to combine separate instances of the Segmental Place Hierarchy for each consonant in the cluster. Consider first clusters with two consonants. The required hierarchy is:

\text{(20) Place Hierarchy for two-segment clusters}
* [lab]\&_{cl} * [lab] \(\gg\) \text{UG} * [lab]\&_{cl} * [cor] \(\gg\) \text{UG} * [cor]\&_{cl} * [cor]

The constraint * [lab]\&_{cl} * [lab] is violated if the two consonants in the cluster are both labial. Crucially, it is \textit{not} violated by two separated labial consonants in a word (\textit{v puff}), as they are not in a single cluster. That is, the constraint * [lab]\&_{cl} * [lab] is violated if there are two violations of * [lab] in a common domain, defined here as a cluster (* affp). This is an instance of the general operation of \textit{local conjunction} of constraints.

\textsuperscript{9} Harmony crucially combines \textit{markedness} and \textit{faithfulness}; but here \textit{faithfulness} does not apply.
(21) Local conjunction within a domain $\mathcal{D}$
\[ *A \&_{\mathcal{D}} *B \] is violated iff there is a violation of \(*A\) and a (distinct) violation of \(*B\) localized within a single domain of type $\mathcal{D}$. 

If we are conjoining a constraint with itself, so that \(*A = *B\), then the self-
conjunction \(*A \&_{\mathcal{D}} *A\) is violated if (and only if) there are two distinct violations of \(*A\) in a single domain $\mathcal{D}$. This is instantiated in (20) in our constraint
\[ *[\text{lab}] \&_{\text{cl}} *[\text{lab}]. \] (\(*A \&_{\mathcal{D}} *A\) is often written more simply as \(*A^2\).)

Now we can see the Cluster Place Markedness Hierarchy (20) above as the result of local conjunction of the single-segment Place Markedness Hierarchy with each of the two constraints in that hierarchy.

(22) Cluster Place Markedness Hierarchy derived by local conjunction
a. For single segments: \(*[\text{lab}] \Rightarrow *[\text{cor}]\)
b. Locally conjoin this hierarchy with the constraint \(*[\text{lab}]\), where the
domain of locality is the cluster:
\[ *[\text{lab}] \&_{\text{cl}} *[\text{lab}] \Rightarrow *[\text{lab}] \&_{\text{cl}} *[\text{cor}] \]
c. Do the same with \(*[\text{cor}]\):
\[ *[\text{cor}] \&_{\text{cl}} *[\text{lab}] \Rightarrow *[\text{cor}] \&_{\text{cl}} *[\text{cor}] \]
d. Since conjunction is symmetric, \(*[\text{cor}] \&_{\text{cl}} *[\text{lab}] = *[\text{lab}] \&_{\text{cl}} *[\text{cor}]\)
\[ *[\text{cor}] \], combining the above two hierarchies gives
\[ *[\text{lab}] \&_{\text{cl}} *[\text{lab}] \Rightarrow *[\text{lab}] \&_{\text{cl}} *[\text{cor}] \Rightarrow *[\text{cor}] \&_{\text{cl}} *[\text{cor}] \]
e. All domination relations here are universal.

Clearly, the principle formalizing Clements’ Sequential Markedness Principle
(19) which has been used in (22b) is (23) (Smolensky 1993).

(23) Preservation of universal markedness hierarchies under local conjunction
\[ *A \gg_{U} *B \Rightarrow *X \&_{\mathcal{D}} *A \gg_{U} *X \&_{\mathcal{D}} *B \]

Now we are prepared to deal with the Cluster Condition (18). Restricting
attention to two-consonant clusters for the moment, the effect of this Condition
is to define a cluster inventory which includes \([\text{cor}] \& [\text{cor}]\) and \([\text{lab}] \& [\text{cor}]\), but
excludes \([\text{lab}] \& [\text{lab}]\). This inventory ‘bans only the worst of the worst’ (Prince
and Smolensky 1993/2004: Chapter 9); this important property will be
designated BOWOW.\textsuperscript{10} BOWOW inventories are common, and they are the
hallmark of local conjunctive constraint interaction.

The particular case of two-consonant clusters is treated in tableau (24). Here
the Parse/Fill version of Faithfulness due to Prince and Smolensky
1993/2004 has been upgraded to the Correspondence Theory version due to
McCarty and Prince 1995 (input and output segments bearing the same
superscript are in correspondence).

In (24), the first input, a labial-coronal cluster, surfaces faithfully. The
markedness of this cluster, registered by its mark from the constraint $* \text{[lab]} \& \text{[cor]}$
$* \text{[cor]}$, is less than the penalty incurred for any unfaithfulness, whether it be
change of Place (candidate $b$, violating the constraint IDENT(Pl) requiring
corresponding segments to have the same Place), or consonant deletion
(candidate $c$, violating the constraint MAX requiring all input segments to have
output correspondents), or vowel epenthesis (candidate $d$, in violation of DEP,
prohibiting output segments with no input correspondent).

\textbf{(24) Cluster condition}  \\

<table>
<thead>
<tr>
<th></th>
<th>MAX \text{DEP}</th>
<th>$* \text{[lab]} &amp; \text{[cor]}$</th>
<th>IDENT(Pl)</th>
<th>$* \text{[lab]} &amp; \text{[cor]}$</th>
<th>$* \text{[cor]} &amp; \text{[cor]}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$/C^1_{\text{lab}} + C^2_{\text{cor}} / \rightarrow$</td>
<td>$a \not\Rightarrow C^1_{\text{lab}} C^2_{\text{cor}}$</td>
<td>$* !$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$b \not\Rightarrow C^1_{\text{cor}} C^2_{\text{cor}}$</td>
<td>$* !$</td>
<td></td>
<td>$* !$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$c \not\Rightarrow C^2_{\text{cor}}$</td>
<td></td>
<td></td>
<td></td>
<td>$* \text{MAX!}$</td>
<td></td>
</tr>
<tr>
<td>$d \not\Rightarrow C^1_{\text{lab}} V C^2_{\text{cor}}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$* \text{DEP!}$</td>
</tr>
<tr>
<td>$/C^1_{\text{lab}} C^2_{\text{lab}} / \rightarrow$</td>
<td>$a' \not\Rightarrow C^1_{\text{lab}} C^2_{\text{lab}}$</td>
<td></td>
<td>$* !$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$b' \not\Rightarrow C^1_{\text{cor}} C^2_{\text{lab}}$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$* !$</td>
</tr>
</tbody>
</table>

\textsuperscript{10} Padgett 2002 also addresses what he dubs ‘WOW inventories’.
An input containing an even less-marked coronal-coronal cluster would also surface faithfully.

But an input with a labial-labial cluster cannot surface faithfully because it is sufficiently highly marked that eliminating this markedness is optimal even though a Faithfulness violation is necessary. The type of unfaithfulness (or ‘repair’) in the optimal candidate is that which violates the lowest-ranking faithfulness constraint below * [lab] & $c_l$ * [lab]; in the ranking shown here, this is IDENT(Pl), so the optimal unfaithful candidate (b) changes a labial to a coronal. The result is that surface clusters can have no more than one non-coronal Place.

The inputs relevant to Yip’s Cluster Condition (18) are monomorphic, so the type of input-output disparity evident in the mapping /$C^1_{[lab]} C^2_{[lab]}$ → $C^1_{[cor]} C^2_{[lab]}$ would never be observed as an alternation; there is (presumably) no morphological environment in which the putative underlying $C^1_{[lab]}$ would ever reveal its labiality. According to the OT principle of Richness of the Base it is exactly a grammar with this property that corresponds to a language obeying the Cluster Condition: *even if there were* underlying forms containing labial-labial sequences, they would surface with only a single labial. There is no input which can produce an output cluster with more than one non-coronal Place, so the cluster inventory of the language is the one specified by the Cluster Condition.

Only a cluster with two labials is sufficiently “visible” to be targeted by the de-labialization “process” in this grammar. It as though the Place of coronals were absent, for the marks incurred by coronal-containing clusters are too low-ranked to matter; they might as well be absent.

Of course the universality of the Cluster Place Markedness Hierarchy (20) ensures that there could be no language in which the roles of coronal and labial Place were exchanged; labial-labial clusters are universally the most marked — the worst of the worst — so if an inventory excludes a single type of cluster on the basis of Place, it must be labial-labial clusters that are banned. (But see note 12, p. 24.)

The preceding analysis can be scaled up to clusters with more than two consonants. The lowest-ranked conjunctive constraints will necessarily be those violated by clusters with at most one non-coronal; just as in (23), these are ranked below a relevant faithfulness constraint F while the more highly-
ranked constraints are ranked above F.

For an application of markedness conjunction to explain consonant cluster inventories revealed in performance data, see Davidson 2001, 2003.

### 4.4. Neutralization and Coda Conditions

Paradis and Prunet claim that coronal underspecification explains why coronals meet coda conditions which prohibit codas from having their own Place specification (Paradis and Prunet 1991: 9, 13) and why Place contrasts are neutralized in coda position, with only coronals surfacing (e.g., Steriade 1982; Itô 1986: 21; Yip 1991: 62).

Effects of the Coda Condition, like those of the Cluster Condition, can be understood in present terms as producing a kind of BOWOW inventory. Here, the ‘worst of the worst’ refers to consonants that are not only in the ‘worst’ syllable position — coda, marked by NoCODA: they also have the ‘worst’ Place, non-coronal (represented here, as before, by labial). These consonants are those that violate the local conjunction NoCODA & \_seg \_ * [lab], where the locality domain is the segment, taken as the locus of the violation of NoCODA as well as the locus of the * [lab] violation. (Again, co-locality of violation is crucial: we need to ban forms that have a labial in coda position, not forms that have both a labial onset and a coronal coda.)

Conjoining the basic Segmental Place Markedness Hierarchy (11) with NoCODA yields (25) (Smolensky 1993; Zoll 1998; Itô and Mester 2002; Morris 2002).

\[(25) \text{Coda Place Markedness Hierarchy} \]

\text{NoCODA & \_seg \_ * [lab] } \gg \text{UG, NoCODA & \_seg \_ * [cor]} \]

Now the same sort of argument as we have seen in the other cases applies.

The first input in (26) features a word-final labial consonant. Faithfully parsing (candidate a) produces a labial coda that violates the conjunction NoCODA & \_seg \_ * [lab], whereas changing the Place to coronal (b) instead violates only lower-ranked NoCODA & \_seg \_ * [cor], as well as the faithfulness constraint IDENT(PI). This is optimal, because the ranking has been chosen so that eliminating the coda altogether by deletion (c) or by V epenthes (d) violates highest-ranked MAX or DEP, respectively. On the other hand, a final
consonant with coronal Place surfaces faithfully \((a')\), violating only low-ranked \texttt{NoCODA} \& \texttt{seg} * [cor]. Since [cor] is already the least-marked Place, the only way to improve upon this violation is to eliminate the coda altogether, but as before the ranking makes this impossible (e.g., the deletion option, candidate \(c'\), fatally violates \texttt{MAX}).

With this sort of ranking, the only possible coda consonant is one with unmarked Place. Conjunction of the Segmental Place Hierarchy with \texttt{NoCODA} allows neutralization to coronal Place only in coda position; the unconjoined constraint \* [lab] must be lower-ranked than the lowest relevant faithfulness constraint, \texttt{IDENT(Pl)}, because otherwise labials could not surface even in onset position, it being more harmonic to change underlying [lab] to surface [cor]. Thus the elevation of the \* [lab] in conjunction with \texttt{NoCODA} enables an inventory permitting codas and labials, but banning the worst of the worst: a segment that is both a coda and a labial.

(26) Coda Place neutralization to [cor]

<table>
<thead>
<tr>
<th></th>
<th>\texttt{MAX} \texttt{DEP}</th>
<th>\texttt{NoCODA} &amp; \texttt{seg} * [lab]</th>
<th>\texttt{IDENT(Pl)}</th>
<th>\texttt{NoCODA} &amp; \texttt{seg} * [cor]</th>
</tr>
</thead>
<tbody>
<tr>
<td>/VC_{[lab]}/ →</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a)</td>
<td>VC_{[lab]}</td>
<td>* !</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>VC_{[cor]}</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>V</td>
<td></td>
<td>* MAX</td>
<td></td>
</tr>
<tr>
<td>(d)</td>
<td>V.C_{[cor]}</td>
<td></td>
<td>* DEP</td>
<td></td>
</tr>
<tr>
<td>/VC_{[lab]}/ →</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a')</td>
<td>VC_{[cor]}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c')</td>
<td>V</td>
<td></td>
<td>* MAX</td>
<td></td>
</tr>
</tbody>
</table>

4.5. Assimilation

Paradis and Prunet assert that underspecification of coronal Place explains a generalization that in Place assimilation, it is the marked Place that spreads; /\texttt{C}_{[lab]}\texttt{C}_{[cor]}/ surfaces as \texttt{C}_{[lab]}\texttt{C}_{[lab]} rather than \texttt{C}_{[cor]}\texttt{C}_{[cor]} (Kiparsky 1985: 100).
This is one pattern that cannot be explained from the present OT perspective, since clearly Place Harmony is greater with two coronals than with two labials. This is an open problem for the present approach, and to my knowledge it is the only general markedness-related phenomenon that can be accounted for by underspecification but not by the OT theory presented here.\footnote{Developing a proposal made by Kiparsky 1994, de Lacy 2002 develops an approach to constraint construction in which the pressure to faithfully express underlying material is greater for marked elements; this allows straightforward treatment of the assimilation generalization.}

While it is certainly premature to claim a solution to this problem, there is reason to believe that an OT theory of recoverability may provide an explanation of this assimilation generalization. Assimilation prevents an underlying feature specification, e.g., [cor], from being expressed; it must be recovered in comprehension though absent from the surface expression. If Place markedness constraints are active during comprehension, imputing an underlying [cor] feature without surface evidence will be less marked than imputing an underlying [lab] feature without surface evidence. Such a recoverability-based account of the assimilation generalization subsumes it under a higher generalization according to which material absent in surface expressions is preferably unmarked material which can be filled in during comprehension — the same overarching generalization under which the effect of the syntactic constraint DROP-TOPIC (Samek-Lodovici 1996; Grimshaw and Samek-Lodovici 1998) is subsumed by a theory of recoverability.

The remaining phenomenon Paradis and Prunet cite as explicable via underspecification of [cor] involves the transparency of coronals to vowel-feature spread. Discussion of this last facet of “invisibility” is deferred until Section 5.2.

5. Markedness Phenomena in Segmental Inventories

Section 4 considered the six principal challenges Paradis and Prunet placed before any theory of markedness (9). These are six phenomena in which unmarked elements appear “invisible” to the phonology. But there are important other phenomena which a theory of markedness must explain, and
which it must unify with the "invisibility" phenomena considered above.

We will next briefly consider three such phenomena, all relating to segmental inventories. The first are universal implications concerning these inventories, where presence of a marked element in the inventory (e.g., a non-coronal) entails the presence of related, less-marked (coronal) elements. This is the topic of Section 5.1, which introduces the notion of harmonic completeness. The second markedness phenomenon is the greater diversity of coronals in consonant inventories of the world; more generally, the generalization states that less-marked contexts license a greater variety of contrasts, another facet of which — coda markedness — was discussed in Section 4.4 (and, less obviously, Section 4.3). This topic is taken up in Section 5.2. The results of Sections 5.1 and 5.2 were derived in Prince and Smolensky 1993/2004: Chapter 9; in the latter case, because it better illustrates the general themes of this paper, I present an analysis employing local conjunction which is a variant of the original analysis.

The final phenomenon we consider is one that involves the connection between inventories and the one Paradis and Prunet "invisibility" phenomenon postponed in Section 4: transparency of unmarked elements to the featural spread comprising harmony phenomena. This is taken up in Section 5.3.

5.1. Implicational Universals

The coronal-unmarkedness ranking (11) was in fact proposed by Prince and Smolensky 1993/2004: Sections 9.1-9.2 as a means of deriving universal inventory implications (Greenberg 1978). I will just quickly review this as a simple instance of Harmonic Completeness.

First a qualification. There may be special environments (e.g., a nasal preceding a labial stop) where there exists a markedness constraint \( \mathbb{M} \) which becomes active and favors [lab] over [cor]. Call this a 'non-neutral' environment, the other environments being 'neutral'. In a non-neutral environment, [lab] can be less marked than [cor], thanks to \( \mathbb{M} \); in a neutral environment, [cor] is unmarked. The implication we seek is that when a more marked segment is in the inventory, so must be a less marked one, and we are assuming that [cor] is the unmarked Place for this purpose — so the relevant type of environment is a neutral one. The goal is to show that, in a neutral environment, if the inventory of a language includes a labial then that
inventory must also include a coronal.\textsuperscript{12}

Now recall how an inventory is defined in OT (Prince and Smolensky 1993/2004: Chapter 9). A structure $x$ is present in the inventory of a language iff for some input $I$, the optimal parse of $I$ contains $x$. According to Richness of the Base, if a labial segment such as $p$ is absent from a language $L$'s inventory, then this means not that $p$ is an impossible input, but rather that it is an impossible output. No matter what the input, the grammar of $L$ ensures that an optimal output will never contain $p$. If the input contains $p$, the grammar assigns an unfaithful parse that lacks $p$.

On the other hand, when $p$ is present in the segmental inventory of $L$, a $p$ in an input $I_p$ surfaces as a $p$ in the optimal output $O_p$ — in the case of interest, in a neutral environment. When does this happen? Consider any unfaithful competitor $X$ to output $O_p$, where in $X$ the [lab] of $p$ does not surface; this violates some faithfulness constraints $\{F_k\}$. The markedness constraint $*$ [lab] prefers $X$ so, since $O_p$ is optimal, there must be an active constraint $C$, dominating $*$ [lab], which prefers that [lab] surface. In a neutral environment, by definition, no active markedness constraint favors [lab] over [cor], so $C$ must be one of the faithfulness constraints $\{F_k\}$: for some $j$, $F_j \gg *$ [lab]. But since necessarily $* *$ [lab] $\gg *$ [cor], this means $F_j \gg *$ [cor] (domination is transitive). So if in the input $I_p$ we replace [lab] with [cor], getting an input $I$, the faithful candidate $O_f$ must still be better than an unfaithful candidate in which [cor] does not surface: if eliminating an underlying Place feature is too costly to avoid the mark $* *$ [lab] it must surely be too costly to avoid the lower-ranked mark $* *$ [cor].\textsuperscript{13}

\textsuperscript{12} The specification of a neutral environment is but one of a number of technical assumptions needed to rigorously prove ‘[lab] $\Rightarrow$ [cor]’. In a non-neutral environment $E$, it is [lab] that is unmarked — e.g., before a [lab] stop, a [lab] nasal is less marked than a coronal nasal with respect to the Nasal Place Agreement constraint NPA Chapter; if NPA is sufficiently high-ranked, the overall markedness of a [lab] segment in this environment $E$ may be less than that of the corresponding [cor] segment. To derive implicational universals concerning $E$, [lab] would replace [cor] as the least-marked Place. The same analysis of the text could be applied to $E$ by simply replacing reversing ‘lab’ and ‘cor’, with the general constraints $* *$ [lab], $* *$ [cor] being replaced by more specialized constraints — effectively, $*$ [lab in $E$], $* *$ [cor in $E$].

\textsuperscript{13} The plausible but unstated assumption here is that the operation on [lab] yielding $X$
follows that an underlying coronal $t$ must surface faithfully, like labial $p$ does. Thus $L'$'s inventory admits the coronal counterpart of any admitted labial.

In other words, in a neutral environment, if a language has labials, then it must have coronals.

The segmental inventory of a language $L$ is *Harmonically Complete* with respect to some structural dimension $d$ (e.g., Place) iff the following holds: if $x$ is a legal segment in $L$, and $y$ differs from $x$ only in that it is more harmonic (less marked) with respect to $d$, then $y$ is also a legal segment in $L$.

The argument above shows that under the treatment of coronal unmarkedness in Prince and Smolensky 1993/2004, segmental inventories must be harmonically complete with respect to Place. The argument can clearly be immediately generalized to any other dimension $d$, with [lab] being replaced by the marked pole of $d$, and [cor] by the unmarked pole.

5.2. Coronal Diversity

The greater diversity of segments with coronal place can be understood as an instance of the general tendency for less marked structures to "license" more contrasts. Consider the contrast [±cont] between obstruents that are continuant (fricatives, more marked) and those that are not (stops, less marked). Will this contrast be preserved at [cor] or [lab] Places?

Suppose the relevant markedness constraints include, in addition to those pertaining to individual features, conjunctions of single-feature constraints. Then, analogously to (22), the universal Place constraint hierarchy (11) entails, by (23)

---

can be applied to [cor] and that the same (or higher) degree of faithfulness violation results. If this assumption fails, however, a different outcome is possible. For example, if the operation is segmental deletion, violating MAX, and there are constraints $\text{MAX}_{p}(x)$ requiring that a specific place specification $[x]$ in the input have an identical correspondent in the output (violated by segmental deletion), an inventory could admit [lab] while rejecting [cor]: with $\text{MAX}_{p}(\text{lab}) \gg * \text{[lab]} \gg * \text{[cor]} \gg \text{MAX}_{p}$(cor) $\gg \text{MAX}$, an underlying coronal gets deleted but an underlying labial does not. This is possible because the faithfulness cost of eliminating [cor] is lower than that of eliminating [lab]. A formal analysis of Harmonic Completeness must make explicit assumptions ruling out this sort of anomaly (Smolensky and Legendre to appear).
(27) * [lab]& * [+cont] \gg_{UG} * [cor]& * [+cont]

Now consider the ranking:
(28) * [lab]& * [+cont] \gg \text{IDENT(Place)} \gg
\{ * [cor]& * [+cont], * [lab]\} \gg \{ * [cor], * [+cont]\}

This generates an inventory, like that of Tagalog (Schachter 1987: 938), in which coronal Place hosts both [+cont] and [−cont] segments (e.g., t/s), but there is less diversity at labial Place, where only the less-marked, non-continuant segment is allowed (e.g., pl/ * f, * Φ).

This argument can clearly be generalized from [±cont] to a large number of other contrasts, including the contrast among secondary Places of Articulation distinguishing complex segments, the case treated in the original analysis of Prince and Smolensky 1993/2004: Section 9.1.2.

5.3. Transparency

Here I will depart from the example of context-free coronal unmarkedness and shift to a case of contextual featural markedness, or the markedness of certain feature combinations. The relevant cases will be the markedness of [+back] in the context of a vowel also bearing the features [−low, −round] (see, e.g., Archangeli and Pulleyblank 1994 and the references therein). This markedness is captured by the feature co-occurrence constraint.

(29) * [+back, −low, −round]

The markedness of [+back] here is relative to [−back]; the relevant universal markedness hierarchy is thus:

(30) Backness markedness hierarchy in context [−low, −round]
* [+back, −low, −round] \gg_{UG} * −back, −low, −round]

This entails two markedness relations on segments, (31a) for [+high] and (31b) for [−high].

(31) Markedness of [±back] in the context [−low, −round]
   a. i > i
b. $e > \ddot{e}$

Here [+back, −low, −round, +high], IPA $u$, is written $\ddot{i}$ (or sometimes $i$ as customary for Turkic); [+back, −low, −round, −high], IPA $\dddot{u}$ (or $\lambda$), is represented $\ddot{e}$. According to Section 5.1, such markedness relations predict two implicational universals: $\ddot{i} \Rightarrow i$ (if a language’s inventory contains $\ddot{i}$, then it will contain $i$) and $\ddot{e} \Rightarrow e$.

Our question is whether the fundamental proposal, “lower marks ⇒ less active” (8), can explain the “invisibility” of redundant features in vowel harmony systems, invisibility which is implemented literally in radical underspecification theory. The relevant sense in which such a feature $[−\varphi]$ is “invisible” in a segment is that this feature does not trigger the spread of $[−\varphi]$, nor block the spread of $[+\varphi]$, the way it does in segments in which it is not redundant. To say here that a feature $[−\varphi]$ is redundant in a segment which bears other features $[…\psi…]$ is to say that while $[−\varphi \ldots \psi \ldots]$ is in the language’s segmental inventory, $[+\varphi \ldots \psi \ldots]$ is not. A goal of the following analysis is to show how this potential consequence of inventory shape — “invisibility” to spread — is made possible by the very constraint rankings which are responsible for producing that inventory in the first place.

In the Finnish vowel inventory ($i\ddot{u}$, $\dddot{o}$, $\dddot{a}$, $i$, $e$), the two $[−low$, $−round]$ front vowels $\ddot{i}$ and $\ddot{e}$ lack back counterparts: the missing vowels are exactly the two segments $i$ and $e$ identified as marked in (31). Thus the feature $[−back]$ is redundant in $i$ and $e$. And these vowels are “invisible” to the backness harmony system of Finnish: the vowels are transparent in that $[+back]$ spreads right through them (see, e.g., Kiparsky 1973).

As we saw in Section 5.1, the presence in the inventory of $i$ and $e$, and the absence of $\ddot{i}$ and $\ddot{e}$, is a consequence of the rankings (32).

(32) Finnish inventory

a. $i$, $e$ present; $\ddot{i}$, $\ddot{e}$ absent

* [+back, −low, −round] $\gg$ $F_{\text{max}}$

$F_{\text{min}}$ $\gg$ * [+back, −low, −round]

b. $i\ddot{u}$, $\dddot{o}$ present

$F_{\text{min}}$ $\gg$ * [+back, +round]

where $F_{\text{max}}$ and $F_{\text{min}}$ are respectively the highest- and lowest-ranked
faithfulness constraints relevant to the markedness constraints * [−back, −low, −round]. For concreteness, let us take \( F_{\min} \) to be \( \text{IDENT}(\text{back}) \); this means that the input segments /i/, /e/ will surface as \( i, e \). The features [back], [low], and [round] are henceforth abbreviated B, L, and R.

For brevity here I will simply present two tableaux illustrating harmony and briefly explain the critical elements. The input in (33) is a word with final stem vowel \( e \) and a suffixal vowel which is underlyingly \( o \). As shown in the optimal output \( a \), these vowels surface as \( e \, \ddot{o} \). (e.g., /heret+koon/ → heretköön ‘let him/her quit’; /keret+koon/ → keretköön ‘let him/her make it on time’; Jussi Valtonen, p.c.) The suffixal vowel has harmonized with the final stem vowel: \( e \) spreads [−back] to \( o \), forming \( \ddot{o} \). This shows that even if a suffix vowel is underlying specified with the ‘wrong’ value of [±back], it will surface with the correct, harmonized, value. The representation in candidate \( a \) consists of a [−back] feature domain (Kirchner 1993; Smolensky 1993; Cole and Kisseberth 1994a, b, 1995b, a, c, 1997), including both vowels; this means both vowels express this feature value. Clearly, faithfulness to backness, \( \text{IDENT}(\text{back}) \) or \( \text{ID}^B \) for short, is violated at the output \( \ddot{o} \); this is indicated by a violation mark ‘ * \ddot{o} ’. In addition, the surface vowels \( e \) and \( \ddot{o} \) respectively violate the feature co-occurrence constraints * [−back, −low, −round] ≡ * −B, −L, −R and * −B, +R.

(33) Harmonic feature domains under Richness of the Base

<table>
<thead>
<tr>
<th>.e.+..o.</th>
<th>Inventory Gap</th>
<th>Transparency</th>
<th>No Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>+B</td>
<td>−L, −R</td>
<td>−L, −R</td>
<td>+R, +R</td>
</tr>
</tbody>
</table>

a. [ _B e ] [ _B e ]

b. [ _B e ] [ _B o ]

c. [ _B e ] [ _B o ]

d. [ _B e ] [ _B o ]

. The unfaithful mapping of underlying /o/ to surface \( \ddot{o} \), violating \( \text{ID}^B \) and increasing the back-markedness to * −B, +R from lower-ranked * +B, +R, is
compelled by the harmony-inducing constraint $\text{ALIGN-R}(\triangleright_B, \text{Wd}) = \text{AL}^{-B}$: this requires that the right edge of each $-B$ domain $\triangleright_B$ coincide with the right edge of the word (Prince and Smolensky 1993/2004: Chapter 7; McCarthy and Prince 1993, 1993/2001). This constraint is violated by the faithful candidate $b$, as shown by the $\text{AL}^{-B}$ mark `* o' (labeled by the alignment-violating vowel separating the right edge of $\triangleright_B$ from the right word-edge: $o$). This violation renders $b$ suboptimal due to the ranking (34).

(34) [--back] Harmony: $\text{AL}^{-B} \gg * -B, +R$

Since Finnish also has [+back] harmony, the corresponding ranking also holds for $\text{AL}^{+B}$.

Candidate $c$ satisfies the harmony constraint $\text{AL}^{+B}$ (and $\text{AL}^{-B}$ too, vacuously); it represents regressive harmony from the suffix to the stem. This is sub-optimal because its unfaithfulness, at the stem vowel, is more marked than the optimal candidate's unfaithfulness at the affix vowel. Employing a standard OT method of expressing this, positional faithfulness (Beckman 1997; Smith 2002; cf. Bakovic 2000), a constraint $\text{In}^{B}_{st}$ specialized to stems is violated by stem unfaithfulness, but not by affixal unfaithfulness; its high rank ensures that stem-controlled harmony ($a$) is always more harmonic than affix-controlled harmony ($c$). Consideration of the final candidate $d$ will be momentarily deferred.

Underspecification theories often take harmonizing vowels, like the affixal one here, to be unspecified underlyingly for the harmonizing feature (e.g., Clements 1976; Pulleyblank 1983). In OT, the Richness of the Base principle requires that the grammar accept any input and produce a grammatical output, so whether or not underspecified inputs are included in an OT account, we cannot count on harmonizing segments to be unspecified. The input we have just considered is a worst case since the affixal vowel is underlying given the 'wrong' specification for this stem, and it must change from the less- to the more-marked vowel, from $o$ to $ö$.

The input of (35) is relevant to the transparency of less-marked vowels. This input contains a stem vowel $o$ followed by two vowels taken to be underlyingly $ë ü$. In the optimal output, candidate $a$, these three vowels surface as $o e u$: the [+back] of stem $o$ has 'spread through' stem $e$ to change the
underlying suffixal ĭ to u. (The surface form is exemplified by totellut, ‘the one having obeyed’; Olli 1958: 181.) The intermediate vowel surfaces as e, even though it is underlyingly ĭ and ĭ has the value [+back] in harmony with the surrounding vowels. We must relate this to the fact that ĭ is not in the Finnish vowel inventory. (Again, Richness of the Base forces the grammar to produce the correct output even for the worst-case input considered here, where the vowel that must surface as e is underlyingly ‘mis’-specified as [+back].)

Before tackling this imposing tableau, let’s consider an underspecification account, where the vowel e would be unspecified underlyingly for [back], and the [+back] feature of the stem vowel would spread to the right edge of the word, producing the desired final u as well as a medial ĭ. At this intermediate stage of derivation, the entire word shares [+back]. Then a rule inserts the value [−back] for the [−low, −round] medial segment, changing it from ĭ to e, and breaking up the span of [+back] so that now the [+back] value on the final u is no longer connected to its source in the stem by a contiguous span of [+back] vowels (Vago 1973). Alternatively, i and e are assumed not to be [±back]-bearing units; feature spread ignores them, as it does consonants (Clements 1976; Kiparsky 1981). Again the result is that a [+back] domain extends throughout the whole word.

(35 ) Transparency of redundant features

<table>
<thead>
<tr>
<th>...o... ĭ...+...ô...</th>
<th>Inventory Gap</th>
<th>Transparency</th>
<th>No Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>a [ +e[ +Bo[ -Be]e]u]</td>
<td>* e * e</td>
<td>* e * u</td>
<td>* o * u</td>
</tr>
<tr>
<td>b [ +Be[ -Be]e ]</td>
<td>* ĭ!</td>
<td>* u</td>
<td>* o * u</td>
</tr>
<tr>
<td>c [ +Be[ -Be]ü ]</td>
<td>* ĭ!</td>
<td>* ü</td>
<td>* ü * o</td>
</tr>
<tr>
<td>d [ +Be[ -Be]ü ]</td>
<td>* e * e</td>
<td>* e * ü!</td>
<td>* e * ü * o</td>
</tr>
<tr>
<td>e [ +Be[ -Be]ü ]</td>
<td>* e * e</td>
<td>* e * ü!</td>
<td>* e * ü * o</td>
</tr>
<tr>
<td>f [ -Be[ e ü ]</td>
<td>* ŭ!</td>
<td>* e</td>
<td>* e * ŭ * ü</td>
</tr>
<tr>
<td>g [ -Be[ -Be[ e [ +Bu]]]</td>
<td>* e * e</td>
<td>* e * u!</td>
<td>* e * u * o</td>
</tr>
</tbody>
</table>


The representation in candidate $a$ has an outer $+$B domain including all vowels; it corresponds to the intermediate derivational stage in the underspecification account. Candidate $a$ also has a $-$B domain *embedded within* the larger $+$B domain (bold). It is the innermost feature value that determines a segment’s phonetic interpretation, so the medial vowel surfaces $-$B, as [e] not [ɛ].

Suffixed /ɨ/ surfaces unfaithfully here for the same reasons that suffixed /ɔ/ surfaced unfaithfully in the first input. What is new in the optimal candidate $a$ is the embedded feature domain, which violates a constraint *EMBED(back) ≡ *EM$^B$. This violation is avoided in the non-embedded candidate $b$, which is sub-optimal because without the embedded domain, the medial vowel surfaces as ɛ̃, in violation of undominated *+$B$, −L, −R. For the same reason, the faithful candidate $c$ is sub-optimal.

There are several ways the medial vowel can surface as [e], which requires that the deepest domain containing this vowel be $-$B. This $-$B domain could extend to the right edge of the word, as in candidates $d$ and $e$. This has the virtue of satisfying AL$^{-B}$, but as this is ranked below *EM$^B$, candidate $h$ is sub-optimal. It is assumed here that *EMBED is violated once for each segment in an embedded domain; this constraint provides a pressure to minimize the extent of embedded domains, which favors the optimal candidate $a$ over $d$. Candidate $e$ satisfies AL$^{-B}$, and avoids *EMBED$^B$ violations altogether, but it violates the higher-ranked AL$^{+B}$.

In candidate $f$, the $-$B domain including medial [e] extends to cover the entire word, avoiding violations of *EMBED$^B$ and AL$^{+B}$ (vacuously). But it is sub-optimal because it is unfaithful to a stem vowel, fatal in this stem-controlled harmony ranking.

The final candidate $g$ has the same phonetic interpretation as the optimal candidate $a$. But there is no motivation for the most-embedded $+$B domain; this candidate can never be more harmonic than $a$ because $a$’s marks are a proper subset of $g$’s marks: no matter the ranking, $a$ must be more harmonic than $g$. Candidate $a$ *harmonically bounds* candidate $g$ (Prince and Smolensky 1993/2004: Chapter 9). Segments transparent to vowel harmony must surface in the simplest form exhibiting transparency, the single embedding of candidate $e$.

That $e$ is transparent, rather than opaque, to B-harmony is determined by the
will begin and continue rightward: e will then be harmonically opaque. It is thus not the transparency of e, but more generally its non-participation in harmony that is crucial; this is what is linked to feature redundancy.

The task at hand is to relate the transparency of \(-B\) in the segment e to its redundancy, that is, to the shape of the segmental inventory, which is what makes this feature redundant in this segment. The ranking shown in tableau (33) determines that [±back] is redundant in e, but not in o, as follows. The most directly relevant environment is the stem-internal one, where harmony does not complicate the mapping of [back]. In stems, the key constraint is \(\text{In}^B_{\text{stem}}\). Since it dominates both \(+B, +R\) and \(+B, +R\), both underlying vowels /o, ö/ will surface faithfully. [back] is contrastive, not redundant, in the context \(+R\). But \(\text{In}^B_{\text{stem}}\) is ranked between the constraints of the Backness Markedness Hierarchy in \(-L, -R\) segments. Thus only the unmarked value of [back] can surface in these segments: e, but not \(\ddot{e}\), is in the inventory — [back] is redundant in e.

5.4. Effects of Target Markedness in Vowel Harmony

In Finnish, the feature co-occurrence condition \(* [+\text{back}, -\text{low}, -\text{round}]\) eliminated \(i = i\) from the vowel inventory. The more subtle status of feature co-occurrence conditions in OT — violable rather than inviolable constraints — predicts that such conditions should produce more subtle markedness effects in languages where they are not unviolated. In such a language, \(i\) would be present in the inventory, but its markedness relative to \(i\), due to \(* [+\text{back}, -\text{low}, -\text{round}]\), should limit its distribution.

Such a language is Turkish. Like Finnish, Turkish displays [back] harmony, but unlike Finnish, the Turkish inventory includes \(i\). The elä distinction of Finnish is absent in Turkish, where e plays the role of \(\ddot{a}\) as the [−back] harmonic alternate of a.

Within Turkish roots, exceptions to vowel harmony are common. However, within morphemes:

(36) “The vowels /ü, ö, i/ do not occur disharmonically in VC\(_2\)V sequences, except that /i, ü/ may occur in either order.” (Clements & Sezer 1982: 228)
Here, we consider only one facet of this behavior: within a root, a disharmonic sequence ati may occur, but eti may not. This will be explained as resulting from the markedness of \( \hat{t} \) relative to \( t \), with the disharmonic environment admitting only the less-marked segment. Despite its markedness, however, \( \hat{t} \) surfaces in roots and affixes under [+back] harmony, and as a sole root vowel.

The tableaux in (37) exhibits the \( i/\hat{t} \) contrast. The new element introduced here is the feature domain head (Smolensky 1995; Cassimjee 1998; Cassimjee and Kisseberth 1998). Each \( \varphi \)-domain has exactly one head, marked \( \varphi^0 \) (like the phrasal head \( X^0 \) of X-bar theory). The constraint \( \text{IDENT}^0(\varphi) \Rightarrow \text{ID}^{\varphi} \) requires that the head of a \( \varphi \) domain be faithful in \( \varphi \). The constraint \( \star \varphi^0_{\text{aff}} \) prohibits a \( \varphi \)-head from appearing in an affix; this is key to the stem-controlled nature of Turkish B-harmony in this analysis. (These two constraints are actually derived by local conjunction from a fundamental constraint of headed-domain theory: \( \star \text{HD}(\varphi) \), the member of the \( \star \text{STRUCTURE} \) family penalizing the additional structure identifying the head of a \( \varphi \)-domain. \( \text{ID}^{\varphi^0} \) is the conjunction \( \text{ID}(\varphi) \&_{\text{seg}} \star \text{HD}(\varphi) \); \( \star \varphi^0_{\text{aff}} \) is \( \star \text{AFFIX} \&_{\text{seg}} \star \text{HD}(\varphi) \), where \( \star \text{AFFIX} \) is the constraint assessing the segments of affixes as marked relative to those in stems.)

The first input of tableau (37) is a word containing the vowel sequence a \( \hat{t} \) in the root, with a suffix containing the vowel \( a \), as in /tarih+sel/ \( \rightarrow \) tarihsel ‘historic’.\(^{14}\) The faithful candidate a violates undominated \( \star b^0_{\text{aff}} \) because the suffixal vowel heads its own domain. Because this constraint outranks \( \text{ID}^B \) and all feature co-occurrence constraints, it is more harmonic to include suffixal vowels in root-headed \( B \)-domains, even if this requires being unfaithful to underlying affixal \( B \) values. Thus suffixal vowels are not heads in all remaining candidates. Candidates b–c include the affix vowel in a \( B \)-domain headed by the root-final vowel; this is embedded within, or follows, a domain headed by the root-initial vowel. Because \( \star \text{EMBED}^B \) out-ranks \( \star \text{ALIGN}^B \), all embedded-domain candidates are less harmonic than their non-embedded counterparts; thus candidate b is less harmonic than candidate c.

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\(^{14}\) Turkish examples are from Lewis 1967, pp. 65, 65, 83, 63, and 60, respectively.
(37) Markedness and Turkish root disharmony

Ranked below the constraints shown: \( \text{ID}^B, \ast [-B, -L, -R], \ast [-B, +L], \ast [+B, +L]. \)

<table>
<thead>
<tr>
<th>a ( [<em>{+B}a^0][</em>{-B}i^0] + [+B]a^0 )</th>
<th>* ( \text{EMB}^B ), * ( \text{ID}^B )</th>
<th>* ( B_0^{\text{aff}} )</th>
<th>* ( +B, -L, -R )</th>
<th>* ( \text{ID}^B_{\text{stem}} )</th>
<th>* ( \text{AL}^B )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( a ) ( [<em>{+B}a^0][</em>{-B}i^0] + [+B]a^0 )</td>
<td>* ( a^0 ! )</td>
<td>* ( i \ast e ! )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( b ) ( [<em>{+B}a^0][</em>{-B}i^0+e] )</td>
<td>* ( i \ast e ! )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( c ) ( [<em>{+B}a^0][</em>{-B}i^0+e] )</td>
<td>* ( i \ast e )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( d ) ( [_{+B}a^0][-B]i^0+a )</td>
<td>* ( i ! )</td>
<td>* ( i )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( e ) ( [_{-B}e i^0+e] )</td>
<td>* ( e ! )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| \( c' \) \( [_{-B}e^0][_{+B}i^0+a] \) | \* \( i ! \) | \* \( i \ast a \) | | | |
| \( d' \) \( [_{-B}e^0+i+e] \) | \* \( i \) | | | | |
| \( e' \) \( [_{+B}a i^0+a] \) | \* \( i ! \) | \* \( a \) | | | |

| \( a'' \) \( [_{+B}a^0][_{-B}i+e^0] \) | \* \( e^0 ! \) | \* \( i \) | \* \( i \ast a \) | | |
| \( c'' \) \( [_{+B}a^0][-B]i+a \) | \* \( i \) | | | | |
| \( d'' \) \( [_{-B}e i^0+e] \) | \* \( i ! \) | \* \( e \ast i \) | | | |
| \( e'' \) \( [_{+B}a^0][_{-B}i^0+e] \) | \* \( i ! \) | \* \( a \) | \* \( i \ast a \) | | |

Candidate c is in fact optimal. Its highest-ranked mark is \( \ast \text{AL}^B \). This is eliminated in candidates \( d-e \), but these are suboptimal because each violates higher-ranked \( \text{ID}^B_{\text{stem}} \). The optimal output \( a \ast +e \) displays harmony of the affixal vowel to the stem-final vowel, but disharmony within the root. The second input reverses the roles of \( \pm B \) (e.g., \(/\text{cebir}+\text{sel}/ = \text{cebirsel} \ '\text{algebraic}'\)). Candidate \( c' \) is the counterpart of optimal c, but now its faithful stem-final vowel violates the high-ranking feature co-occurrence constraint marking \( i \), \( \ast [+B, -L, -R] \). Because this outranks \( \text{ID}^B_{\text{stem}} \), it is more harmonic to include \( i \ast i \) in the \( -B \) domain headed by the initial vowel: candidate \( d' \), the counterpart of \( d \). Clearly this is more harmonic than a single domain headed by \( i \).
candidate $e'$. The resulting output $e \ i + e$ is fully harmonic.

The point is that the markedness of $i$ relative to $i$ makes possible a ranking in which faithfulness to stem $\pm B$ values generates disharmonic stems, except when there is a chance to eliminate /i/ by inclusion in a $-B$ domain headed by a stem vowel.

As the third input in tableau (37) shows, it is sub-optimal to eliminate /i/ by including it in an affix-headed $-B$ domain, or in $a-B$ domain that it heads as a surface $i$, unfaithfully to its underlying $+B$ value (incurring $* \text{Id}^B$). Underlying /a i + e/ surfaces as $a \ i + a$, fully harmonic despite the resulting surface $i$ (as in /alti + ṣer/ $\rightarrow$ altı sar 'six each').

The first input in tableau (38) makes a similar point, showing that a single root /i+ i/ surfaces as $i$ and initiates a $\pm B$ harmony domain (/yi1 + lik/ $\rightarrow$ yil ليك 'yearling'). The second input in this tableau shows that a disharmonic $i$ in a root is impossible not only when it follows $e$ (37), but also when it precedes $e$ (this input surfaces like liseli $\leftarrow$ liše + li/ 'lyceé student').

(38) Markedness and Turkish root disharmony, continued

<table>
<thead>
<tr>
<th></th>
<th>$\text{EMB}^B$</th>
<th>$\text{Id}^B$</th>
<th>$\text{B}_0^{\text{aff}}$</th>
<th>$\text{B}_r^B$ + $\rightarrow$</th>
<th>$\text{Id}^B_{\text{stem}}$</th>
<th>$\text{Al}^B$</th>
</tr>
</thead>
<tbody>
<tr>
<td>/i + i/ $\rightarrow$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a $\equiv ^\text{=} \ [_{+B}i^0+\lambda] $</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b $\iff$ $[_{+B}i^0+[-_B]i^0]$</td>
<td></td>
<td></td>
<td></td>
<td>$*i^0$ !</td>
<td>$*i$</td>
<td></td>
</tr>
<tr>
<td>c $\iff$ $[-_B]i^0+i$</td>
<td></td>
<td></td>
<td></td>
<td>$*i^0$ !</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d $\iff$ $[-_B]i^0+i$</td>
<td></td>
<td></td>
<td></td>
<td>$*i^0$ !</td>
<td>$*i$</td>
<td></td>
</tr>
<tr>
<td>/i + i/ $\rightarrow$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>q $\iff$ $[_{+B}i^0[-_Be^0+i]]$</td>
<td></td>
<td></td>
<td></td>
<td>$*c \ i$ !</td>
<td>$*i$</td>
<td></td>
</tr>
</tbody>
</table>

15 Notice that $\text{ALIGN}^B$ does no work here; disharmonic affix vowels are sub-optimal because they require a head in an affix, which is more marked than unfaithfulness in affixes. In many harmony situations domain heads eliminate the need for alignment constraints. The simplest $q$-harmony-inducing constraint is $*$ $\text{Hd}(q)$: No heads $q^B$. Minimizing $q$-head structure requires having a single $q$-domain (in the relevant context where $\text{MAX}$ prevents total segment deletion).
### 6. Summary

The point I have tried to make in this paper is simply this. A wide range of phenomena that have been attributed to underspecification can be accounted for in a simple, uniform way, using only the central grammatical apparatus of OT, without stipulating a separate representational device for unmarkedness: invisibility. ‘Invisibility’ is a derived property; (39) summarizes the examples discussed in this article.

(39) ‘Process’ Marks $\supset$ Element Marks $\Rightarrow$ Element is ‘invisible’ to ‘process’

<table>
<thead>
<tr>
<th>Sec.</th>
<th>Visible Element Mark</th>
<th>Condition/Process Mark</th>
<th>Invisible Element Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Epenthetic Labial * [lab]</td>
<td>Epenthesis</td>
<td>Epenthetic Coronal * [cor]</td>
</tr>
<tr>
<td>4.2</td>
<td>Labial Segment * [lab]</td>
<td>Deletion * PARSE</td>
<td>Coronal Segment * [cor]</td>
</tr>
<tr>
<td>4.3</td>
<td>Lab-Lab Cluster * [lab] &amp; [lab]</td>
<td>Cluster Condition * IDENT(PI)</td>
<td>Lab-Cor, Cor-Cor Clusters * [lab] &amp; [cor] * [cor]</td>
</tr>
<tr>
<td>4.4</td>
<td>Labial Coda * [lab] &amp; NOCODA</td>
<td>Coda Neutralization * IDENT(PI)</td>
<td>Coronal Coda * [cor] &amp; NOCODA</td>
</tr>
<tr>
<td>4.5</td>
<td>[Lab]??</td>
<td>Assimilation??</td>
<td>[Cor]??</td>
</tr>
</tbody>
</table>
5.3 \[ \text{Banned} + b \quad \text{Non-Harmonizing} - b \quad \text{Redundant} -b \]

* [+B, −L, −R] = * ě \[ \Rightarrow \] * IDENT\text{stem}_B \[ \Rightarrow \] * e = * [−B, −L, −R]

5.4 \[ \text{Highly Marked} + b \quad \text{Del. Disharmonic} + b \quad \text{Unmarked} + b \]

* [+B, −L, −R] = * ĩ \[ \Rightarrow \] * IDENT\text{stem}_B \[ \Rightarrow \] * [+B, +L, ] = * a

Note that all these explanations are merely various consequences of the elementary defining property of coronal unmarkedness:

(40) \[ * \text{[lab]} \gg \text{UG} * \text{[cor]} \]

Rather than structural absence, what may ultimately explain the "invisibility" of the unmarked is quite simply the invisibility to the optimizing grammar of non-existent or low-ranked marks — inactive constraint violations. This property of the unmarked is integral to the grammatical architecture of Optimality Theory; there is no need — and indeed no opportunity — to manipulate the visibility of phonological material with special representational stipulations controlling the inputs to the grammar. The OT perspective connects the invisibility properties of unmarked elements with their role in inventories, including the implications of inventory shape for vowel harmony systems. Also inherent in this unified theory of markedness is an explanation of an important property quite at odds with structural absence: the strong licensing capabilities of the unmarked, as manifest for example in the relative diversity of coronals in segmental inventories.

References


Markedness, Harmony, and Phonological Invisibility

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