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Covert generalizations in Optimality Theory: the role of stratal faithfulness constraints

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Ito, Junko, and Armin Mester. 2001. Covert generalizations in Optimality Theory: the role of stratal faithfulness constraints. *Studies in Phonetics, Phonology and Morphology* 7.2. xxx-xxx. Is it possible for a phonological generalization to persist even when it has ceased to hold of the whole lexicon? We show how the basic architecture of Optimality Theory (OT) imposes a subset organization on lexical inventories, which manifests itself in lexically covert generalizations. The central predictions flow directly from the core tenets of OT, namely, that all grammatical constraints are ranked in a strict order of preference and are in principle violable, with violation always minimized in winning outputs. On the empirical side, we review the evidence for subset organization in the lexical inventories of real languages, focusing on grammar-induced entailment relations between nativization phenomena that other approaches fail to predict. On this foundation, we build a general optimality theoretic model of the phonological lexicon that accommodates the familiar differences between strata—including, but not limited to, the distinction between native words and loanwords—within a unitary constraint system and correctly predicts the existence of a core-periphery structure in the lexicon, without additional assumptions and mechanisms. Formally speaking, our proposal reduces to the claim that stratum-specific input-output faithfulness is both necessary and sufficient (i) to account for the stratal organization of a language's lexicon and (ii) to capture higher-level entailment relations between nativization effects. **(University of California, Santa Cruz)**

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1. Introduction

Since its inception, generative phonology has pursued the idea that there is more to phonetic form than what can be determined by applying distributional methods of analysis to corpora of utterances. Such procedures of segmentation and classification yield useful prerequisites for analysis, such as phonemic inventories with lists of allophonic variants, morphemes and their allomorphs, and the like, but they do not provide access to the rich world of structural and derivational relations that underlies the output forms and constitutes the main point of interest of modern linguistics. In this context, *covert* generalizations have always played a privileged role—

generalizations that are valid in spite of being violated in some surface forms.

While many phonotactic and segmental generalizations about the sound patterns of languages are *overt*—i.e., borne out in all surface forms and never contradicted—phonologists have devoted special attention to *covert* generalizations. Covert phonological generalizations come in several types, the most familiar of which is *opacity*, which arises whenever certain aspects of the process cannot be directly induced by a distributional study of the data because of characteristic syndromes of overapplication ("counterbleeding") or underapplication ("counterfeeding"; recent discussions include McCarthy 1998, Kiparsky 1998, and Ito & Mester 2001, to appear).

The topic of this paper is covert generalizations of a different type, namely those that owe their existence to the fact that the phonological lexicon of a language is usually not a homogeneous structure, but shows considerable internal subdivision. Historically speaking the result of grammar-external factors of a social, cultural, or political nature, such non-uniformity of structure is a considerable challenge to language learners, who have to come to terms with it. Earlier work (see Ito and Mester 1995a,b et sqq.) has tried to demonstrate that the lexical non-uniformity under discussion is best characterized by a kind of subset organization centered on a maximally unmarked core. Phonological generalizations can thus be covert by being lexically partial: they hold within a subdomain of the whole lexical space, but are violated in peripheral areas occupied, e.g., by loanwords or onomatopoeia.

As a simple illustration, consider the well-known generalization in Japanese (as well as in countless other languages) requiring palatalization of coronal plosives before high front vocoids. On the one hand, a large number of morphemes alternate their shape to accord with this palatal agreement requirement, such as /mat/ 'to wait', where [t] in [mat-ana-i] 'wait-NEG-PRESENT' corresponds to [tʃ] in [matʃ-i-mas-u] 'wait-POLITE-PRESENT', etc. As a static counterpart to such alternations triggered by hetero-morphemic [i], we find a distributional gap in the internal structure of morphemes: [d] and [t], while they occur freely before other vowels,[1] are generally absent before tautomorphemic [i]. Thus among basic verbs, we encounter roots like [de-] 'go out', [das-] 'put out', [tas-] 'to add', [te-] 'to shine', [tor-] 'to take', but no forms like *[ti-] or *[di-].

Palatal agreement thus appears to be a textbook example of an unproblematic phonological generalization (and it figures in this role in many introductions to phonology). Still, when it comes to loanwords and other lexically peripheral items in modern Japanese, the English word *tea* appears as [tii] (not [tʃii]), *party* is taken up as [paatii] (not [paatʃii]), and a recently introduced new car model was giving the name [diŋgo] (not

[1] For [u], a similar co-occurrence restriction demands affrication of coronal plosives.

[dʒiŋgo]), etc.—the list of such "unassimilated loans" is long. At the same time, it is not true that loanwords always disregard palatal agreement: *team* is [tʃiimu], *dilemma* is [dʒiremma], not to speak of *digital* pronounced as [dedʒitaru], with a prophylactic height adjustment of the vowel, etc. The list of such "assimilated loans" can also be carried on indefinitely (for further examples and detailed analysis, see Ito and Mester 1995a,b).

What are we to make of this kind of situation? Since phonetic forms like [diŋgo] are by no means exceedingly rare, strict distributional analysis of text corpora of contemporary Japanese speech will have a difficult time avoiding the conclusion that palatal agreement is no longer a "productive generalization", and hence has no legitimate place in the grammar. "Once a phoneme, always a phoneme", according to a time-honored structuralist slogan: If so, the existence of [tii] alongside [tʃiimu] will force a hypothetical hard-nosed distributionalist to accept /t/ vs. /t͡ʃ/ as a contrast before /i/ everywhere, and live with the consequences. In this view, it makes no longer any sense to speak of palatalization governing the synchronic behavior of speakers in any way. Rather, it has turned into an historical event. While it was a genuine phonological process at earlier stages of Japanese, all that remains synchronically are the results of palatalization scattered over the lexicon, with all morphemic variants fully listed in their various environments: /mat-ana-i/ vs. /matʃ-i-mas-u/, etc.

The line of reasoning leading to this result shows remarkable methodological rigor, but, with Mr. Keuner's notorious gardener in Bertolt Brecht's story, one is left wondering what else it has to recommend it. Compared to an earlier time when the sequences [ti] and [di] were presumably[2] not part of the input relevant for Japanese language learners, what else is tangibly different now that [paatii] and [diŋgo] are around—i.e., besides the very fact that such forms are now part of the linguistic environment? If the existence of [ti] in a few forms had automatically triggered a fundamental shift in speakers' grammars, there should be many other tangible changes accompanying it since the differences between productive derivation and lexical listing of variants are multiple and deep (see Pinker 1999 for an overview of the grammatical, psycholinguistic and neurological facts and processes differentiating the two). But it is hard to pinpoint any other changes correlated with the presumed abrupt end-of-palatalization-as-a-process in Japanese. In all other respects—i.e., *apart from* the appearance of [paatii] and the like—the palatal agreement seems to have maintained its force. The alternations are easily acquired, their production is effortless and quasi-automatic, and the reason is not far to

[2] It is worth bearing in mind that the existence of a palatalization-wise pure prior state of the language is itself only a hypothesis and not an established empirical fact.

seek: Palatalization is firmly rooted in markedness, namely, in the *universal dispreference* of non-palatalized coronals before palatal vowels. It is hard to see what a claim that palatalization is no longer "psychologically real" would actually mean in such a situation. According to Generative Grammar (and different from empiricist approaches to language), learners do not have to inductively learn universal constraints such as palatal agreement from data. Their task is rather the more limited one of activating and deactivating the universal constraint in their grammars, and OT is a specific proposal as to how this comes about.

Here we see the reason why most working phonologists have routinely assumed that the process in question continues to be a productive part of the grammar—but with a restriction of its lexical domain. This presupposes that the lexicon of a language is a structured and stratified entity, and our task as theorists is to work out in detail what it means for a process to be lexically partial. Examples similar to Japanese palatalization can easily be multiplied for other alternations and for other languages. They teach us that, if we were to narrow down the notion of 'productive generalization' to the point where the existence of even a single case of non-application in a speech community, in some peripheral area of the lexicon, would suffice to stamp the generalization as "non-productive", we would have emptied it of most of its useful content. We would be left with nothing but literally surface-true allophonics as legitimate phonological generalizations, and even these would be constantly threatened with elimination since a closer scrutiny of the facts might uncover traces of fluctuation and variation.

Claiming that phonological opacity does not exist has not proved a productive research strategy in phonology (see McCarthy 1998 for useful discussion), and trying to deny the reality of lexically partial generalizations seems hardly more productive—at least, it does not seem to have contributed to any of the major advances in theory and analysis in the past. Exceptions are by themselves no threat to a grammatical generalization, provided it is well-founded and well integrated into a general theory of grammar, and provided there is a systematic place for exceptions in the overall system of grammar and lexicon. Seen from this perspective, their existence is an essential and irreducible property of phonological processes that are considered "lexical" (see Kiparsky 1982 and related work), setting them apart from other processes for which exceptions are inconceivable, the truly "exceptionless" ones. Lexical processes are regular without subscribing to neogrammarian *Ausnahmslosigkeit.*

But how can a phonological generalization be valid when it is lexically partial and not total? Our main finding is that the basic architecture of Optimality Theory ("OT"; Prince & Smolensky 1993) gives rise to a subset structure in lexical inventories, which in turn manifests itself in lexically covert generalizations. We focus on a few central predictions that, with the

aid of ancillary hypotheses, directly follow from the OT framework, in particular from the twin assumptions that (i) all constraints are ranked in an order of preference, and that (ii) all constraints are in principle violable, with the ranking being strict and violations always minimized in winning outputs. On this basis, we construct a general optimality-theoretic model of the phonological lexicon that accounts for differences between strata—including, but not limited to, the distinction between native words and loanwords—within a unitary constraint system.

Besides these theoretical deductions and developments, we will show, on the empirical side, that real languages show evidence for inventory subset structure and, as we will see, characteristic grammar-induced implications between nativization phenomena that other approaches fail to predict.

The core of our proposal lies within faithfulness theory. While markedness constraints are traditional elements of phonological theory, faithfulness constraints are the central innovation of Optimality Theory. The specific conception of an input-output accounting system encoded in these constraints is the strength of the theory (and also its Achilles' heel, as skeptics have not failed to notice). Not surprisingly, the development of OT has, to a significant extent, been the development of its faithfulness component, with 'containment theory' giving way to 'correspondence theory', and with further extensions such as 'output-output constraints', 'positional faithfulness', 'sympathy', and even 'anti-faithfulness', which are all localized within the faithfulness component (for references, too numerous to be included here, see Kager's 1999 textbook). Our basic hypothesis can be reduced to the assertion that stratum-specific input-output faithfulness constraints are necessary and sufficient (i) to account for the stratal organization of a language's lexicon and (ii) to capture higher-level implicational relations between nativization effects, thus deriving the existence of a core-periphery structure in the lexicon from basic tenets of Optimality Theory, without additional mechanisms.

2. Harmonic completeness: universal and language-specific

What can Optimality Theory contribute to the study of lexical inventories? Cross-linguistic research has uncovered a significant number of implicational hierarchies holding between linguistic elements and structures. For example, regarding the occurrence of voiceless stops in the inventories of a representative sample of 318 languages included in the UCLA Phonology Segment Inventory Database, Maddieson (1984:35) observes that "an implicational hierarchy can be set up such that the presence of /p/ implies the strong likelihood of the presence of /k/, which similarly implies presence of

/t/." In OT, this is expressed as the harmonic order in (1), which is in turn a reflection of the universally fixed ranking of constraints in (2)

(1) [t] > [k] > [p] "α>β" = "structure α is more harmonic (less marked) than structure β"

(2) *P »*K »*T "C_1»C_2" = "constraint C_1 is ranked higher than constraint C_2"

Other universal markedness hierarchies involve vowels (such as [i] > [y] > [ø]), laryngeal states of consonants (e.g., [k] > [g] > [g^h]), or rhythmic feet (e.g., for quantity-sensitive trochees: {('**L**L), ('**H**)} > ('**H**L) > ('**L**H) > ('**L**), see Prince 1990).

These empirically well-founded hierarchies are manifestations of constraint families whose internal rankings are universally fixed and not changeable in individual grammars. OT's strict ranking principle then entails that faithfulness constraints can intervene only in specific niches, as shown in (3).

(3) *output inventory:*

a.		*P	»		*K	»	*F(PL)*	»	*T	[t]
b.		*P	»	*F(PL)*	»	*K	»		*T	[k,t]
c.	*F(PL)*	»	*P	»		*K	»		*T	[p,k,t]

"F(PL)" = "Faithfulness to consonantal place of articulation"

The output inventories have a characteristic subset structure: output inventory ((3)a) is a subset of ((3)b), ((3)b) is a subset of ((3)c). This means that— barring additional machinery—there is no grammar that produces the system [p,t], which is "harmonically incomplete" in the sense of (4).

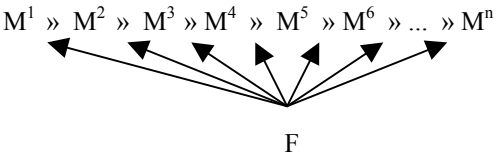
(4) Harmonic completeness: If α>β and β∈S, then α∈S.

> Let and α, β be elements or structures that are markedness-wise comparable, with α being more harmonic than β. Then any system of linguistic structures S containing β must also contain α (see Prince & Smolensky 1993, Prince 1998).

The output inventories of natural languages tend to be harmonically complete in this sense. The central finding of our previous work on the structure of the lexicon (Ito and Mester 1995a,b, 1999) is that a kind of harmonic completeness emerges not only in a cross-linguistic perspective from universally fixed rankings, but also within an individual grammar from

its parochial ranking of markedness constraints. The latter, while free from the point of view of Universal Grammar, is fixed for the grammar in question. Consider a hierarchy M^1 »... » M^n of markedness constraints and some faithfulness constraint F, as depicted in (5).

(5)



The higher the position of F, the stronger its influence, the weaker the potential impact of the M^i, and concomitantly, the larger the corresponding output inventory of elements and structures.[3] As the basic set of F constraints is mapped to its different correspondence-theoretic incarnations—for different classes of input items (roots vs. affixes: McCarthy & Prince 1995), for different positions (prominent vs. non-prominent: Beckman 1997, 1998, Casali 1997, Padgett 1995, Lombardi 1999), etc.—, an inventory subset structure emerges. For example, the scheme in (6) ensures that more structures are admitted in roots than in affixes.

(6) $\{M^{1\text{-}i}\}$ » F-Root » $\{M^{j\text{-}m}\}$ » F-Affix » $\{M^{n\text{-}z}\}$

↑ *more structures admitted in roots*

↑ *fewer structures (a proper subset) admitted in affixes*

Other parts of the F-differentiation program seek to explain reduplicative identity, truncation, language game forms, and other output-output relations between basic forms and derived forms (see, among others, Benua 1995, 1997, Burzio 1997, Ito & Mester 1996a, 1997, Kager 2000, Kenstowicz

[3] Of course, F will not impinge on *every* lower-ranked M, but within an overall theory in which the faithfulness constraints are independent from markedness constraints and highly symmetric, it will impinge on *some* of them. In this respect, more and more elaborate articulations of faithfulness are problematic since they threaten to result in a version of OT where a set of markedness constraints is pitted against a shadow world of individuated faithfulness constraints that correspond to them in a point-by-point fashion, with each M facing its own F. While usually motivated by apparent descriptive needs, expansions of this kind are collectively detrimental to the overall theory since they tend to undermine its basic M/F architecture. Phonological processes are not basic elements, but rather emerge from the interaction of conflicting but independent M and F constraints. Once each M is assigned its tailor-made F as an antagonist, we have not just expanded the power of the theory, but in effect reintroduced the traditional phonological process through the back door—in the guise of individual MF pairings that collectively make up the grammar, but are encoded in a less than perspicuous fashion.

1996, 1997, McCarthy & Prince 1995, Steriade 1997; for a critical view, see Kiparsky 1998).

In our earlier work on the phonological lexicon (Ito & Mester 1995a, 1999 cf. also Yip 1993, Davidson and Noyer 1996, Fukazawa 1998, Fukazawa, Kitahara, and Ota 1998, Pater 2000, and Smolensky, Davidson, and Jusczyk 2000), we argue that F-differentiation leads to a stratified lexicon ("loanwords" vs. "native vocabulary", etc.). An individual grammar fixes a particular M-hierarchy, defining the setting for the overall "language" (such as "English"). Different sublexicons are carved out by inserting elements of F in different places, leading to different degrees of "nativization". The overall lexicon has a core-periphery structure, i.e., a subset structure of sublexicon inventories, where $Lex^0 \subset Lex^1 \subset Lex^2 \subset \ldots \subset Lex^{max}$. Each sublexicon is harmonically complete, and lexical strata are defined by set complementation, following the general schema $Lex^i – Lex^{i-1}$ (i.e., the set of "foreign" items is coextensive with the whole lexicon minus the "native" items, etc.).

Rather than reiterating familiar cases of stratification such as Japanese, we illustrate the model by means of a less well-known, but still illuminating case of harmonic completeness within a single language uncovered by Meade (1998)—namely, the system of registers in Jamaican Creole. Building on the work of DeCamp 1971, Meade 1998 uncovers an extensive system of lexical subsets and implications within the continuum of registers available between *basilect* and *acrolect* (varieties of Jamaican Creole most/least distinct from British English). The intermediate varieties are referred to as *masolects*, and most Jamaican Creole speakers control several registers to be used in different situations.

Two processes found in Jamaican Creole are relevant: cluster simplification (e.g., [st]*ick* → [t]*ick*) and hardening of voiced interdentals (e.g., [ð]*at* → [d]*at*). The phrase *that stick* is pronounced as [dat tɪk] in the basilect (with both simplification and hardening), but as [ðat stɪk] in the acrolect (with neither process applying). We also encounter the masolect pronunciation [dat stɪk] (with hardening but without simplification). However, there is no masolect with the fourth logical possibility *[ðat tɪk] (i.e., with simplification but without hardening). There are thus only three distinct registers for *that stick*, and the summary in (7) reveals a subset structure: {[C, d, …} ⊂ {[CC, [C, d, …} ⊂ {ð, [CC, [C, d, …}, where "[C" and "[CC" stand for simple and complex onset structures, respectively.

(7) Registers for *that stick*:

	/ðat stɪk/	hardening	simplification	
a.	dat tɪk	*yes*	*yes*	basilect
b.	dat stɪk	*yes*	*no*	masolect
c.	ðat stɪk	*no*	*no*	acrolect
d.	*ðat tɪk	*no*	*yes*	impossible register

Given the ranking *ð » *[CC, a grammar with differentiated FAITH-constraints captures precisely this set of registers, as shown below in (8) (after Meade 1998). In the A-register, the two markedness constraints outrank faithfulness, so the output is markedness-wise optimized. B-register faithfulness is sandwiched between the two markedness constraints, so the output fulfills the higher markedness constraint *ð but not the lower one (*[CC). C-register faithfulness ranks above both markedness constraints, forcing violations of both.

(8)

	←	Faith-C (acrolect):	no hardening, no simplification	[ðat stɪk]
*ð				
				[dat stɪk]
	←	Faith-B (masolect):	hardening, no simplification	
*[CC				
				[dat tɪk]
	←	Faith-A (basilect):	hardening, simplification	

The absence of a register with the mapping /ðat stɪk/→[ðat tɪk] is straightforwardly explained—there are no further positions in the hierarchy available for faithfulness to intervene. The indexed Faith-approach implies that all registers *R* must admit complex onsets if they admit the segment ð (i.e., $ð \in R \rightarrow [CC \in R)$, and this implication follows from a central property of OT grammars: the total ranking of all constraints.[4]

[4] The cover term "Faith" is somewhat loose for Jamaican Creole since we are dealing with different types of processes: feature manipulation and whole segment deletion. Meade 1998 argues for the internal hierarchy "DEP » MAX » IDENT(F)" It is crucial that this relative ranking of the faithfulness constraints be preserved in all Faith-X constraint families, otherwise we predict other kinds of nativization not observed in the Creole register continuum. Furthermore, the faithfulness hierarchies in the different registers must fulfill the principle of *Ranking Consistency* (Ito & Mester 1999), which maintains that it must always be possible to 'fold up' the many specific faithfulness constraint tokens (F1-A, F2-A, F1-B, F2-B, etc.) into a single

3. Nativization strategies in German

3.1 Markedness ranking and differentiated faithfulness

Most discussions of loanwords start with the truism that the sound pattern of the recipient language leaves its mark on loanword adaptations. As an example, let us consider English loanwords in German, concentrating on two small areas of the phonotactic and segmental inventories of the two languages. First, where English has syllable-initial [sC] clusters, as in [s]*tone*, [s]*py*. [s]*now*, native German shows palato-alveolar [ʃC] ([ʃ]*tein*, [ʃ]*pion*, [ʃ]*nee*, etc), and the name of the popular novelist Danielle Steele is often pronounced as [ʃ]*teele*. Second, the German counterpart to English retroflex-coronal [ɹ] is uvular [ʀ], as in [ʀ]*ock'n* [ʀ]*oll Fans*, etc. Many observers are also aware that nativization is not an all-or-nothing affair, but comes in degrees: different loanwords, and different speakers, show various intermediate steps ranging from entirely foreign renditions, filled with non-native sounds and sound combinations, to fully nativized adaptations. Less widely appreciated, however, is the fact that there are subtle but very robust implicational relationships between individual nativizations. Consider a word like *story*, with both an initial [s]C-cluster and a retroflex [ɹ]. As a popular loanword, *Story* is attested with different degrees of nativization, as summarized in (9).

(9) 'story'		*rhotic nativization* /ɹ/ → [ʀ]	/ɹ/ → [ɹ]
[sC-*nativization*	[st → [ʃt	a. *Yes*: ʃtɔʀi fully nativized	c. *No*: *ʃtɔɹi impossible nativization
	[st → [st	b. *Yes*: stɔʀi partially nativized	d. *Yes*: stɔɹi not nativized

Both the fully nativized [ʃtɔʀi] ((9)a) and the thoroughly foreign [stɔɹi] ((9)d) are unremarkable. Noteworthy is the fact that partial nativization is possible as [stɔʀi] ((9)b) (*with* rhotic nativization and *without* sC-cluster nativization), but not as *[ʃtɔɹi] ((9)c) (*with* [sC-cluster nativization but *without* rhotic nativization). Besides its lack of attestation, the form *[ʃtɔɹi] was declared "impossible", "unnatural", etc., by all native consultants.

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consistently ranked hierarchy of faithfulness constraint types (F1»F2), see Ito and Mester 1999 for further explication and discussion.

The existence of such systematic gaps among partial nativizations is predicted by our optimality-theoretic model of the lexicon[5]. We will refer to the constraints responsible for the pattern in (9) as *RETROFLEX-RHOTIC and *[SC, respectively, side-stepping an (obviously needed) further analysis that would take us too far afield at this point. The strict ranking principle of standard OT (Prince and Smolensky 1993) requires that ranking be total. The two constraints are therefore ranked either as *RETROFLEX-RHOTIC » *[SC or as *[SC » *RETROFLEX-RHOTIC, *tertium non datur*. Preliminary considerations favor the first since context-free segmental markedness, as rule of thumb, tends to rank higher than context-sensitive sequential markedness: Extending the distribution of an existing segment is often less difficult than acquiring a new segment. In the case at hand, the retroflex rhotic is totally excluded from the German segmental inventory, whereas the voiceless coronal sibilant [s], while absent syllable-initially, occurs elsewhere (namely, in codas and in ambisyllabic positions).

While obviously too crude as a general theory, the rule of thumb generates *RETROFLEX-RHOTIC » *[sC as a reasonable first hypothesis. An F-differentiating grammar with stratal faithfulness constraints FAITH-A, FAITH-B, and FAITH-C occupying all the three niches provided by the two fixed markedness constraints makes exactly the right predictions, as can be seen in (10).

(10)

| *ɹ	←	Faith-C (unassimilated)	▶[stɔɹi]
| *[sC	←	Faith-B (partially assimilated)	▶ [stɔʀi]
|	←	Faith-A (native, fully assimilated)	▶[ʃtɔʀi]

The tableaux in (11) derive the result in greater detail. With the ranking of the two markedness constraints fixed as *RETROFLEX-RHOTIC » *[SC, there is no possible ranking of faithfulness that would result in the non-existent mapping /stɔɹi/ → [ʃtɔɹi], with ɹ-preservation and s-palatalization.

[5] The same point is made in Ito and Mester 1995b using variant renditions of the name *Citibank* in Japanese, the crucial factor being the different palatalization propensities of fricatives and stops.

(11) 'story'		Faith-C	* ɹ	Faith-B	*⌈sC	Faith-A
a. /stɔɹi/ A	▶ ʃtɔʀi	*d.n.a.*		*d.n.a.*		**
	stɔʀi				*!	*
(most nativized)	stɔɹi		*!		*	
	ʃtɔɹi		*!			*
b. /stɔɹi/ B	ʃtɔʀi	*d.n.a.*		**!		*d.n.a.*
	▶ stɔʀi			*	*	
	stɔɹi		*!		*	
	ʃtɔɹi		*!	*		
c. /stɔɹi/ C	ʃtɔʀi	**!		*d.n.a.*		*d.n.a.*
	stɔʀi	*!			*	
(least nativized)	▶ stɔɹi		*		*	
	ʃtɔɹi	*!	*			

The logic of the situation is summarized in (12).

(12) a. Entailment between nativizing mappings:
/st/ → [ʃt] implies /ɹ/ → [ʀ] "If [sC is nativized, so is ɹ."

b. Entailment between faithful mappings:
/ɹ/ → [ɹ] implies /st/ → [st] "If ɹ is preserved, so is [sC."

The result just derived bears on a fundamental aspect of OT as a diversified constraint system. It crucially presupposes that only faithfulness constraints have stratum-specific incarnations (as FAITH-A, FAITH-B, etc.), not structural constraints. This is a by no means self-evident restriction (see Ito and Mester 1999 for further discussion). If markedness constraints had independently rankable stratum-specific incarnations, nothing would preclude a stratum X with the properties seen in (13), selecting as optimal precisely the unwanted mapping /stɔɹi/ → [ʃtɔɹi].

(13) Overgeneration problem with stratum-specific markedness:

/stɔɹi/ X	*⌈sC-X	Faith	*ɹ-X
ʃtɔʀi		**!	
stɔʀi	*!	*	
stɔɹi	*!		*
▶ ʃtɔɹi		*	*

It would perhaps be possible to make further assumptions and provisions to get around this unwanted side effect of stratum-specific markedness, but by making stratum-specificity an exclusive property of faithfulness, our model does not allow situations as (13) to arise in the first place. In this sense, stratal faithfulness goes beyond the level of adequate description and provides an explanation for the existence of implicational patterns in loan mappings, a point sometimes neglected in the evaluation of alternatives.

Entailment relations of the kind just seen are very common in languages, although they often require some probing because of their covert nature. This necessitates a careful exploration of all possible combinations of a given set of phonological properties, coupled with acceptability judgments by competent speakers. Going beyond corpus work, the analyst must obtain judgments of new forms, not unlike the acceptability judgments of sentences that are a routine part of syntactic investigations. The proper object of phonological study is the phonological ability of competent speakers, not some given set of forms. Unfortunately, much work in phonology seems to still be limiting itself, implicitly or explicitly, to the structuralist corpus or, worse yet, to the set of forms that happens to be printed in some dictionary or grammar book. This makes it hard to even get access to the facts in situations involving language contact and loan adaptations. As half a century of syntactic research makes abundantly clear, acceptability judgments on novel forms are part of the basic data that a generative grammar must account for—and sometimes they are indeed crucial if further progress is to be made.

3.2 Underspecification and missed implications

Following the basic thrust of explanation in OT and the principle of Richness of the Base (Prince and Smolensky 1993), our account of lexical stratification is based exclusively on output-oriented constraints, rather than on properties of the input. In this respect, it is almost diametrically opposed to approaches within traditional generative phonology, where differences in the way inputs are specified play a pivotal role in most phonological explanations, including accounts of the phonological differences between lexical strata. The input-driven approach is closely associated with the mechanism of underspecification and builds on the well-known idea that underspecification leads to unmarkedness, prespecification to markedness. For the underspecificationist, lexically central native items end up with unmarked properties because their input representations are sparsely specified. Default mechanisms therefore have an opportunity to fill the gaps, and as a result the unmarked phonotactics and segmentism of the language emerge in the output. Loanwords and other peripheral items, on the other

hand, are more heavily (pre)specified. This makes them immune to feature-filling defaults, and they end up with marked elements and structures in the output.

This scenario ("the more nativized, the less specified") looks attractive, but as we develop this input-driven, underspecificationist alternative, the neat picture falls apart. In particular, it turns out that all crucial predictions regarding entailments between loan adaptations are lost.

Underspecificationism aims to represent the distinction between alternative pronunciations, as in the case of *story*, by the presence vs. absence of feature specifications. For concreteness, we use [anterior] and [coronal], as shown in (14), noting that other appropriate features are equally viable, as long as they express all the necessary distinctions.

(14) sC-cluster underspecification:

/ St /	→ ʃt	S	[0 anterior]
/ st /	→ st	s	[+anterior]

rhotic underspecification:

/R/	→ ʀ	R	[0 coronal]
/ɹ/	→ ɹ	ɹ	[+coronal]

Instead of differently ranked faithfulness constraints (FAITH-A vs. FAITH-B, see (10)-(11) above), the contrast between strata A and B is merely a matter of input specification, with A-forms being more heavily underspecified than B-forms. In this underspecificationist model of stratification, FAITH is uniformly high-ranking: In order for input specifications [+anterior] or [+coronal] to assert themselves in the output, FAITH must outrank the relevant markedness constraints. This is illustrated in (15)a and (15)b for nativized and non-nativized pronunciations of *Tory*.[6]

[6] (15) presupposes high-ranking constraints ensuring that place-wise underspecified candidates are never optimal. Following Inkelas, Orgun, and Zoll (1997, 408), we assume, non-crucially, that specifying a feature in an underspecified segment incurs a FAITH violation. Given that the two candidates in (15)a tie on FAITH, FAITH only makes a difference in (15)b, where GEN has performed a feature-changing and not a feature-filling operation.

(15) "Tory"	*input*	*output*	Faith	*ɹ
a. nativized:	[0cor] | /tɔ R i/	[-cor] | ▶ tɔ ʀ i	*	
		[+cor] | tɔ ɹ i	*	*!
b. not nativized:	[+cor] | /tɔ ɹ i/	[-cor] | tɔ ʀ i	*!	
		[+cor] | ▶ tɔ ɹ i		*

Underspecificationism works well when there is only a single locus of adaptation (i.e., of underspecification, in this view), as in (15). A problem surfaces once forms with more than one such locus are encountered. Underspecificationism is atomistic: The specification or non-specification of a feature in a given position is a local affair, independent of the specification or non-specification of another feature in another position. This means, however, that implicational relations between faithful and nativizing mappings in the two different positions (see (12)) come as a surprise. Consider again the earlier example *story*, with its three viable loan adaptations, as seen in (9). There are two underspecifiable positions of relevance, occupied by the segments /S/ and /R/. Consequently there are four possible ways in which the input can be specified, as given in (16). Each results in a different output, including the unattested (16)d.

(16) a. [0ant] [0cor] → ʃtɔʀi
| | |
/ S t ɔ R i /

b. [+ant] [0cor] → stɔʀi
| | |
/ s t ɔ R i /

c. [+ant] [+cor] → stɔɹi
| | |
/ s t ɔ ɹ i /

d. [0ant] [+cor] → *ʃtɔɹi (unattested nativization)
| | |
/ S t ɔ ɹ i /

Tableau (17) shows that the underspecification analysis, with its commitment to high-ranking FAITH as a protector of input specifications, produces not only the possible nativizations ((16)a,b,c), but also the impossible one ((16)d).

(17) story		Faith	*ɹ	*ʃsC
a. /StɔRi/	▶ ʃtɔʀi	**		
	stɔʀi	**		*!
	stɔɹi	**	*!	*
	ʃtɔɹi	**	*!	
b. /stɔRi/	ʃtɔʀi	**!		
	▶ stɔʀi	*		*
	stɔɹi	*	*!	*
	ʃtɔɹi	*	*!	
c. /stɔɹi/	ʃtɔʀi	**!		
	stɔʀi	*!		*
	▶ stɔɹi		*	*
	ʃtɔɹi	*!	*	
d. /Stɔɹi/	ʃtɔʀi	**!		
	stɔʀi	**!		*
	stɔɹi	*	*	*!
	wrong winner ▶ ʃtɔɹi	*	*	

It is instructive to analyze in more detail at what point things go wrong in the underspecificationist story. It turns out that the crucial misstep is the very existence of ((16)/(17)d) /Stɔɹi/ as an input. Underspecificationist theory will therefore need to come up with a general way of removing such 'wrong' inputs from consideration, i.e., for the case at hand, declaring /Stɔɹi/ once and for all *verboten* for speakers of German. It is hard to see, however, how this could be accomplished, especially within Optimality Theory.

To begin with, any notion of "impossible input" violates the principle of *Richness of the Base*, a cornerstone of standard OT, which accepts literally all universally viable linguistic representations as possible inputs. We should note, however, that underspecificationism, in its quintessential reliance on the certifiable absence of specific feature specifications in inputs, is founded on the explicit rejection of free and rich inputs. Invoking Richness of the Base as an argument will therefore leave the convinced underspecificationist unfazed. Instead of belaboring the general virtues of this principle, we will here show that there are a number of independent considerations militating against the underspecification strategy.

First, it is difficult to see what exactly it is about ((16)/(17)d) that earmarks it for elimination, as an unwanted input. What is wrong with underspecifying segment$_1$ as [0ant] when segment$_4$ is [+cor], when it is at the same time perfectly permissible to underspecify segment$_1$ as [0ant] when segment$_4$ is [0cor]? The reason could be uniformity of specification, were it not for the hybrid but nevertheless viable input ((16)/(17)b), which combines segment$_4$ underspecified as [0cor] with segment$_1$ specified as [+ant]. This path of inquiry seems to lead from mystery to further mysteries, not to clarity.

Underspecificationism could take the bull by the horns, admit its inability to predict implicational relations between loan adaptations, and provide some means of encoding the observed entailments as independent truths. But the trouble is that these truths are not independent: In the model with stratal faithfulness constraints the entailments are already predicted from very basic properties of OT-grammars, as seen above. Even if combinatorial restrictions were imposed on feature specifications in inputs, the real explanation would continue to lies elsewhere, namely, in the field of markedness. What makes [stɔʁi] viable as a loan adaptation but not *[ʃtɔɹi] must be grounded in the relative importance of the two constraints involved, *ɹ and *[sC. The ranking *ɹ » *[sC naturally leads to the expectation that, once loan faithfulness can compel a speaker to violate the former constraint, it should definitely also be able to compel him/her to violate the latter. The model of the stratified lexicon laid out above and in our earlier work explores one way, among conceivable alternatives, of turning this basic idea into a formal theory. It places the burden of explanation squarely on the relation between the relevant markedness constraints (see (10) and (11)), i.e., on output constraints and their ranking. No restriction on inputs that duplicates the effects of the markedness relations can count as an explanation.

The upshot is that even in situations where all relevant distinctions can in principle be expressed by the presence vs. absence of specifications, crucial implicational relations between adaptations go unexpressed. In addition to this overgeneration problem, underspecificationism also faces the opposite difficulty, namely, *insufficient expressive power*. It turns out that there are phonologically relevant distinctions that cannot be adequately expressed by the presence vs. absence of features (and/or of phonological structure).[7] For instance, given standard assumptions, the markedness contrast [st] vs. [t] (as onsets) seen in Jamaican Creole (see (7)-(8) above) cannot adequately be

[7] This problem is not specific to the current OT-context, but holds for earlier derivational theories as well. The representational resources of underspecificationist phonology were always well-suited for the task of encoding only a small subset of markedness contrasts, leaving many others unexpressed.

expressed by means of underspecification. It is not the lack of the segment /s/ alone and/or of its features that makes the second less marked than the first, but rather the force of the phonotactic constraint against complex onsets. Markedness cannot in general be a matter of how many segments the input contains, otherwise /V/ would constitute a better input than /CV/, etc. Underspecification can only represent a small subset of markedness contrasts in an adequate way and is the wrong tool for many others.

A final problem with underspecificationism that is of some general interest is that it leads to a *proliferation of lexical entries.* When a stratified system consists not of sets of different lexical items assigned to different strata, but rather of different registers all sharing essentially the same set of lexical items, as in Jamaican Creole (see (7)-(8) above), a single input has multiple realizations, depending on the register. In order to account for this, the underspecifiationist strategy needs to posit multiple inputs (/Dat/ vs. /ðat/ etc.), one for each register. But it seems implausible to picture register speakers as carrying around several versions of the same lexicon, one for each context of speech, differently specified in order to produce the register effects ([d]*at* vs. [ð]*at*, etc). The register distinction between [dat] and [ðat] as realizations of *that* does not seem properly characterized as a distinction between two different lexical items involving two different inputs. Rather, speakers seem to have acquired a general system allowing them to parse a single input item in different ways, not of cloning it into a set of specificationally different inputs.

In sum, the model of the lexicon based on stratal faithfulness offers the right predictions and does not encounter the problems faced by the underspecificationist alternative.

3.3 Grammatical and Ungrammatical Nativizations

The more phonological constraints are crucially involved in the parsing of a particular item, the more nativization variants will appear. The investigation of such cases not only furthers our understanding of loanword adaptation, but also sheds light on the relationship between different types of markedness constraints. Continuing our study of loanwords in German, we take up an example involving loans from French. Such loan words often feature the voiced palatal fricative [ʒ] and nasalized vowels, both not native to German. Wiese (1996, 12) observes an important difference between the two cases of imported segments. On the one hand, "[t]here seems to be no tendency to assimilate /ʒ/ to the system of more native sounds" ((18)a). The only exceptions are some older loans ((18)b) which replace [ʒ] with [j], perhaps under the influence of the spelling <j>.

(18) a. [ʒ]enie 'genius'
Gara[ʒ]e 'garage'
Oran[ʒ]e 'orange'

b. [j]ust (<Fr. [ʒ]uste)
[j]ustament (<Fr. [ʒ]ustement)
[j]ustine (<Fr. [ʒ]ustine)

On the other hand, "the nasalized vowels, which are also borrowed from French, and probably in a larger number of words than /ʒ/, rarely occur in normal speech. These words are readily assimilated, usually in such a way that the non-nasalized vowel plus the velar nasal [ŋ] is used instead of the nasalized vowel" (Wiese 1996, 12). We illustrate this with the examples in (19).

(19) $\tilde{v} \rightarrow vN$ (usually, vŋ)

orthography	[$\tilde{v}$]	[vŋ]	
Annonce	Ann[$\tilde{ɔ}$]ce	Ann[ɔŋ]ce	'advertisement'
avancieren	av[$\tilde{a}$]cieren	av[aŋ]cieren	'advance'
Balkon	Balk[$\tilde{ɔ}$]	Balk[ɔŋ]	'balcony'
Balance	Bal[$\tilde{a}$]ce	Bal[aŋ]ce	'balance'
Bassin	Bass[$\tilde{ɛ}$]	Bass[ɛŋ]	'basin'
blanchieren	bl[$\tilde{a}$]chieren	bl[aŋ]chieren	'to blanch'
Bonbon	B[$\tilde{ɔ}$]b[$\tilde{ɔ}$]	B[ɔm]b[ɔŋ]	'candy'
Branche	Br[$\tilde{a}$]che	Br[aŋ]che	'branch'
Chaiselongue	Chaisel[$\tilde{ɔ}$]gue	Chaisel[ɔŋ]	'lounge'
Champignon	Ch[$\tilde{a}$]pign[$\tilde{ɔ}$]	Ch[am]pign[ɔŋ]	'champignon'
Cousin	Cous[$\tilde{ɛ}$]	Cous[ɛŋ]	'(male) cousin'
Fasson	Fass[$\tilde{ɔ}$]	Fass[ɔŋ]	'fashion'
Jongleur	J[$\tilde{ɔ}$]gleur	J[ɔŋ]gleur	'juggler'
lancieren	l[$\tilde{a}$]cieren	l[aŋ]cieren	'launch'
Nuance	Nu[$\tilde{a}$]ce	Nu[aŋ]ce	'nuance'
Restaurant	Restaur[$\tilde{a}$]	Restaur[aŋ]	'restaurant'
Revanche	Rev[$\tilde{a}$]che	Rev[aŋ]che	'revenge'
tranchieren	tr[$\tilde{a}$]chieren	tr[aŋ]chieren	'to carve'
Teint	T[$\tilde{ɛ}$]	T[ɛŋ]	'complexion'

As before, the observed differences in nativization pressure can be rationalized as a consequence of the ranking relation between the two constraints given in (20).

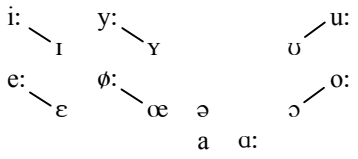
(20) *$\widetilde{\text{v}}$ No nasalized vowels.
|
*ʒ No voiced palato-alveolar obstruents.

(21) lists two further markedness constraints that are of relevance.

(21) a. *LaxLong: Lax vowels are short (*[œː], *[ʊː], *[ɪː], etc.).
b. *Coda/ʀ: [ʀ] does not appear in syllable codas.

They are responsible for two basic properties of the sound pattern of standard modern German: Long vowels are tense (see (22)),[8] and in coda position the dorso-uvular rhotic [ʀ] is vocalized to [ɐ̯], a non-syllabic low central vocoid ([.tyː.ʀən.] vs. [.tyːɐ̯.] 'doors/door', etc.), phonetically resulting in centering diphthongs.[9]

(22) German vowel inventory



It is not hard to see why borrowing a French word such as *jongleur* [.ʒ$\widetilde{\text{ɔ}}$.glœːʀ.] 'juggler' in (23)a will be a challenge. The multiple replacements seen in (23)b, the fully nativized version, show the effects of all four constraints.

(23) *Jongleur* 'juggler'
a. [ʒ$\widetilde{\text{ɔ}}$ˈglœːʀ] (totally faithful to the original)
b. [jɔŋˈgløːɐ̯] (fully nativized)

[8] This constraint concerns non-low vowels, and we simplify here by abstracting away from the presence of long lax [ɛː] in the inventory of standard German, where *Säle* [zɛːlə] 'halls' contrasts with *Seele* [zeːlə] 'soul', the verbal form *sehe* [zeːə] ('see', 1sg.pres. indicative) is not homonymous with its subjunctive II counterpart *sähe* [zɛːə], etc. Much discussed as an example of an isolated opposition without historical precedent, the contrast apparently arose through spelling pronunciations in the Northern (originally Low German-speaking) areas, which set the pronunciation standard. Due to its isolated character and in spite of its functional load, this contrast has in many areas been neutralized (or was never established there in the first place), with speakers using tense [eː] in both cases, thus showing the unmitigated force of the markedness constraint (21)a.

[9] This constraint, whose strictest version concerns syllables with long nuclei, can be thought of as a conjunction of elementary constraints, see Ito and Mester (to appear).

(24) lists the four replacements that have taken place in (23)b in response to the demands of the markedness constraints in (20) and (21).

(24)	[ʒ~j]	[ɔ̃~ɔŋ]	[g]	[l]	[œ:~ø:]	[ʀ~ʁ̞]
	↑	↑			↑	↑
	*ʒ	*ṽ			*LaxLong	*Coda/ʀ

Given that each of the four varying segments can appear in two forms, there are in principle 2^4=16 possible realizations of the word *Jongleur*. The table in (25) is an attempt to illustrate the variations systematically, moving through the word from left to right. The leftmost column ((25)i) shows the original French source word. The second column ((25)ii) contains two variants: One preserves the palatal fricative [ʒ] (i.e., it is identical to the French original), the other one shows instead the palatal glide [j]. In column ((25)iii), these two variants are then each subjected to the [ɔ̃]~[ɔŋ] variation, resulting in 4 variants. The process is repeated in column ((25)iv) for [œ:]~[ø:], yielding 8 variants, and finally in column ((25)v) for [ʀ]~[ʁ̞], resulting in the 16 possible variants. The significant point is the following: Out of the 16 possibilities, only 5 are admitted, and 11 are excluded, as shown by bolded typeface and parentheses in the rightmost column ((25)v).

(25) i.	ii. [ʒ] ~ [j]	iii. [ɔ̃]~ [ɔŋ]	iv. [œ:]~ [ø:]	v. [ʀ] ~ [ʁ̞]
ʒɔ̃glœ:ʀ	[ʒ] ʒɔ̃glœ:ʀ	[ɔ̃] ʒɔ̃glœ:ʀ	[œ:] ʒɔ̃glœ:ʀ	[ʀ] **ʒɔ̃glœ:ʀ**
				[ʁ̞] (ʒɔ̃glœ:ʁ̞)
			[ø:] ʒɔ̃glø:ʀ	[ʀ] (ʒɔ̃glø:ʀ)
				[ʁ̞] (ʒɔ̃glø:ʁ̞)
		[ɔŋ] ʒɔŋglœ:ʀ	[œ:] ʒɔŋglœ:ʀ	[ʀ] **ʒɔŋglœ:ʀ**
				[ʁ̞] (ʒɔŋglœ:ʁ̞)
			[ø:] ʒɔŋglø:ʀ	[ʀ] **ʒɔŋglø:ʀ**
				[ʁ̞] **ʒɔŋglø:ʁ̞**
	[j] jɔ̃glœ:ʀ	[ɔ̃] jɔ̃glœ:ʀ	[œ:] jɔ̃glœ:ʀ	[ʀ] (jɔ̃glœ:ʀ)
				[ʁ̞] (jɔ̃glœ:ʁ̞)
			[ø:] jɔ̃glø:ʀ	[ʀ] (jɔ̃glø:ʀ)
				[ʁ̞] (jɔ̃glø:ʁ̞)
		[ɔŋ] jɔŋglœ:ʀ	[œ:] jɔŋglœ:ʀ	[ʀ] (jɔŋglœ:ʀ)
				[ʁ̞] (jɔŋglœ:ʁ̞)
			[ø:] jɔŋglø:ʀ	[ʀ] (jɔŋglø:ʀ)
				[ʁ̞] **jɔŋglø:ʁ̞**

The other 11 logical possibilities are thus ungrammatical as nativizations of the loanword. An inspection of the 5 grammatical nativizations yields

some fruitful insights. A priori, one might have surmised that the dividing line might be an issue of 'recoverability', perhaps a function of the number of changes. For example, two changes might be admissible, but not more. This is far from being the case, however, as demonstrated by chart (26), which presents the 16 forms in terms of the number of changes that they have undergone.

(26) *Jongleur* 'juggler'	[ʒ] ↓ [j]	[$\widetilde{ɔ}$] ↓ [ɔŋ]	[œ:] ↓ [ø:]	[ʁ] ↓ [ʁ̞]	number of changes
a. ʒ$\widetilde{ɔ}$glœ:ʁ					0
b. * j$\widetilde{ɔ}$glœ:ʁ	yes				1
c. ʒɔŋglœ:ʁ		yes			1
d. * ʒ$\widetilde{ɔ}$glø:ʁ			yes		1
e. * ʒ$\widetilde{ɔ}$glœ:ʁ̞				yes	1
f. * jɔŋglœ:ʁ	yes	yes			2
g. * j$\widetilde{ɔ}$glø:ʁ	yes		yes		2
h. * j$\widetilde{ɔ}$glœ:ʁ̞	yes			yes	2
i. ʒɔŋglø:ʁ		yes	yes		2
j. * ʒɔŋglœ:ʁ̞		yes		yes	2
k. * ʒ$\widetilde{ɔ}$glø:ʁ̞			yes	yes	2
l. * jɔŋglø:ʁ	yes	yes	yes		3
m. ʒɔŋglø:ʁ̞		yes	yes	yes	3
n. * jɔŋglœ:ʁ̞	yes	yes		yes	3
o. * j$\widetilde{ɔ}$glø:ʁ̞	yes		yes	yes	3
p. jɔŋglø:ʁ̞	yes	yes	yes	yes	4

We find 1 form with 0 changes ((26)a), 4 forms with 1 change ((26)b-d), 6 forms with 2 changes ((26)f-k), 4 forms with 3 changes ((26)l-o); and 1 form with 4 changes ((26)p). When we consolidate all the information in a chart, as in (27), it becomes apparent that grammaticality has nothing to do with the sheer number of changes. Rather, from each of the groups situated at greater and greater distances from the source, only *one* form is allowed.

(27)

number of changes:	possible variants:	variants that are grammatical:
0	1	1
1	4	1
2	6	1
3	4	1
4	1	1

This is not at all what a measure defined in terms of number of changes would lead us to expect. Rather, the picture immediately recalls one of the most basic ideas of OT, viz., that grammaticality consists in being the (usually) unique winner of a competition between many co-candidates.

When the grammatical forms are separated out into a separate chart (28), we see that the allowed variations follows a clear subset structure, with systematically increasing degrees of nativization.

(28)	Possible realizations of *Jongleur*	Nativizations				number of changes
		[ʒ] ↓ [j]	[ɔ̃] ↓ [ɔŋ]	[œ:] ↓ [ø:]	[ʁ] ↓ [ʁ̰]	
a.	ʒɔ̃glœ:ʁ	—	—	—	—	0
b.	ʒɔŋglœ:ʁ	yes	—	—	—	1
c.	ʒɔŋgløːʁ	yes	yes	—	—	2
d.	ʒɔŋgløːʁ̰	yes	yes	yes	—	3
e.	jɔŋgløːʁ̰	yes	yes	yes	yes	4

The nativization pattern reveals a clear order in which the various constraints must 'fire'. The chart (28) shows the implications: If [ʒ]→[j] occurs, then all the other nativizing changes must also take effect; if [ʁ]→[ʁ̰] occurs, then [ɔ̃]→[ɔŋ] and [œ:]→[ø:] must also occur; if [œ:]→[ø:] takes place, so must [ɔ̃]→[ɔŋ]. On the other hand, the occurrence of [ɔ̃]→[ɔŋ] does by itself not force any other change, etc.

With the distributional analysis of the pattern advanced up to this point, the OT account deriving it is straightforward. The facts suggest that the markedness constraints are strictly ranked as in (29).

(29)			
	***ṽ**	No nasalized vowels	Effect: [ɔ̃]→ [ɔŋ]
	|		
	***LaxLong**	No lax long vowels	Effect: [œ:]→ [ø:]
	|		
	***Coda/ʁ**	No rhotic in codas	Effect: [ʁ] → [ʁ̰]
	|		
	***ʒ**	No voiced palatal fricative	Effect: [ʒ] → [j]

The hierarchy in (29) allows only five positions where faithfulness constraints can lodge. As shown in (30), stratum-specific faithfulness in

each of these positions lead to the selection of precisely the five attested grammatical forms as winners, and of no other forms.[10]

(30)	Faith-E	▶ [ʒ͡ɔglœːʀ]	(faithful version used by newscasters)
	*͡v		
	Faith-D	▶ [ʒɔŋglœːʀ]	(affected stage pronunciation)
	LaxLong		
	Faith-C	▶ [ʒɔŋglɸːʀ]	(stage pronunciation)
	*Coda/ʀ		
	Faith-B	▶ [ʒɔŋglɸːʁ̞]	(usual pronunciation)
	*ʒ		
	Faith-A	▶ [jɔŋglɸːʁ̞]	(over-nativized)

By insisting on strict ranking and admitting stratally indexed faithfulness, the model is thus able to do justice to the delicate balance between markedness and faithfulness effects that is a hallmark of loan nativization.

4. Conclusion

In Optimality Theory, the total set of possible linguistic structures, a central part of human linguistic competence, forms a hierarchy of more and more inclusive sets of structures. Basic OT-principles ensure that individual languages arise by carving out subsets from this vast set, always starting with the core. This is the essence of harmonic completeness (Prince and Smolensky 1993), and it is the intervention of faithfulness constraints at specific points in the overall ranking that is decisive in this context.

This paper shows how distinctions between vocabulary strata within the phonological lexicon also arise as effects of faithfulness constraints, differentiated through stratum-indexation. This idea, a natural outgrowth of current OT, captures crucial organizational properties of the lexicon akin to harmonic completeness. Complementing our previous work in this area (Ito and Mester 1995a,b, 1999), the paper develops its argument by investigating evidence from the system of registers in Jamaican Creole and from the levels

[10] For reasons of space, we do not supply tableaux here, the basic points should be obvious from (30).

of loanword nativization in German. An important advantage of the approach is that it explains why the phenomenon of impossible nativizations arises so frequently. Underspecification, a favored tool of traditional phonological analysis, was seen to have no principled way of making the crucial distinctions. By insisting that stratal differentiation is strictly a property of faithfulness, whereas structural markedness is never relativizable to specific lexical items or specific constructions, the model makes a host of predictions about admissible combinations of nativization properties, the relations between lexical strata, and other features of the phonological lexicon that remain to be probed in future empirical studies.

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