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The Core-Periphery Structure of the Lexicon and Constraints on Reranking

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Introduction.

In virtually all languages that have been the object of reasonably complete and detailed linguistic description, the lexicon invariably shows evidence for internal stratification. The different strata of the lexicon are usually referred to with terms like "native vocabulary", "assimilated loans", "foreign vocabulary", or by labels identifying the loan source ("Arabic", "Latinate", "Sanskrit", "Spanish", "Sino-Korean", "Swahili", "Portuguese", etc.). In the typical case, these distinctions are not (or at least not primarily) etymological labels, but have genuine synchronic import, in the sense that several different criteria (morpheme combinatorics, morpheme structure constraints, applicability of phonological rules) converge on an overall partitioning of the total set of lexical items into distinct subsets.

While the facts of lexical stratification can hardly be in doubt, their theoretical significance has remained somewhat unclear. There has been relatively little linguistic work on the consequences for the theory of the lexicon and for the organization of the grammar. After an early flurry of interest in Praguian phonology (Mathesius 1929 and related work), the issue attracted only sporadic attention from American structuralists (see e.g. Fries & Pike 1949), and emerged again in early generative phonology (in Chomsky & Halle 1968 and related work), where lexical stratification was used to motivate several exception-specific devices (diacritic features denoting lexical strata,

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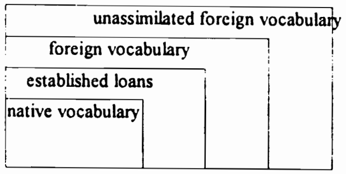
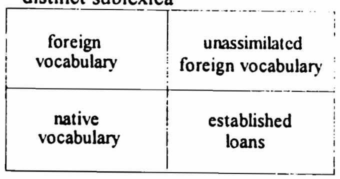
rule features, minor rules, etc.). Besides adding considerably to the descriptive power of phonological theory, these devices increased the availability of a certain type of abstract phonological analysis (see e.g. the diacritic treatment of all vowel harmony processes argued for in Chomsky & Halle 1968, 377-379) which is incompatible with the goal of genuine phonological explanation, as demonstrated by Kiparsky 1968. It is the latter work, extended in a comprehensive study by Saciuk 1969, which contains important new insights regarding the facts and the theoretical significance of lexical stratification. Building on these works and on the empirical results of our own investigation of the phonological lexicon of contemporary Japanese, we have recently argued for a new approach to lexical stratification (Itô & Mester 1994a). In this conception, to be further developed and motivated below, the central notion is that of a "lexical constraint domain"; analyzing lexical stratification means analyzing the inclusion and overlap relations between constraint domains. The main empirical result of our earlier study is that the elements that make up the lexica of natural languages are organized in terms of an overall *core-periphery structure* (for further developments, see Paradis & Lebel to appear on Quebec French, Pater to appear on English stress). Elements in the lexical core fulfill all lexical constraints; moving outward towards less central areas of the lexicon, we encounter items that violate more and more constraints, until we reach a periphery of items fulfilling only a subset of the constraints (the truly fundamental ones, determining, among other things, the basic syllable canons). The resulting organization, graphically depicted in (1a), consists in a hierarchy of implicational relations between phonological properties: If an item is subject to constraint *x*, it is also subject to constraint *y*, but not necessarily vice versa. In the contrasting model in (1b), where the lexicon is partitioned into separate sublexica, each equipped with its own phonology, no hierarchical structure and core-periphery organization is posited or implied.

(1) a. Core/periphery organization



b. Partitioning of the lexicon into distinct sublexica



It goes without saying that the observations and generalizations motivating (1a) have not escaped the attention of serious students of the lexicon in the past (see in particular Saciuk 1969, 480-488). Evidence against the bifurcationist view of lexical strata (1b) is found in the often gradual character of lexical stratification, where, for example, different degrees of nativization among foreign words are commonplace, as shown in some detail in Itô & Mester 1994a building on earlier work (see e.g. Holden 1976 and Lightner 1972 for Russian and Nessly 1971 for English, and Saciuk 1969 for a broad overview). An early recognition of the theoretical significance of such findings is found in Kiparsky (1968, 13b), who suggests that the feature [Foreign] be replaced by a sequence of redundancy rules of the form

"[−Rule *X*]→[−Rule *Y*]", predicting, in the typical case, "a hierarchy of foreignness, with exceptions to one rule always being exceptions to another rule, but not vice versa". This is akin to the kind of organization we are positing in (1a). What remains to be done, is to give an adequate expression to this idea, and to pursue the consequences and implications for the formal theory of the lexicon.

In this paper, we will attempt to show that significant progress in this direction can be made when the issue is approached within Optimality Theory. The main results of our study, to be fleshed out and motivated below, can be summarized in three points:

(2) a. **Ranking invariance** (null hypothesis): In the unmarked case, there is a single constraint ranking for the whole lexicon.
b. **Reranking:** Lexical stratification is a consequence of constraint (re)ranking.
c. **Constraint typology and the limits of reranking:** The core-periphery organization of the lexicon is a consequence of the fact that, in the typical case, reranking is limited to Faithfulness constraints (PARSE and FILL), within an otherwise invariant constraint system.

The first two points (2a,b) are widely assumed, explicitly or implicitly, in optimality-theoretic work. We are here mostly concerned with the hypothesis (2c), which asserts the existence of a single constraint hierarchy characterizing the phonology of a language, invariant (modulo reranking of Faithfulness) through the entire lexicon. This hypothesis will be developed, motivated, and illustrated with examples from Japanese and Russian in the following sections.[1]

1. Faithfulness and Core-Periphery in Japanese and Russian

Sola fide. (M. Luther)

The core-periphery structure of the phonological lexicon will first be illustrated by the syllable-related constraints in the Japanese lexicon (henceforth, "J-Lexicon") discussed in Itô & Mester 1994a.

(3) Syllable-related constraints in the J-Lexicon:

a. **SYLLSTRUC**: Constraints defining the basic syllable canons of Japanese, including NOCOMPLEXONSET, NOCOMPLEXCODA, CODACOND.
Domain: J- Lexicon.

b. **NOVOIGEM:** "No voiced obstruent geminates" (**bb, *dd, *gg, *zz*): Geminate obstruents must be voiceless.
Domain: J-Lexicon excluding Unassimilated Foreign (e.g. *doggu* 'dog').

[1] The results of Yip's 1993 work on Cantonese loanword phonology provide independent support for a conclusion similar to the one reached here.

c. **No-[P]**:"No (single) [p]": A constraint against single (nongeminate) [p] ([p] is licit in doubly linked configurations: *kappa* 'river imp', *nippoN* 'Japan', *kampai* 'cheers', but not **paka* or **nipoN*).
Domain: J-Lexicon excluding Foreign and Unassimilated Foreign (e.g. *sepaado* 'shepherd', *peepaa* 'paper').[2]

d. **PostNasVoi**:"Post-nasal obstruents must be voiced", ruling out clusters like **nt*, **mp*, **ŋk*: Post-nasal obstruents must be voiced (*tombo* 'dragonfly', *kande* 'chewing', *šombori* 'lonely', *unzari* 'disgusted').[3]
Domain: J-Lexicon excluding Unassimilated Foreign, Foreign, and Sino-Japanese (e.g. *sampo* 'walk', *hantai* 'opposite', *kompyuutaa* 'computer', *santa* 'Santa')

A significant aspect of this constraint system lies in the hierarchical inclusion relations between the associated domains in the J-lexicon, which emerge more clearly in table (4).

(4)

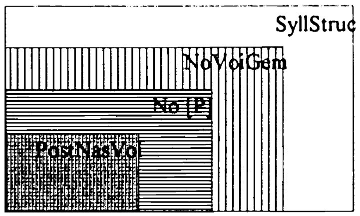
	SyllStruc	NoVoiGem	No [P]	PostNasVoi
Yamato	✓	✓	✓	✓
Sino-Japanese	✓	✓	✓	d.n.a.
Foreign	✓	✓	d.n.a.	d.n.a.
Unassimilated Foreign	✓	d.n.a.	d.n.a.	d.n.a.

The pattern in (4) recalls Kiparsky's (1968) "hierarchy of foreignness": Everything subject to NoVoiGem is also subject to SyllStruc, but not vice versa; everything subject to No-[P] is also subject to NoVoiGem, but not vice versa, etc. Given the crosslinguistic frequency of such patterns (see e.g. the discussion of Russian below), it stands to reason that some fundamental property of lexical constraint systems must be at work here, leading to such characteristic nesting of constraint domains, as depicted in (5).

[2] For Mimetics like *pika-pika* 'shining', see below.

[3] We are here abstracting away from the fact that, as shown in the optimality-theoretic analysis in Itô, Mester & Padgett 1995, postnasal voicing is not enforced by a single constraint, but rather appears as an interaction effect involving several constraints. The same is no doubt true for No-[P] and NoVoiGem.

(5) J-LEXICON



This kind of inclusion organization entails the existence of a core area, which is governed by the maximum set of lexical constraints and is by definition "unmarked" (i.e. if markedness is measured in terms of constraint violations). In this model, certain—but not all— of the traditional vocabulary strata stand out as lexical areas circumscribed by bundles of closely coinciding constraint isoglosses;[4] on the other hand, the class of Foreign items (cf. Saciuk's 1969 "[-homogeneous]" class) does not constitute a uniform stratum, but is simply the cumulative totality of the items occupying less and less central areas of the lexicon, where more and more constraints are violated. The less nativized an item, the more it disobeys lexical constraints, i.e. falls outside of various constraint domains and is located towards the periphery of lexical space.

Our next task is to express these general properties of lexical structure in Optimality Theory. For this purpose, we need to be more precise with respect to the idea that certain constraints are "not in force" in certain areas of the lexicon. In OT, the traditional notion of a parametrized constraint— something that can be turned "on" or "off" in the grammars of particular languages (or, as here, in the different subgrammars associated with different lexical strata in a single language)—is replaced by the idea that constraints are ranked and violable (minimally, under the pressure of dominant constraints); see Prince & Smolensky 1993 for conceptual and empirical arguments for the superiority of the new theory). In this view, all constraints are universal, uniformly present in all grammars; the effects of a given constraint differ from grammar to grammar, depending the constraint's place in the overall constraint ranking. In this light, the "on/off" approach of earlier theories can be seen as a rough approximation to a more accurate theory based on the notions of ranking and violability.

For the case at hand, the question becomes how the core-periphery structure in (5) can be obtained with a uniform constraint set: How do the various areas of the lexicon differ, if they do not differ in terms of which constraints are "on" and which are "off"? The obvious suggestion is that they differ in what order the constraints are

[4] For the J-Lexicon, this is true for Yamato and Sino-Japanese (see Itô & Mester 1993, 1994a and Tateishi 1989 for details, and Martin 1952 and McCawley 1968 for earlier comprehensive studies); such groupings constitute genuine morphological classes (in the sense of Aronoff 1994) which can be referred to as such in the grammar.

ranked. In pursuing this line of investigation, familiar considerations of restrictiveness suggest that we explore the possibility that there are strict limits on such lexicon-internal rerankings.[5] In OT, crucial aspects of a constraint's role are determined by the way it is ranked with respect to the Faithfulness constraints PARSE and FILL (henceforth collectively referred to as "FAITH" whenever no further differentiation is called for). For a given wellformedness constraint (say, "NOCODA"), being ranked above some conflicting Faithfulness constraints is roughly analogous to being "on", in terms of traditional analyses; being ranked below all conflicting Faithfulness constraints is roughly analogous to being "off". In OT, as discussed in Prince & Smolensky 1993 as well as in later work (e.g. in Itô, Mester & Padgett 1995), the "underlying inventory" of a certain language (segments, clusters, syllable types, etc.) is determined indirectly: Inputs themselves are not directly regulated, anything at all can in principle serve as an input; the grammar, as a system of ranked constraints, determines how, if at all, the input gets parsed.

A natural hypothesis at this point is to take a cue from the relation between the domains seen above in (4) and (5) and to start with the ranking of the four constraints in (6):

(6) Proposed constraint ranking: SYLLSTRUC » NOVOIGEM » NO-[P] » POSTNASVOI

In order to focus on the essential point, we abstract away from the differentiation between various Input/Output constraints and consider the family of Faithfulness conditions as a single unit (abbreviated as "FAITH"). In this simplified picture, ranking FAITH below some constraint C means that C can command violations of Faithfulness—i.e., at least one of the relevant Faithfulness constraints is ranked below C. Likewise, ranking FAITH above some constraint C means that C cannot command violations of Faithfulness—i.e., none of the relevant Faithfulness constraints is ranked below C.

Our goal, as stated in (2c) above, is to understand most, if not all, cases of lexical stratification as arising through the reranking of Faith within an otherwise invariant ranking of wellformedness constraints and other constraints. For the case at hand, a moment's reflection shows that the invariant ranking of the four wellformedness constraints posited in (6) leaves five 'niches' where FAITH can in principle move, indicated by the positions (a)-(e) in (7).

(7) $\underset{(e)}{\_\_\_}$ »SyllStruc» $\underset{(d)}{\_\_\_}$ »NoVoiGem» $\underset{(c)}{\_\_\_}$ »No-[P]» $\underset{(b)}{\_\_\_}$ »PostNasVoi » $\underset{(a)}{\_\_\_}$

[5] Otherwise we would be left with a theory asserting that constraint rankings coexisting in the same grammar could "differ from each other without limit and in unpredictable ways" (to recruit Joos' (1957, 96) famous characterization of the "American (Boas) tradition" in contrast with "Trubetzkoy phonology"). See Inkelas, Orgun & Zoll 1994 for a discussion of the limits on positing different "cophonologies" within the same grammar.

The four columns in (8a-d) identify the FAITH-orderings (7a-d) as the ranking configurations characteristic of the strata of the J-Lexicon discussed above: Yamato, Sino-Japanese, Foreign, and Alien (we will henceforth use this term as an abbreviation for "unassimilated foreign"). (7e) is never occupied by FAITH, since SYLLSTRUC is undominated in Japanese.

(8) Reranking of FAITH

a. Yamato	b. Sino-Japanese	c. Foreign	d. Alien
SYLLSTRUC	SYLLSTRUC	SYLLSTRUC	SYLLSTRUC
|	|	|	|
NOVOIGEM	NOVOIGEM	NOVOIGEM	**FAITH**
|	|	|	|
NO-[P]	NO-[P]	**FAITH**	NOVOIGEM
|	|	|	|
POSTNASVOI	**FAITH**	NO-[P]	NO-[P]
|	|	|	|
FAITH	POSTNASVOI	POSTNASVOI	POSTNASVOI

Ranking FAITH below all four wellformedness constraints (8a) means that all four will be in full force— violations of Faithfulness constraints are preferred over violations of segmental, sequential, or syllabic wellformedness. This means core behavior (in Japanese, characteristic of Yamato items). Ranking FAITH above POSTNASVOI and below the other three constraints (8b) means that an input sequence like /...nt.../ will be parsed as such in the output, in violation of POSTNASVOI, but the other three constraints can still command violations of FAITH. Analogous observations hold for the remaining rerankings of FAITH.

The full picture is given in the tableaux below for the hypothetical inputs /kadda/, /kanta/, /paka/. When FAITH is ranked lowest (9) ("Yamato"), all four wellformedness constraints are scrupulously observed in the selected output. The faithfully parsed forms will always be outranked by other forms with PARSE/FILL violations: **kadda, *kanta, *paka.*

(9)

Yamato ranking:		{SYLLSTRUC, NOVOIGEM, NO-[P], POSTNASVOI}	FAITH
/kadda/	kadda	*! NOVOIGEM	
☞	katta[6]		*FAITH[voi]
/kanta/	kanta	*! POSTNASVOI	
☞	kanda		*FAITH[voi]
/paka/	paka	*! NO-[P]	
☞	haka		*FAITH[lab]

Consequences for Yamato outputs: **kadda*, **kanta*, **paka*.

In (10) ("Sino-Japanese"), FAITH is ranked above PostNasVoi but below NoVoiGem and No-[P], hence **kadda* and **paka* are inadmissible as Sino-Japanese outputs (they will always be in the shadow of more harmonic candidates like *katta* and *haka*). But *kanta* is allowed because it is more important to parse a postnasal /t/ as is than it is to obey PostNasVoi.

(10)

Sino-Japanese ranking:		{SYLLSTRUC, NOVOIGEM, NO-[P]}	FAITH	POSTNASVOI
/kadda/	kadda	*! NOVOIGEM		
	☞ katta		*FAITH[voi]	
/kanta/	☞ kanta			*
	kanda		*!FAITH[voi]	
/paka/	paka	*! NO-[P]		
	☞ haka		*FAITH[lab]	

Consequences for Sino-Japanese outputs: **kadda*, ✓*kanta*, **paka*.

[6] Presenting *katta* as the winning candidate serves illustrative purposes only—what matters is only that some candidate or other is more harmonic than *kadda*, not that *katta* is the most harmonic candidate (which might not be true in a more comprehensive analysis). Similar remarks apply to the winners in the tableaux below (see also Prince & Smolensky (1993, 177-178) for general discussion of this type of "Harmonic Bounding" argumentation).

In (11) ("Foreign"), FAITH loses to NOVOIGEM (and SYLLSTRUC), but dominates over NO-[P] and POSTNASVOI, with the result that **kadda* remains excluded in outputs, whereas *paka* and *kanta* are the outputs assigned to the inputs /paka/ and /kanta/.

(11)

Foreign ranking:		{SYLLSTRUC, NOVOIGEM}	FAITH	{NO-[P], POSTNASVOI}
/kadda/	kadda	*!NOVOIGEM		
	☞ katta		*FAITH[voi]	
/kanta/	☞ kanta			*POSTNASVOI
	kanda		*!FAITH[voi]	
/paka/	☞ paka			*NO-[P]
	haka		*!FAITH[lab]	

Consequences for Foreign outputs: **kadda*, ✓*kanta*, ✓*paka*.

In (12) ("Alien", i.e. "Unassimilated Foreign"), FAITH dominates NOVOIGEM, NO-[P], and POSTNASVOI, hence *kadda*, *kanta*, and *paka* are the outputs of choice for our schematic inputs.[7]

(12)

Alien ranking:		SYLLSTRUC	FAITH	{NOVOIGEM, NO-[P], POSTNASVOI}
/kadda/	☞ kadda			*NOVOIGEM
	katta		*!FAITH[voi]	
/kanta/	☞ kanta			*POSTNASVOI
	kanda		*!FAITH[voi]	
/paka/	☞ paka			*NO-[P]
	haka		*!FAITH[lab]	

Consequences for Alien (Unassimilated Foreign) outputs: ✓*kadda*, ✓*kanta*, ✓*paka*.

[7] Even in the unassimilated foreign vocabulary, FAITH is dominated by the undominated constraints of Japanese, e.g. NO-COMPLEX and CODACOND (both Alignment constraints, in our conception, see Itô & Mester 1994b,c). With {*COMPLEX, CODA-COND} ≫ FAITH, the input /krismas/ will be mapped onto the output [kUrisUmasU], which is more harmonic than the faithful candidate [krismas], in spite of three FILL-violations.

Note that only the ranking of FAITH with respect to the four wellformedness constraints is crucial in this partial analysis of stratification in the J-lexicon —the latter four constraints are ranked only by transitivity (if $\alpha \gg \mathcal{F}$ and $\mathcal{F} \gg \beta$, then $\alpha \gg \beta$), looking at the totality of the lexicon, with all its subclasses. That is, there is no ranking argument with respect to the output of each class—rather, the argument for an overall ranking of constraints comes from the systematic differences that arise as the periphery of the lexicon is approached. This is a different kind of ranking argumentation from the usual one (see also Cohn & McCarthy 1994 for a comparable case where a usually unrankable constraint pair becomes rankable in a certain class of lexical items). It remains to be seen whether this type of ranking argumentation is valid.

This concludes the basic outline of our approach to lexical stratification, as illustrated for the Japanese lexicon. Our results are compatible with the hypothesis stated at the outset, namely that a reranking of FAITH within an otherwise invariant network of constraints is sufficient to capture the relevant generalizations. In order to appreciate the significance of this result, it is useful to consider the class of mimetic items, a part of the J-Lexicon we have so far not included in our analysis. In terms of the analysis above, the characteristic property of Mimetic words is that they do contain single [P] (in violation of the NO-[P] constraint), but never contain violations of the POSTNASVOI constraint. On the face of it, this seems to call for a direct re-ranking of POSTNASVOI and NO-[P], resulting in a ranking opposite to the one holding in Sino-Japanese, i.e.: {NOVOIGEM, POSTNASVOI} » FAITH » NO-[P]. This would yield the desired output generalization (**kadda, ✓paka, *kanta*). We could leave matters there, noting that this kind of direct reranking can be expected to be rare, occurring only in special circumstances (here plausibly due to extralinguistic factors involved in sound symbolism and onomatopoeia). But an additional consideration shows that the direct reranking approach is actually incorrect: /p/ is possible in mimetic outputs, but only in initial position (*pika*), not medially (**kipa*).[8] This suggests that in the case of Mimetics the constraint No-[P] is outranked not by FAITH, but rather by a more specific constraint forcing faithful parsing of stem-initial segments—in other words, by an ALIGN-LEFT constraint (ALIGN-LEFT (stem, PCat), with PCat=PrWd or Ft, see McCarthy & Prince 1993a,b).[9] If this line of analysis turns out to be correct, it suggests that the prime targets of reranking might include, besides Faithfulness constraints, certain types of Alignment constraints.

[8] Thanks to Philip Spaelti for bringing this positional difference to our attention.

[9] There are further asymmetries in Japanese Mimetics that single out the stem-initial position as a privileged locus for complex segmental configurations, see Mester & Itô 1989 for an analysis in classical nonlinear phonology, and Zoll 1994b for an optimality-theoretic reanalysis. We anticipate that the alignment-based approach sketched in the text can be extended to cover all of these facts, by ranking the Stem-Alignment constraint above No-[P] as well as above other constraints penalizing segmental complexity. Note that in our conception, there exist *no* constraints explicitly requiring left-alignment for voiceless labial stops, complex segments, etc.—arguably a good result, since such empirical generalizations should ideally emerge from constraint interactions and not be postulated as constraints by themselves.

Returning to our main issue, namely, the reranking of FAITH and lexical core-periphery organization, it should be clear that nothing in our approach is specific to Japanese—in fact, there is a wealth of past linguistic work documenting similar patterns in other languages that fall to an entirely parallel analysis. As an example, we will here briefly consider a case from Russian first presented in Holden 1976.[10] Holden observed that borrowings in Russian are not phonologically homogeneous, but show different degrees of assimilation. Three features identifying foreignisms in Russian are involved: (i) the existence of phonemic /f/, (ii) non-palatalization of consonants before [e], and (iii) non-reduction of unstressed [e,o] to [ɪ,ə] (the reduced vowels have different phonetic realizations, depending on context). These features constitute violation of the constraints in (13a-c).

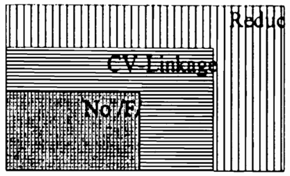
(13) a. **NO-/F/**: /f/ is not admitted (see section 2 below for further discussion of constraints of this kind).
b. **CV-LINKAGE**: Consonants are palatal before front vowels (this type of sequential constraint will be further discussed in section 3).
c. **REDUC**: No unstressed [o]/[e].

Holden 1976 observes that compliance with NO-[F] entails compliance with CV-LINKAGE (but not vice versa), and compliance with CV-LINKAGE entails compliance with REDUC (but not vice versa). Some examples appear in (14a); (14b) illustrates the relations between constraint domains, and (15) shows how the observed stratification can be obtained from a reranking of FAITH within the invariant overall ranking REDUC » CV-LINKAGE » NO-/F/.

(14)

a.
'coffee'	[kóf^{y}ɪ]	✓Reduc,	✓CV-Linkage,	*No-[F]
'Forelle'[11]	[fərél^y]	✓Reduc,	*CV-Linkage,	*No-[F]
'fox terrier'	[foksterjér]	*Reduc,	*CV-Linkage,	*No-[F]

b.



[10] Thanks to John McCarthy for drawing out attention to this paper. Our understanding of the phenomena has been considerably enhanced by having had the opportunity to study a course paper on a closely related topic by Chris Kennedy (1993, UCSC).

[11] "trout" (German).

(15) Reranking of FAITH

a. native Russian	b. most assimilated ([kófʏɪ], etc.)	c. less assimilated ([fərelʸ], etc.)	d. least assimilated ([foksterjér], etc.)
REDUC	REDUC	REDUC	**FAITH**
|	|	|	|
CV-LINKAGE	CV-LINKAGE	**FAITH**	- - - - - - -
|	|	|	REDUC
NO-/F/	**FAITH**	- - - - - - -	|
|	|	CV-LINKAGE	CV-LINKAGE
FAITH	- - - - - - -	|	|
	NO-/F/	NO-/F/	NO-/F/

2. Inventory Theory

2.1 Segment inventories and phonemicization.

Optimality Theory is based on constraints that are output-oriented. For the underlying phonemic inventory of a language, this means that it is defined not by direct stipulation on possible *inputs* (see Prince & Smolensky 1993 and Itô, Mester, & Padgett 1995 for discussion), but rather by some class of segmental constraints S_1 that militate against *outputs* containing instances of segment types not admitted in the language in question. In order to be decisive in candidate selection, S_1 must dominate some Faithfulness constraint f, as indicated in (16).

(16) $S_1 \gg f \quad (f \in \mathcal{F})$

The Faithfulness constraints most relevant in the present context are the two constraints in (17) banning both "deletion" and "epenthesis" of feature specifications (see P&S 1993, ch.9).

(17) Feature Faithfulness (FAITH-FEAT):
PARSE-FEAT: All underlying featural information must be parsed into segments.
FILL-FEAT: All featural information must be contained in the underlying representation.

For example, consider the constraint NOVOIFRIC (* [−son,+cont] / [+voi]) ruling out voiced fricatives. The ranking [NOVOIFRIC $\gg f$] means that voiced fricatives will be avoided, at the cost of violating a lower-ranking Faithfulness constraint f (by failing to parse subsegmental structure, such as stricture information ([+continuant], etc.), and/or by filling in such structure epenthetically). As a result, voiced fricatives, even if supplied to the grammatical system in the input, will never appear in the output in such a language; they will rather turn into something less

marked (such as voiceless fricatives, voiced stops, or something else, depending on what the lowest-ranking Faithfulness constraint turns out to be, see Prince & Smolensky (1993, ch.9) for discussion).

The segments that are admitted as phonemes in a given language, even though they are (usually) abundantly represented in output forms, also violate some set of constraints, here referred to as S_2. Different from S_1, the members of S_2 rank below *all* Faithfulness constraints, as indicated in (18)—they are thus not enforcible by breaches of Faithfulness with respect to feature specifications. This is the situation in a language which possesses voiced stops, like English, where NOVOIFRIC is part of S_2.

(18) $\mathcal{F} \gg S_2$

Combining (16) and (18), we have the overall ranking scheme in (19).[12]

(19) $\{f_1,\ldots,f_k\} \gg S_1 \gg \{f_l,\ldots,f_n\} \gg S_2 \qquad \mathcal{F} = \{f_1,\ldots,f_k\} \cup \{f_l,\ldots,f_n\}$

As a concrete example, let us consider the alveolar affricate [t͡s], which is not part of the underlying core segment inventory of Japanese ([t͡s] occurs only before [u] as an allophone of /t/, leading to alternations like *kat-anai* 'win-NEG' vs. *kat͡s-u* 'win-PRES'; we will return to this allophonic relation below). This gap is due to the constraint NO-AFFRIC (20), which bans the segment [t͡s] (as well as [p͡f] and [k͡x]).[13]

(20) NO-AFFRIC: Affricates are disallowed.

This constraint against affricates can be considered as a family, including the members NOAFFRIC[COR], NO-AFFRIC[LAB], ranked above the Faithfulness constraint PARSE-FEAT. (We will sometimes use *TS as a shorthand reference to the member of the NOAFFRIC family outlawing [t͡s].)

(21) NO-AFFRIC $\gg$ PARSE-FEAT

What happens when a grammar with the ranking in (21) receives an input containing /t͡s/, such as the hypothetical form /kat͡sa/ (22)? As emphasized by Prince & Smolensky 1993, input representations are not under the direct regime of the grammar—in principle, any segment at all can occur in inputs, there is no restriction to phonemes of the language, etc. In our example, the optimal candidate (phonetically

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[12] (19) is simplified in various respects: for example, the S_1 constraints could be interspersed among $f_l \ldots f_n$, etc.

[13] We simplify the analysis by tacitly regarding the palatal affricate /t͡ʃ/ as exempt from this constraint. In terms of markedness, /t͡ʃ/ plays a role very different from [t͡s] and [p͡f] in segmental inventories and acts as the canonical representative of the stop series in the palatal region, see Kingston 1993 for documentation and discussion. In terms of OT, the constraint(s) favoring palatal affricates over palatal stops (no doubt grounded in the functional anatomy of the human mouth) must outrank (20).

realized as [kasa]) is a form that leaves one input feature (here represented by the symbol *t*) unparsed.[14]

(22)

/kat͡sa/ (core ranking:)	NOAFFRIC (*TS)	PARSE-FEAT
kat͡sa	*!	
☞ ka<t>sa		*

More generally, it is the constraint system itself that encodes the structural properties of a language, there is no separate mechanism (morpheme structure constraints, constraints on underlying representations, or the like) which directly inscribes these properties into underlying forms.[15] Nonexistent segments are nonexistent in the output because the constraint system fails to parse them (or some of their features), not because they are already sifted out at the input stage by some prefiltering mechanism.

Within this general framework, the ranking of PARSE-FEAT (or more exactly, of the two Feature Faithfulness constraints in (17)) with respect to the various segmental constraints plays the role of the 'phonemicization parameter'. When ranked below a certain segment structure constraint C, PARSE-FEAT cannot prevent a (total or partial) deparsing of C-violating input elements. Such C-violators are therefore excluded from the 'phonemic inventory' of the language (in the sense that they will not appear in the output). This case was illustrated in (22) above for [t͡s] in (core) Japanese. But when PARSE-FEAT is ranked above C, C-violators are parsed in spite of C—they are part of the 'inventory'.

Continuing along this line, it is natural to hypothesize that phonemicizing a certain type of segment in a non-core stratum of the lexicon means reranking Feature Faithfulness constraints, in terms of the theory developed in section 1. As a simple example, consider the appearance of /t͡s/ as a phoneme in peripheral domains of the Japanese lexicon. The examples in (23) show that here the alveolar affricate is found quite freely, before different vowels.

[14] The winner could also be kat<s>a, depending on whether or not Parse[-cont] is ranked higher than Parse[+cont]. All that matters is that the candidate [kat͡sa] is harmonically bounded by at least one more harmonic candidate (P&S 1993, ch.9).

[15] The independent existence of two mechanisms was the cause of major difficulties in traditional generative phonology, cf. the longstanding 'duplication problem' (Kenstowicz &Kisseberth 1977), which was never satisfactorily solved in derivation-based approaches to phonology. It is a separate question whether all duplication issues automatically evaporate in Optimality Theory (the dichotomy between Parse and MParse (P&S 1993) raises some questions in this regard; see also Duncan 1994 for relevant evidence and discussion).

(23)

[t͡sa]	t͡saitogaisuto	'Zeitgeist'	[t͡se]	t͡serutozakku	'Zeltsack'
[t͡sɪ]	erit͡siN	'Yeltsin'	[t͡so]	kant͡soone	'canzone'

The analysis is straightforward: The peripheral lexical domain differs from the core lexical domain in that FAITH-FEAT is ranked *above* NOAFFRIC instead of below it. This is shown in (24), which should be compared with the earlier tableau (22).[16]

(24)

'Zeitgeist' /t͡s.../ (peripheral ranking:)	FAITH-FEAT	NOAFFRIC (*TS)
☞ t͡saitogaisuto		*
t<s>aitogaisuto	*PARSE!	
<t>saitogaisuto	*PARSE!	
t͡sUaitogaisuto	*FILL!	*

2.2 Allophony and CV-Linkage.

In the typical case, certain sound types, even though excluded as phonemes from the inventory, are nevertheless found in particular environments. Returning to core Japanese, with its exclusion of /t͡s/ as a phoneme, we find [t͡s] as an allophonic replacement of /t/ before /u/. The distributional facts are given in (25). As in all such allophonic relations, the fact that [t͡su] occurs correlates with the fact that *[tu] does not (as a phonetic sequence).

(25) a.

*t͡sa	*t͡si	t͡su	*t͡se	*t͡so
ta	či[17]	*tu	te	to

b.

kat͡s-u	'win-PRES' (cf. kat-anai 'win-NEG')
t͡sunami	'tsunami'
fut͡suu	'ordinary'

[16] FILL violations are marked by capitalization. In (24), we have sidestepped the issue of marking multiple PARSE-FEAT and FILL-FEAT violations by using a strictly categorical Pass/Fail tally, which is sufficient for our examples. This is not generally the case, however, raising a host of issues regarding the representation, parsing, and insertion (by Gen) of featural information that cannot be addressed in this paper.

[17] We are abstracting away here from the palatalization effect in |či|, see section 3 for discussion.

The traditional analysis posits an underlying phoneme /t/, with [t͡s] derived by means of an allophonic rule (26), ensuring complementary distribution.[18]

(26) /t/ → [t͡s] / __ /u/

Such allophonic relations receive a different analysis in Optimality Theory. We hypothesize that they are instances of a type of linkage constraint proposed in Itô & Mester 1992, here restated in (27).

(27) CVLinkage: $C^\frown V \supset \{C^\frown V\}_V$, "Every consonant-vowel sequence forms a linked domain headed by V."

Affrication in (25b), then, is due to a general sequential constraint demanding the presence of continuancy (or stridency) in coronal obstruents before the high back vowel *u*: For the stops *t* and *d*, this amounts to affrication. The idea is that CV-LINKAGE (28) compels violation not only of NOAFFRIC, but also of the Faithfulness constraint discouraging the insertion of non-underlying phonological material (FILL-FEAT, see (17)). The constraint in question (28) results in the presence of enhancing frication/stridency in the coronal obstruents [t,d] before [u] (see Stevens, Keyser, and Kawasaki 1986 for an approach to such enhancement phenomena).

(28) CVLinkage (*TU)[19] A sequential constraint demanding the presence of continuancy in coronal obstruents before the high back vowel *u*.

The core ranking in the Japanese lexicon is shown in (29): CVLinkage (28) is ranked above NO-AFFRIC (otherwise [t͡s] would be outlawed even in 'allophonic' CVLinkage cases), and NO-AFFRIC in turn outranks FAITH-FEAT (otherwise NoAffric would be powerless to prevent a faithful parsing of (for example) an input containing /...t͡sa.../).

(29) Ranking (core): CVLINKAGE (*TU) » NOAFFRIC (*TS) » FAITH-FEAT

The tableaux in (30) show how this analysis accounts for a typical example of allophonic alternation.

[18] The same distribution holds for the bilabial fricative [f] (= [ɸ]), an allophonic variant of /h/: /h/ → [f] / __ /u/ (toofu 'tofu', fuji 'Mt. Fuji', afureru 'overflow', etc.).

[19] For visual perspicuity and mnemonic ease, we indicate the ban against the segment type (*TS) and the sequence (*TU) by referring only to the voiceless element. It should be clear, however, that the constraints denoted by these labels hold for both voiceless and voiced segments.

(30)

a.

/kat-u/ 'win-Pres' Core ranking:	CVLINKAGE (*TU)	NOAFFRIC (*TS)	FAITH-FEAT
☞ kat͡su		*	*FILL
katu	*!		

b.

/kat-anai/ 'win-Neg'	CVLINKAGE (*TU)	NOAFFRIC (*TS)	FAITH-FEAT
kat͡sanai		*!	*FILL
☞ katanai			

In the periphery of the Japanese lexicon, even though /t͡s/ is a phoneme in its own right (due to a reranking of FAITH-FEAT above NOAFFRIC, see (24)), the sequence [tu] is still disallowed. Where the loan source contains [tu] (31), the sequence is rendered with affrication.

(31) t͡suaa 'tour'
t͡suiN 'twin'
t͡suuraN 'two-run homer'
t͡suna 'tuna'

This follows from the way reranking has affected the position of FAITH-FEAT in the lexical periphery, in comparison with the core: Even though FAITH-FEAT has come to dominate NOAFFRIC, it is still dominated by CVLINKAGE (32). In other words, while input /t͡s/ reaches the output unscathed (because NOAFFRIC ranks below FAITH-FEAT), input /t/ before /u/ is still turned into [t͡s] (because CVLINKAGE ranks above FAITH-FEAT).

(32) Core: CVLINKAGE » NOAFFRIC » **FAITH-FEAT**
Periphery: CVLINKAGE » **FAITH-FEAT** » NOAFFRIC

As a result, input /...tu.../, if it is posited, will come out as [...t͡su...].[20] This is illustrated in (33).

[20] With our crude ("PASS/FAIL") method of marking violations, this outcome amounts to a ranking argument for PARSE-FEAT » FILL-FEAT, as indicated in the tableau.

(33)

'tour' /tu.../ Foreign ranking:	CVLINKAGE (*TU)	PARSE-FEAT	FILL-FEAT	NOAFFRIC (*TS)
☞ tS uaa			*	*
tuaa	*!			
t<u>aa		*!		

In certain highly anglicized pronunciations, younger speakers use the unaffricated coronal before [u] (in examples like ***duu itto yuaserufu*** 'do-it-yourself' or ***duu-wappu*** 'doo-wop (music)'). This indicates that for such speakers there is an outermost lexical area where FAITH-FEAT (or at least FILL-FEAT) outranks even CVLINKAGE, as shown in (34) and (35).

(34)

'doo-wop' /du.../ Alien ranking:	FAITH-FEAT	CVLINKAGE (*TU)	NOAFFRIC (*TS)
☞ duuwappu		*	
dZuuwappu	*! FILL		*
d<u>oowappu	*! PARSE		

(35) Native: CVLINKAGE » NOAFFRIC » **FAITH-FEAT**
Foreign: CVLINKAGE » **FAITH-FEAT** » NOAFFRIC
Unassimilated Foreign: **FAITH-FEAT** » CVLINKAGE » NOAFFRIC

The picture of the lexicon that emerges from this brief look at the Japanese lexicon is in many ways reminiscent of observations familiar from work in derivational phonology, most notably, Lexical Phonology (under the rubric "Structure Preservation", see Kiparsky 1985, Borowsky 1986, Myers 1991, among others), where rules and constraints can be individually 'turned off' at various point during the derivation. In these terms, in the lexical core the constraint against affricates is in force (so there is no affricate phoneme), and the affrication rule is operative; when the Foreign stratum is reached, the constraint against affricates is turned off, but the affrication rule is still operative; and finally, when the derivation faces totally unassimilated elements, both the constraint against affricates and the affrication rule are turned off. But this description already shows why such a derivational conception of lexical stratification is flawed: Any appeal to a 'derivation' in the distinction between core items and peripheral items is besides the point—the periphery is just as "underlying" as the core. We would like to claim that the optimality-theoretic conception developed above preserves the insights behind the lexical-phonological notion "Structure Preservation" without derivational metaphors. What is special about peripheral items is not that they are somehow derived at a later stage, but rather that they are processed by a phonological system with reranked constraints; and reranking, as we have argued, is (at least to a large extent) restricted to a reranking of FAITH alone.

3. Peripheral Weakening and Constraint Splitting

A recurrent theme of optimality-theoretic work is the idea that in individual grammars, broad constraints are often split into smaller subconstraints: While the ranking of the subconstraints to each other is (typically) fixed and does not change, other constraints appear interdigitated at different points in different grammars. Constraint splitting and interdigitation constitutes an important source of variation between languages. The approach appeared first in Prince & Smolensky's 1993 treatment of syllable sonority (*Margin/α, *Peak/α) and consonantal place (*Place/α) and has since played an important role in optimality-theoretic studies.

In this section, we will look more closely at the ways in which constraint splitting influences the core-periphery organization of the lexicon. As our object of study, we choose an allophonic CV-Linkage phenomenon in Japanese affecting coronal consonants and front vowels (see Itô & Mester 1994a for further empirical details). The examples in (36) exhibit palatalization before /i/ in native forms (from the verbal paradigm), and those in (37) show established loans which replace a nonpalatal coronal in the loan source by a palatal.

(36) /kat/ + /i/ → kač-i 'win, infinitive'
/hanas/ + /i/ → hanaš-i 'talk, infinitive'

(37) čiimu 'team' ǰiremma 'dilemma'
šinema 'cinema' ǰiguzagu 'zigzag'

As with the affrication process, we interpret this as resulting from a constraint requiring CV-linkage for coronalC + frontV sequences (i.e. *ti, *si, *di, *zi, etc.). The constraint disallowing alveolar consonants before /i/ is formulated in (38), with the featural assumptions in (39).[21]

(38) CVLINKAGE (I): *[−HIGH, CORONAL, C]⌢[+HIGH, FRONT, V]

(39) [CORONAL, +HIGH] = palatal consonants (š, č, ǰ, y, etc.)
[CORONAL, −HIGH] = nonpalatal coronal consonants (s, t, d, etc.)
[FRONT, +HIGH] = [i]
[FRONT, −HIGH] = [e]

[21] The feature name "front" is intended as a cover term neutral with respect to open questions regarding the relations (and possible identifications) between consonant and vowel features (see Clements 1991, Hume 1992, Gnanadesikan 1993, Ní Chiosáin & Padgett 1993, among others).

The tableau in (40) shows how the core ranking "CVLINKAGE(I) » FAITH [HIGH]" results in the desired output.

(40)

/kat-i/ core ranking:	CVLINKAGE(I)	FAITH [HIGH]
a. kati	*!	
b. ☞ kači		*

This fairly unremarkable constraint ranking analysis becomes more interesting when viewed in conjunction with a closely related depalatalization effect excluding palatals before the nonhigh front vowel [e] (*če, *še, *že, *ǰe, *ye, etc.) The depalatalization constraint is stated in (41) as a counterpart to (38), disallowing high coronals (palatals) before /e/.

(41) CVLINKAGE (E): *[+HIGH, CORONAL, C]⁀[–HIGH, FRONT, V]

(41) is responsible for the loss of stem-final [y] before the intransitivizing suffix /-e/ (42), and for depalatalization in established loans (43).

(42)	TRANSITIVE	INTRANSITIVE	
	moy-as-u	mo-e-ru	'burn'
	tay-as-u	ta-e-ru	'extinguish / be extinct'
	koy-as-u	ko-e-ru	'make / become fat'
cf.	sam-as-u	sam-e-ru	'cool down'
	hag-as-u	hag-e-ru	'peel off / become bald'

(43)		
	sepaado	'shepherd (dog)'
	rosanzerusu	'Los Angeles'
	zene-suto	'general strike'

Depalatalization results from the ranking of FAITH[HIGH] below CVLINKAGE(E):

(44)

'Los Angeles' /...ǰe.../	CVLINKAGE (E)	FAITH [HIGH]
a. rosu anǰerusu	*!	
b. ☞ rosu anzerusu		*

The parallelism of the two constraints CVLINKAGE(I) and CVLINKAGE(E) makes it tempting to try to collapse them into a single broader constraint, affecting all coronal consonants and front vowels. Indeed, students of Chomsky & Halle 1968 will hardly encounter any trouble collapsing the two rules with alpha variable notation, as in (45).

(45) CVLINKAGE(I,E): * [αHIGH, CORONAL, C]⁀[–αHIGH, FRONT, V]

This constraint disallows a C⁀V sequence consisting of a coronal consonant followed by a front vowel to have different height specifications. In more articulated feature-geometric models that allow for a host of consonant and vowel feature interactions, it is undoubtedly possible to state this constraint in a simpler way (without e.g. using alpha variables). However, the search for an appropriate feature-geometric representation to capture the broader generalization is somewhat elusive: Once we look beyond the core lexicon, the evidence supports not the collapsed constraint (45), but rather the two separately ranked constraints (38) and (41). In fact, we will later see that these two constraints—while members of the same family— are not only kept separate, but are even further split up into still smaller subconstraints.

Using the analytical method established in the previous section regarding constraint reranking, we can establish CVLINKAGE(I) and CVLINKAGE(E) as separate constraints, ranked in that order in the J-Lexicon. This can be demonstrated by considering, for example, the variant surface forms of the loanword for 'gelatine', whose source is noteworthy in containing both a CVLINKAGE(E) violation and a CVLINKAGE(I) violation. As shown in (46), only three out of the four logically possible relevant pronunciations are actually attested.

(46)	'gelatine'	/ǰe...ti.../	a.	zeračiN	[ze...či...]
			b.	ǰeračiN	[ǰe...či...]
			c.	ǰeratiN	[ǰe...ti...]
			d.	*zeratiN	*[ze...ti...]

Given our reranking theory of core-periphery phenomena developed in section 1, the explanation for this kind of pattern is close at hand: Assuming as fixed the ranking of the two CVLinkage constraints in (47), the reranking of FAITH upwards towards the periphery of the J-Lexicon gives us the three possible forms (48).

(47) CVLINKAGE(I) » CVLINKAGE(E)

(48) a. CVLINKAGE(I) » CVLINKAGE(E) » FAITH → zeračiN
b. CVLINKAGE(I) » FAITH » CVLINKAGE(E) → ǰeračiN
c. FAITH » CVLINKAGE(I) » CVLINKAGE(E) → ǰeratiN

The three possible rankings are illustrated in the tableaux (49)-(51).

(49)

'gelatine' /ʃe..ti../	CVLINKAGE(I)	CVLINKAGE(E)	FAITH[HIGH]
a. ʃeratiN	*!	*	
b. zeratiN	*!		*
c. ʃeračiN		*!	*
d. ☞ zeračiN			**

(50)

'gelatine' /ʃe..ti../	CVLINKAGE(I)	FAITH[HIGH]	CVLINKAGE(E)
a. ʃeratiN	*!		*
b. zeratiN	*!	*	
c. ☞ ʃeračiN		*	*
d. zeračiN		*!*	

(51)

'gelatine' /ʃe..ti../	FAITH [HIGH]	CVLINKAGE(I)	CVLINKAGE(E)
a. ☞ ʃeratiN		*	*
b. zeratiN	*!	*	
c. ʃeračiN	*!		*
d. zeračiN	*!*		

Our hypothesis regarding the overall constraint ranking (see section 1) correctly predicts that the fourth logical possibility **zeratiN* (fulfilling CVLINKAGE(E) but violating CVLINKAGE(I)) does not exist, since in order for it to be the optimal output, it would be necessary to rerank the two linkage constraints, with FAITH intervening, as in (52).

(52) Impossible reranking: CVLINKAGE(E) » FAITH » CVLINKAGE(I)

Although the two linkage constraints are independent and can therefore be separately ranked, this does not mean that they are totally unrelated. They are part of a closely knit constraint family of CV-interactions, as partially depicted in (53).

(53) ... C⁀HighV > C⁀NonHighV ...

We hypothesize that the ranking in (53) is substantively fixed by a universal interaction hierarchy, which determines that consonants are more prone to interact

with high vowels than with nonhigh vowels. We will return below to the causes that lead to the establishment of such universal hierarchies; for now, an important implication is the fact that the ranking in (52) is not only impossible for Japanese, but also universally.

Further investigation reveals that the two linkage constraints differ in still another respect in the periphery. As already seen above (48), the higher ranking FAITH constraint suppresses the effects of CVLINKAGE(I) in peripheral lexical items. Additional examples are given in (54).

(54) tiiN 'teen(ager)'
paatii 'party'
disuku-ʃokkii 'disc jockey'

However, a simple reranking of FAITH and CVLINKAGE(I) is insufficient to account for the facts. This becomes evident when the behavior of fricatives is considered. Even in the periphery, fricative (strident) coronals always become palatal before /i/, as shown in (55).

(55) šii fuudo 'sea food' (*sii fuudo, etc.)
žippu koodo 'zip code'
šitiibaNku 'Citibank™'

The last example [šitiibaNku] is revealing in that the two coronals are treated differently in one and the same form. Our analysis so far is not fine-grained enough to differentiate in the appropriate way. The interplay of the two constraints only yields either the fully palatalized [šičiibaNku] (CVLINKAGE(I) »FAITH) or the fully unpalatalized [sitiibaNku] (FAITH [HIGH] » CVLINKAGE(I)). This nonuniform weakening of the palatalization requirements in the periphery shows that the CVLINKAGE(I) constraint (56) itself is made up of still smaller subconstraints, as indicated in (57).

(56) CVLINKAGE(I): *[−HIGH, CORONAL, C]⁀[+HIGH, FRONT, V]

(57) Subconstraints:
a. CVLINKAGE(*si): *[−HIGH, CORONAL, +CONT]⁀[+HIGH, FRONT, V]
b. CVLINKAGE(*ti): *[−HIGH, CORONAL, −CONT]⁀[+HIGH, FRONT, V]

In the core, both CVLINKAGE(*si), and CVLINKAGE(*ti) are higher ranked than FAITH, and therefore do not show their individuality. However, in the periphery, FAITH intervenes between them, rendering CVLINKAGE(*ti) invisible, but not CVLINKAGE(*si), as illustrated by the tableau in (59).

(58)
Core Ranking: CVLINKAGE(*si) » CVLINKAGE(*ti) » FAITH
Peripheral Ranking: CVLINKAGE(*si) » FAITH » CVLINKAGE(*ti)

(59)

'Citibank' /s...t.../	CVLINKAGE(*si)	FAITH [HIGH]	CVLINKAGE(*ti)
a. sitiibaNku	*!		*
b. šičiibaNku		**!	
c. sičiibaNku	*!	*	
d. ☞ šitiibaNku		*	*

Turning next to CVLINKAGE(E) in the periphery, we find that both fricatives and stops/affricates are faithfully parsed before [e].

(60)
čeeN	'chain'
niiče	'Nietzsche'
ǰeemuzu	'James (Bond)'
ǰetto	'jet'
šerii	'sherry'

The sequence [ye] (approximant+vowel), however, is still disallowed; loan sources containing [...ye...] are treated either by deletion or by vocalization of the palatal glide, as shown in (61).

(61)
eri͡tsiN	'Yeltsin'
eeru	'Yale (university)'
ehoba	'Jehovah('s witness)'
erusaremu	'Jerusalem'
i.emeN	'Yemen'
i.eroo peeǰi	'yellow pages'

The recipe for the analysis is by now familiar: CVLINKAGE(E) (62) is split between the approximant version and the consonantal version (63). FAITH is ranked below both linkage constraints in the core J-Lexicon but intervenes in the periphery (64).

(62) CVLINKAGE(E): *[+HIGH, CORONAL, C]⁀[−HIGH, FRONT, V]

(63) Subconstraints:
a. CVLINKAGE(*ye): *[+HIGH, CORONAL, −CONS]⁀[−HIGH, FRONT, V]
b. CVLINKAGE(*če): *[+HIGH, CORONAL, +CONS]⁀[−HIGH, FRONT, V]

(64)
Core Ranking: CVLINKAGE(*ye) » CVLINKAGE(*če) » FAITH
Peripheral Ranking: CVLINKAGE(*ye) » FAITH » CVLINKAGE(*če)

The tableau in (65) illustrates the peripheral constraint ranking, distinguishing between *Nietzsche* and *Yeltsin*.

(65)

	CVLINKAGE(*ye)	FAITH	CVLINKAGE(*če)
a. ☞ niiče			*
b. niite		*!	
c. yeri͡tsiN	*!		
d. ☞ eri͡tsiN		*	

CVLINKAGE(I) distinguishes between continuants and stops (57), whereas CVLINKAGE(E) distinguishes between approximants and everything else (63). Just as the ranking between CVLINKAGE(I) and CVLINKAGE(E) is not accidental, it stands to reason that the ranking between the two parts of the CVLINKAGE(I) and CVLINKAGE(E) constraints should also be substantively fixed. Given a universal hierarchy (66) of interaction strengths between segment types (which, in turn, is partially determined by the universal sonority hierarchy), we predict e.g. that linkage effects on stops entail linkage effects on fricatives, but not vice versa. Whether such entailments hold true universally is a topic of future research.

(66) Approx⁀V > Fric⁀V > Stop⁀V

Comparing the consonant-calibrated interaction hierarchy (66) with the vowel-calibrated interaction hierarchy (52) (repeated in (67)), we see an apparent reversal of the effects of sonority: The *more* sonorous the consonant, the more prone it is to interact with vowels. But (adopting the common assumption that high vowels are less sonorous than nonhigh vowels) the *less* sonorous the vowel, the more prone it is to interact with consonants.

(67) C⁀HighV > C⁀NonHighV

The reversal is not surprising when the driving force of such CV interactions is understood: *"The more similar the segments, the stronger the interaction"* (see Pierrehumbert 1993 for a recent discussion of such similarity effects). High vowels are most consonant-like (see Zoll 1994a for evidence involving the superhigh vowels in some Bantu languages), and approximant consonants are most vowel-like (often the two are distinguished only by their position in the syllable). It is not likely that the hierarchies (66) and (67) are directly encoded in the linguistic part of the genome; they are rather obtained as weighted function of (i) similarity in sonority, (ii) similarity in stricture (McCarthy 1985, Yip 1989, Padgett 1991, 1994), and (iii) similarity in other properties (including Place).[22]

[22] Earlier dependency models of segment-internal structure (Mester 1986, Selkirk 1988) can be reinterpreted, from the present perspective, as somewhat crude geometric approximations of such a function. The central idea of dependent feature representations is to encode similarity (in some respect) between adjacent segments by assigning them identical specifications on a central feature tier (inducing

4. Summary

It is a common observation that the lexica of natural languages show internal variation, giving rise to distinct strata defined by clusters of properties. We have shown elsewhere (Itô & Mester 1994a) that lexical stratification usually gives rise to a clear core-periphery organization. Within Optimality Theory, lexicon-internal variation is an effect of constraint reranking. In this paper, we show that in a substantial class of cases constraint reranking can be limited to a reranking of Faithfulness constraints, within an otherwise invariant ranking order of constraints. It is this limit on reranking that gives rise to the core-periphery structure, appearing observationally as a gradual "weakening" of the "force" of various wellformedness constraints. Within this overall theory of lexical stratification, the paper discusses the status of phonemic inventories and of allophonic alternations. Finally, the hierarchies determining the strength of segmental interaction effects are found to play a significant role in fine-tuning the distinctions between lexical strata.

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OCP-violations) and distinct specifications on a dependent tier. In its attempt to perform all relevant similarity calculations directly within autosegmental displays, with the OCP as the only principle to rely on, this kind of proposal appears insufficiently general. In any case, central analytical elements of the dependency model—like the idea of parametric tier ordering— never found a home in the standard feature-geometric approach (Clements 1985, Sagey 1986), which is closely wedded to the anatomy of the vocal tract (as articulated, for example, by Halle & Vaux 1994: "[..] the tree directly reflects aspects of the human anatomy used in the production of speech"). It is an interesting question whether parametric variation of the kind posited in dependency models can be fruitfully recast, in a non-representational mode, in terms of different constraint rankings.

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