Markedness and Word Structure: OCP Effects in Japanese

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1. Introduction[1]

1.1 Dissimilation and the OCP

The Obligatory Contour Principle (1) was originally conceived for tonal dissimilation phenomena in Mende and other African tone languages (see Leben1973; the name, which reveals the tonal origin of the principle, is due to Goldsmith 1976).

(1) The Obligatory Contour Principle (OCP):
"At the melodic level, adjacent identical elements are prohibited."

Subsequent work was characterized by two different strands of development. On the one hand, problems began to appear with the OCP as an absolute principle governing phonological representations (see, for example, Goldsmith 1976). On the other hand, the OCP took on a more and more central position in phonological theory, and was called on for a wide variety of dissimilatory phenomena involving segmental features. The most influential and worked-out proposal, supported with a variety of empirical evidence, including novel facts involving antigemination, appeared in McCarthy (1986), who proposed the formulation in (1) (p.208).

A classic illustration of the OCP involving whole segments is the well-known ban in Semitic languages against nominal and verbal stems of the form (2a) (Greenberg 1950), i.e., with identical consonants in stem-initial position. In Arabic, for example, the impossible type (2a) contrasts with (2b), which is well attested.

(2) a. $*C_i\ V\ C_i\ V\ C_j$ *sasam
b. $C_i\ V\ C_j\ V\ C_j$ samam 'poison'

The theoretical understanding of this restriction is due to McCarthy 1981 and involves the following elements:

(3) a. *Association*: melody elements (here, whole segments) are assigned to prosodic positions by means of the central autosegmental principle of one-to-one left-to-right association (Leben 1973, Goldsmith 1976).
b. *Spreading parameter*: All spreading is rightward (in Arabic).
c. *C/V separation*: consonantal and vocalic melodies are segregated onto separate tiers (in Arabic and other root-and-pattern systems).
d. *Melody structure*: Roots are subject to the OCP, i.e., no repetition of melody elements.

In the present context, (3d) is the important point. In McCarthy's 1981 analysis, it is the OCP that accounts for the systematic absence of roots like /ssm/, as shown in (4).

```
(4) a.                    b.                    c.
      *sasam                *sasam                samam
         a                     a                     a
        / \                   / \                   / \
      C V C V C             C V C V C             C V C V C
      |   |   |              \ /    |                 |    \ /
      s   s   m               s     m             s      m
```

(4a) is ruled out by the OCP at the melodic level, and (4b) violates one-to-one left-to-right association. (4c), on the other hand, violates neither. Note that *samam* involves the biliteral root /sm/, not a triliteral /smm/.

An example of an OCP-effect involving single features is the ban in Sanskrit against roots with two aspirate consonants (related to the deaspiration in reduplication known as Grassmann's law) shown in (5). While there are Sanskrit roots of the forms CVC^h and C^hVC (5a,b), there are no roots of the form C^hVC^h (5c).[2]

```
(5) a.                    b.                    c.
    ----------------------------------------------------------------
        [+]                 [+]                   [+]    [+]          ←  [spread glottis] tier
    -----|-------------------|---------------------|------|---------
    C  V C                 C  V  C                C  V  C
    b  u dʰ                bʰ  i  d             (∄ bʰ  i  dʰ)
    'to be awake'          'to split'
```

An OCP-effect of a similar kind is the restriction against multiple obstruent voicing in native Japanese morphemes seen in (6). While *futa*, *fuda*, and *buta* are all possible (and actually existing) morphemes, a sequence like **buda* is not.

```
(6) Lyman's Law in Japanese: effects in morpheme structure
    a.          b.              c.                d.
    ------------------------------------------------------------------
                       [+]       [+]                [+]   [+]          ←  (obstruent) [voice] tier
    --------------------|---------|------------------|-----|---------
    C  V  C  V    C  V  C  V    C  V  C  V       C  V  C  V
    f  u  t  a    f  u  d  a    b  u  t  a     (∄ b  u  d  a)
    'lid'         'sign'        'pig'
```

Ito & Mester (1986, 67, 71-72) derive this restriction from the OCP, which here applies on the [voice] tier, with underspecification of all predictable voicing–i.e., the relevant voicing is thus only obstruent voicing.

Within the grammar of Japanese, this OCP-triggered voicing restriction has further repercussions in the phonology of compounds ("Lyman's Law") that will be the topic of discussion later in this work. Unlike the Arabic root structure conditions (McCarthy 1985), which are limited in their role to the population of the root lexicon, the OCP on [voice] shows an unusual degree of phonological activity by interacting crucially with a central morphophonemic process, namely, Rendaku (Compound Voicing in Japanese). It is therefore well suited as an object of empirical probing.

In the past, the standard explanation for such dissimilation effects on whole segments, features, or feature groups involved the specific principle stated above in (1), in some form or other. In autosegmental terms, a prototypical OCP violation has the schematic form in (7), where the same feature specification recurs in two adjacent locations.

(7)
$$\begin{array}{ccccc} & \alpha F & & \alpha F & \\ & | & & | & \\ X & X & X & X & X \end{array} \qquad \leftarrow \text{ OCP violation}$$

Of central importance here is the notion of ‘adjacency’ (see Archangeli 1986, Archangeli & Pulleyblank 1987, Myers 1987, and Odden 1994 for important discussion). Without entering into the complex issues surrounding this notion, we can distinguish two aspects of adjacency:

(8) a. segment adjacency (e.g., of the X-slots in (7))
b. tier adjacency (e.g., of the two feature specifications in (7) on the F-tier).

It is the second aspect of adjacency that is instrumental in classical Autosegmental Theory, as developed by Leben 1973 and Goldsmith 1976, with its goal of reducing apparent action-at-a-distance to locality (i.e., in terms of tier adjacency). In this way, the locality of OCP-interactions finds a representational expression, in terms of adjacency of autosegments on a tier, as shown in (7) above.

In the further pursuit of this program, a number of additional representational assumptions became necessary, many of them with independent support, but many also fraught with problems. These assumptions, the details of which need not detain us at this point, include feature-geometric separation of feature groups (Clements 1985, Sagey 1986, Mester 1986, and many subsequent works), morphemically defined tiers (McCarthy 1981,1986), and crucial underspecification of certain features (Kiparsky 1982, Archangeli 1984, Ito & Mester 1986, 1989, Steriade 1987, and many other works).

1.2 The OCP in Optimality Theory

This study is couched within the framework of Optimality Theory (abbreviated as “OT”; Prince & Smolensky 1993 et sqq.). Its central goal is to better understand the status of the OCP, and of featural dissimilation in general, in an optimality-theoretic conception of phonology. One possibility is to maintain the principle in a more-or-less unchanged form, with diversification in terms of special features and feature groups, as one of the rankable and violable constraint that make up an OT-grammar. This line has been taken by a number of researchers, both in the tonal area (Myers 1997) and in segmental phonology (McCarthy & Prince 1995). A more ambitious undertaking, which we would like to pursue here, would be to ask whether it is possible within

OT to reduce the OCP to more fundamental notions and restrictions, thereby perhaps achieving a deeper level of explanation.

Our main tenets are summarized in (9). The central idea is that *there is no Obligatory Contour Principle* per se: Universal Grammar is not concerned about adjacent identicals qua identicals. Rather, OCP-effects arise when markedness constraints are violated more than once.[3]

(9) i. OCP-effects obtain when a *given marked type of structure* is present *more than once* within the same local domain.

ii. Multiple violations of one and the same markedness constraint do not simply add up, but interact more strongly, so that a double violation within a given domain is worse than simply the sum of two individual violations.

iii. This notion of violation enhancement can be formally expressed by means of *self-conjunction of constraints* (see Smolensky 1995 and below).

We will pursue (9i-iii) as a unified program, but it should be clear that they constitute logically and empirically independent claims—this is in particular obvious for (iii) in relation to (i) and (ii).

The rest of this work is organized as follows. In chapter 2, we lay the groundwork by presenting a theory of local constraint conjunction, starting with Smolensky's (1993, 1995, 1997) work, and a markedness-based conception of the OCP on this basis. In chapter 3, this approach to dissimilatory phenomena is applied to three different classes of phenomena in Japanese, involving degemination, accent, and voicing. Chapter 4 deals with the hierarchy of domains that determines locality, as far as OCP-interactions are concerned. Chapter 5 pursues this topic further by investigating word-structural prerequisites for a correct treatment of domains, and presents some consequences of a specific optimality-theoretic version of economy-driven structure assignment. Chapter 6 summarizes the theoretical results of the work and assembles the various analytical proposals dealing with Japanese phonology into an overall picture. A final appendix is devoted to open questions. It returns to some of the issues dealt with earlier and presents some alternatives and further developments.

2. Markedness

This chapter develops a conception of the OCP that is rather different from the tier-adjacency picture familiar from the classical work of Leben 1973 and McCarthy 1986, as epitomized by statements as in (10).

(10) "At the melodic level, adjacent identical elements are prohibited."

Our claim is that we can advance our understanding of OCP-effects, and of their connections with other phonological and grammatical factors, by establishing a stronger link between dissimilation and markedness. Our overall goal is to explain all OCP-effects as a particular type of markedness effect, involving nothing besides the familiar markedness constraints of phonological theory (which are also present in OT). The feasibility of this reductionist strategy depends on a enhanced form of markedness constraints made possible by a particular kind of constraint interaction known as 'local constraint conjunction' (Smolensky 1993, 1995) , a topic we will turn to first.

2.1 Local constraint conjunction

In pursuit of the goal of reducing the OCP to more fundamental factors, our first step will be to establish a connection between markedness constraints and OCP-effects. Phonological analysis conducted in most theoretical frameworks, past and present, routinely invokes segmental markedness constraints as in (11).

(11) Segmental markedness constraints:
   a. *[+consonantal, +spread glottis]
   b. *[+constricted glottis]
   c. *[−consonantal, +nasal]
   d. *[−sonorant, +voice]
   e. *[−consonantal, −back, −high, +round]

(11a) holds for phonological representations in languages such as Polish or Lardil that lack distinctively aspirated (true) consonants [pʰ, tʰ, etc];[4] it is violated in Hindi or Korean, where such segments exist and systematically contrast with unaspirated obstruents. (11b) is observed in Italian, a language without ejectives [k', t', etc.] and without a phonemic glottal stop [ʔ]; it is violated, for example, in Navajo. (11c) holds in Indonesian and Quechua, languages without distinctive nasal vowels [ã, õ, etc.] and is violated in Portuguese and Dakota. (11d) is observed in Yokuts, which lacks voiced obstruents [b, d, z, etc.], and is violated in Yoruba, English, and many other languages. (11e) holds in Albanian or Mandarin Chinese, which do not possess nonhigh front rounded vowels [ø, œ], and is violated in Finnish and French.

Regarding the statements in (11), one can quibble with the particular vocabulary in which the markedness constraints are expressed—the specific distinctive feature system chosen, whether a richer set of phonetic properties should be directly appealed to, or, on the other hand, whether more abstract components are more suitable as elements (Harris 1994). We are here not taking a particular position regarding such questions. The important point is rather that, in some form or other, statements as in (11) are essential ingredients of any version of phonological theory. The general form of these statements, cast in the form of constraints, is as in (12).[5]

(12) The feature combination F is prohibited: $*F$ $F = [\alpha F_1, ..., \beta F_n]$, where F_i stands for a particular distinctive feature and $\alpha,\beta \in \{+,-\}$.

“Feature combination” here means any set of feature specifications, from single specification sets (11b) to multi-member combinations (11e).

Taking up the example (5) in chapter 1, consider again the case of Sanskrit aspirates:

(13) Sanskrit roots permit only one aspirate:

```
    a.                    b.                     c.
    ------------------------------------------------------------------------------
-      [+]                  [+]                    [+]    [+]     ←  [spread glottis] tier
    ------------------------------------------------------------------------------
-       |                    |                      |      |
    C  V  C              C  V  C                C  V  C
    b  u  dʰ             bʰ  i  d             * bʰ  i  dʰ
    ‘to be awake’        ‘to split’
```

Why is (13c) ruled out in Sanskrit as a root, whereas (13a) and (13b) are admitted? The standard autosegmentalist answer (Leben 1973, McCarthy 1986, Borowsky & Mester 1983) is that (13c), in contrast to (13a) and (13b), violates the OCP as a constraint on representations: two identical specifications are adjacent on an autosegmental tier (here, the [spread glottis] tier) within the domain of the root.

Note that for this explanation to go through, it is imperative that all intervening segments are unspecified for [spread glottis]. In other words, underspecification is a crucial requirement, representations such as (14) do not appear at the relevant stage.

```
(14) a.                   b.                     c.
    ------------------------------------------------------------------------------
-.  [−] [+]              [+][−]                 [+][−][+]      ←  [spread glottis] tier
    ------------------------------------------------------------------------------
-    |\  |                |  |\                  |   |   |
    C  V  C              C  V  C                C   V   C
    b  u  dʰ             bʰ  i  d             * bʰ   i   dʰ
    ‘to be awake’        ‘to split’
```

The necessity to rule out representations like (14) leads to an essentially privative mode of representation, where marked properties are indicated, but not their unmarked counterparts.[6]

Suppose, however, that what is wrong with (13c)/(14c) has nothing to do with representational adjacency per se. Rather, the phonological object represented by both representations is ruled out by markedness prohibitions against aspirated segments. The basic idea is this: A candidate root with a single aspirate violates the markedness constraint *[+spread glottis] once, and this is still considered acceptable. But a candidate root with two aspirates violates *[+spread glottis] twice, and this results in unacceptability.

Expressed in a more general form, our proposal is that *two* violations of some constraint **F* within some local domain, such as the root, weigh more heavily than just as the sum of two individual violations in separate locations. This, we claim, is the essence of the OCP. In order to give substance to the proposal, and in order to give it a precise meaning within OT, a theory which is formally a calculus of marks, the phrase "weigh more heavily" needs clarification.

Smolensky (1993, 1995, 1997) proposes that in addition to a set *Con* of universal constraints, Universal Grammar contains an operation on *Con*: local conjunction.[7] In addition to the primary source of language variation in OT, namely, *reranking* of constraints, local conjunction introduces a second way in which individual grammars can differ: by making use of *combined* constraints. Combined constraints are produced by local conjunction of basic UG-constraints. They allow grammars to capture a particular type of constraint interaction which cannot be obtained in a theory exclusively built on direct strict domination (Prince & Smolensky 1993), but is attested in the phonologies of natural languages.

Consider a grammar where two constraints $\mathbb{C}_1$ and $\mathbb{C}_2$, whose ranking with respect to each other is immaterial, are both dominated by a third constraint $\mathbb{C}_\alpha$ (15).

(15) Constraint ranking: $\mathbb{C}_\alpha \gg \mathbb{C}_1, \quad \mathbb{C}_\alpha \gg \mathbb{C}_2$

Abstracting away from any ordering due to multiple violation of single constraints, (16) shows the harmonic ordering of candidates induced by (15) (see Prince & Smolensky 1993, 68-71 for the notation). Curly braces enclose the list of marks of each candidate: the candidate violating only C_1 has the mark $\{*C_1\}$, the candidate violating C_1 and C_2 is marked $\{*C_1, *C_2\}$, and the candidate violating no constraints is assigned $\{\varnothing\}$ (the empty list).

(16) Evaluation of marks:

	$\vdots$		*less harmonic*
	$\{*\mathbb{C}_\alpha\}$		↑
	$\{*\mathbb{C}_1, *\mathbb{C}_2\}$		
$\{*\mathbb{C}_1\}$		$\{*\mathbb{C}_2\}$	
	$\{\varnothing\}$		↓
			most harmonic

The important point is a familiar one: Under direct strict domination, the candidate $\{*\mathbb{C}_1, *\mathbb{C}_2\}$ is more harmonic than the candidate $\{*\mathbb{C}_\alpha\}$, even though the former has two violations and the latter only one. This is the celebrated strictness of strict domination, depicted in (17) in the familiar tableau form.

(17)

	$\mathbb{C}_\alpha$	$\mathbb{C}_1$	$\mathbb{C}_2$
☞ *candidate₁*		*	*
candidate₂	*		

$= \{*\mathbb{C}_1, *\mathbb{C}_2\}$

$= \{*\mathbb{C}_\alpha\}$

Under no circumstances can any number of violations of lower-ranking constraints ‘gang up’ against even a single violation of one higher-ranking constraint. Given the constraint rankings $\mathbb{C}_\alpha \gg \mathbb{C}_1$ and $\mathbb{C}_\alpha \gg \mathbb{C}_2$ (15), the harmonic order of candidates $\{*\mathbb{C}_1, *\mathbb{C}_2\} \succ \{*\mathbb{C}_\alpha\}$, as in (16), is unavoidable. The grid in (18) shows the harmonic ordering relations between eight distinct types of candidates for the three constraints C_1, C_2, and C_α (here “a→b” means “a is more harmonic than b”). Note in particular the one ‘diagonal’ harmonic ordering relation between ✓C_α *C_1 *C_2 and *C_α ✓C_1 ✓C_2, where the former is more harmonic than the latter.

(18)

$$\begin{tikzcd}
\checkmark C_\alpha\ \checkmark C_1\ \checkmark C_2 \arrow[r] \arrow[d] & \checkmark C_\alpha\ \checkmark C_1\ {*C_2} \arrow[d] \\
\checkmark C_\alpha\ {*C_1}\ \checkmark C_2 \arrow[r] \arrow[d] & \checkmark C_\alpha\ {*C_1}\ {*C_2} \arrow[d] \arrow[dl] \\
{*C_\alpha}\ \checkmark C_1\ \checkmark C_2 \arrow[r] \arrow[d] & {*C_\alpha}\ \checkmark C_1\ {*C_2} \arrow[d] \\
{*C_\alpha}\ {*C_1}\ \checkmark C_2 \arrow[r] & {*C_\alpha}\ {*C_1}\ {*C_2}
\end{tikzcd}$$

There are indications, however, that the strictness of strict domination is in some respects excessive. Situations arise (a concrete example will be discussed below) where, even though violations of $\mathbb{C}_\alpha$ are still fatal when compared with $\mathbb{C}_1$ and $\mathbb{C}_2$ individually, *simultaneous violations* of $\mathbb{C}_1$ and $\mathbb{C}_2$ within a local domain δ appear to count heavier than a violation of $\mathbb{C}_\alpha$.

(19) The worst-of-the- worst candidate wrt. constraints C_1 and C_2:

✓C_1 ✓C_2	✓C_1 * C_2
* C_1 ✓C_2	* C_1 * C_2

For the candidate grid in (18) above, this means that diagonal harmonic ordering relation between ✓C_α *C_1 *C_2 and *C_α ✓C_1 ✓C_2 is reversed, as shown in (20).

(20)
$$\begin{tikzcd}
✓C_\alpha\ ✓C_1\ ✓C_2 \arrow[r] \arrow[d] & ✓C_\alpha\ ✓C_1\ {*}C_2 \arrow[d] \\
✓C_\alpha\ {*}C_1\ ✓C_2 \arrow[r] \arrow[d] & ✓C_\alpha\ {*}C_1\ {*}C_2 \arrow[d] \\
{*}C_\alpha\ ✓C_1\ ✓C_2 \arrow[r] \arrow[d] \arrow[ur] & {*}C_\alpha\ ✓C_1\ {*}C_2 \arrow[d] \\
{*}C_\alpha\ {*}C_1\ ✓C_2 \arrow[r] & {*}C_\alpha\ {*}C_1\ {*}C_2
\end{tikzcd}$$

The desired harmonic ordering of violation mark lists is thus as in (21), where the candidate displaying, to use the term chosen by Prince & Smolensky (1993, 180), the 'worst-of-the-worst' wrt. constraints $\mathbb{C}_1$ and $\mathbb{C}_2$ is accorded a special status. $\{*\mathbb{C}_1,*\mathbb{C}_2\}_\delta$ is used to indicate that $\mathbb{C}_1$ and $\mathbb{C}_2$ are violated in a common local domain δ, the co-occurrence of the two violation marks is δ-local.

(21) δ-local interaction between $*\mathbb{C}_1$-marks and $*\mathbb{C}_2$-marks:

$$\begin{tikzcd}
 & \vdots & \\
 & \{*\mathbb{C}_1,*\mathbb{C}_2\}_\delta \arrow[d, dash] & \\
 & \{*\mathbb{C}_\alpha\} \arrow[dl, dash] \arrow[dr, dash] & \\
\{*\mathbb{C}_1\} & & \{*\mathbb{C}_2\}
\end{tikzcd}$$

Letting ˜δ stand for any domain that is not equal to, or included in, δ, we use $\{*\mathbb{C}_1,*\mathbb{C}_2\}_{\sim\delta}$ to denote any co-occurrences of $*\mathbb{C}_1$ and $*\mathbb{C}_2$ that are not δ-local. Such co-occurrence continue to count more lightly than $*\mathbb{C}_\alpha$, resulting in the overall picture in (22). Here $\{*\mathbb{C}_1,*\mathbb{C}_2\}$ is split into two separate lists of marks: $\{*\mathbb{C}_1,*\mathbb{C}_2\}_\delta$, those cooccurring within δ, and those cooccurring anywhere else, but not within δ.

(22) Overall evaluation with δ-local interaction:

$$\begin{tikzcd}
 & \vdots & & \textit{less harmonic} \\
 & \{*\mathbb{C}_1,*\mathbb{C}_2\}_\delta \arrow[d, dash] & & \\
 & \{*\mathbb{C}_\alpha\} \arrow[d, dash] & & \\
 & \{*\mathbb{C}_1,*\mathbb{C}_2\}_{\sim\delta} \arrow[dl, dash] \arrow[dr, dash] & & \\
\{*\mathbb{C}_1\} \arrow[dr, dash] & & \{*\mathbb{C}_2\} \arrow[dl, dash] & \\
 & \{\varnothing\} & & \textit{most harmonic} \arrow[uuuuu, <->]
\end{tikzcd}$$

In current understanding, this special role of $\{*\mathbb{C}_1,*\mathbb{C}_2\}_\delta$ obtains on a language-particular basis. Given the constraint ranking (23a), the harmonic ordering of candidates (23b) is the universal default, with $\{*\mathbb{C}_\alpha\}$ being less harmonic than *any* co-occurrence of $*\mathbb{C}_1$ and $*\mathbb{C}_2$, whether δ-local or not δ-local. (23c) is the special case, which can be opted for by individual grammars.

(23) a. constraint ranking:

$\mathbb{C}_\alpha \gg \mathbb{C}_1$
$\mathbb{C}_\alpha \gg \mathbb{C}_2$

b. default ordering of candidates:

$\{*\mathbb{C}_\alpha\}$
|
$\{*\mathbb{C}_1,*\mathbb{C}_2\}$

c. special ordering of candidates:

$\{*\mathbb{C}_1,*\mathbb{C}_2\}_\delta$
|
$\{*\mathbb{C}_\alpha\}$
|
$\{*\mathbb{C}_1,*\mathbb{C}_2\}_{\sim\delta}$

But how is it that an individual grammar can make the decision between (23b) and (23c)? After all, OT-grammars have no way of directly manipulating the harmonic ordering of candidates. This happens only through constraint ranking—but no reranking of the constraints in (23a) is able to produce the effects in (23c).

One way of achieving the desired result while observing strict domination is by turning the 'worst-of-the-worst'-case (the list of violation marks $\{*\mathbb{C}_1,*\mathbb{C}_2\}_\delta$) into a new constraint by itself, written as $\mathbb{C}_1\&_\delta\mathbb{C}_2$, which can then be ranked separately by individual grammars. This is local constraint conjunction, as introduced by Smolensky (1993, 1995, 1997). Restating his proposal for our purposes, we define local constraint conjunction (LCC) as in (24).[8]

(24) Local Conjunction of Constraints (LCC)

a. Definition

Local conjunction is an operation on the constraint set forming composite constraints: Let $\mathbb{C}_1$ and $\mathbb{C}_2$ be members of the constraint set *Con*. Then their local conjunction $\mathbb{C}_1\&_\delta\mathbb{C}_2$ is also a member of *Con*.[9]

b. Interpretation

The local conjunction $\mathbb{C}_1\&_\delta\mathbb{C}_2$ is violated if and only if both $*\mathbb{C}_1$ and $*\mathbb{C}_2$ are violated in some domain δ.[10]

c. Ranking (universal)

$\mathbb{C}_1\&_\delta\mathbb{C}_2 \gg \mathbb{C}_1$
$\mathbb{C}_1\&_\delta\mathbb{C}_2 \gg \mathbb{C}_2$

$\mathbb{C}_1\&_\delta\mathbb{C}_2$ has tangible effects only when some other constraint is ranked *between* the conjoined constraint and the individual constraints $\mathbb{C}_1$ and $\mathbb{C}_2$. Otherwise, the violation marks incurred for the derived constraint redundantly reiterate the fact that the individual constraints are violated. We can say that $\mathbb{C}_1\&_\delta\mathbb{C}_2$ is *potentially active* when there is some constraint $\mathbb{C}_\alpha$ (typically, but not necessarily a faithfulness constraint militating against violations of $\mathbb{C}_1$ and/or $\mathbb{C}_2$) ranked between the conjoined constraint and at least one of the two basic constraints, such that (25) holds.

(25) $\mathbb{C}_1\&_\delta\mathbb{C}_2 \gg \mathbb{C}_\alpha \gg \mathbb{C}_1$
or
$\mathbb{C}_1\&_\delta\mathbb{C}_2 \gg \mathbb{C}_\alpha \gg \mathbb{C}_2$

As a simple illustration of the new level of explanation that local constraint conjunction makes possible within OT, consider the case of German coda devoicing, well-known from introductory phonology. Some examples appear in (26), where syllable-initial [d] in the genitive form [.ra:.dəs.], for example, alternates with syllable-final [t] in the nominative [.ra:t.] and in the diminutive [.rɛ:t.çən.].

(26) German coda devoicing (from Vennemann 1978, 178-179)

Rades	[.ra:.dəs .]	Rad	[.ra:t.]	Rädchen	[.rɛ:t.çən.]	'wheel (gen., nom., dim.)'
Bünde	[.bʏn .də.]	Bund	[.bʊnt.]	Bündnis	[.bʏnt.nɪs.]	'union (pl., sg.); alliance'
liebe	[.li:.bə.]	lieb	[.li:p.]	lieblich	[.li:p.lɪç.]	'dear (attr. , pred.); lovely'
Tage	[.ta:.gə.]	Tag	[.ta:k.]	täglich	[.tɛ:k.lɪç.]	'day (pl., sg.); daily'
Motive	[.mo .ti:.və.]	Motiv	[.mo.ti:f]	Motivs	[.mo.ti:fs.]	'motive (pl., sg., gen.)'
lesen	[.le:.zen.]	lies	[.li:s.]	lesbar	[.le:s.ba:r.]	'read (inf., imp.); readable'

The direction of the process (voiced → voiceless) is clear from the existence of nonalternating voiceless segments, which remain consistently voiceless regardless of syllable position (27).[11]

(27)

Rates	[.ra:.təs.]	Rat	[.ra:t.]	'council (gen., nom.)'
tiefe	[.ti:.fə.]	tief	[.ti:f.]	'deep (attr., pred.)'
aßen	[.a:.sən.]	aß	[.a:s.]	'(they, he) ate'

The constraint-conjunctive analysis of German Coda Devoicing[12] gives formal expression to a very simple idea: Voiced obstruents are marked elements, and syllable codas are marked positions. The phonology of German permits both, insisting on faithful parsing of the input. What is ruled out, however, is *the marked in a marked position*: a voiced obstruent as a coda. Here input voicing yields to the combined power of two markedness constraints.

The constraint-conjunctive analysis of German syllable-final devoicing appears in (29). The two basic constraints involved are the syllable structure constraint NoCoda and the segmental markedness constraint against voiced obstruents in (28). Since this constraint will play a major role throughout this work, we have assigned it a special name, namely, the Voiced Obstruent Prohibition (VOP).

(28) Voiced Obstruent Prohibition (VOP): *[+voi,−son]

The crucial step in the analysis is pictured in (29): Given NoCoda and VOP, LCC derives a new constraint NoCoda&$_\delta$VOP. This composite constraint militates against codas containing voiced obstruents.

(29)

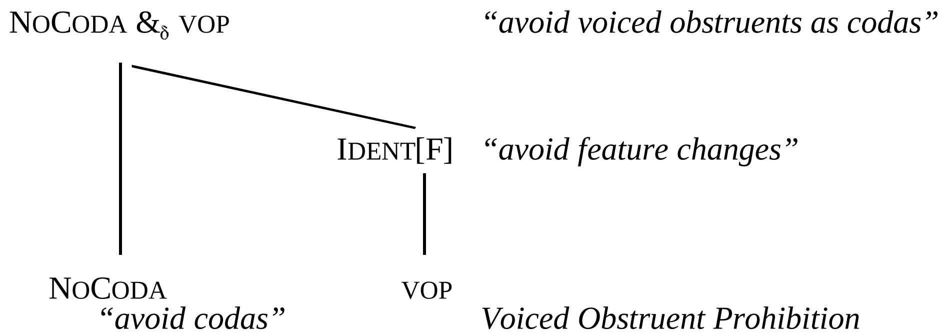
$\boxed{\text{NoCoda} \ \&_\delta \ \text{VOP}}$ (composite constraint)

↗ ↖

$\boxed{\text{NoCoda}}$ $\boxed{\text{VOP}}$ (basic constraints)

The additional factor making devoicing possible, and at the same time limiting it to coda position, is the faithfulness ranking in (30): the position of IDENT[F][13] *below* the conjoined constraint NOCODA&$_\delta$VOP and *above* the simple feature markedness constraint VOP. (In (30), informal glosses indicate the force of the constraints.)

(30)



As tableau (31) shows, this ensemble of constraints results in coda devoicing (31a), but not in onset devoicing (31b).

(31)a.

/li:b/ *lieb* 'dear, pred.'	NOCODA&$_\delta$VOP	IDENT[F]	VOP	NOCODA
.li:b.	*!		*	*
☞ .li:p.		*		*

b.

/li:bə/ *liebe* 'dear, attr.'	NOCODA&$_\delta$VOP	IDENT[F]	VOP	NOCODA
☞ .li:.bə..			*	*
.li:.pə.		*!		*

Another potential surface candidate for the input /li:b/ (31a) is [li:], which removes the coda voicing problem by eliminating the unloved coda altogether. As illustrated in the more detailed tableau (32), this candidate loses because the higher-ranking constraint MAX prohibits segment deletion (32a). The tableau also illustrates the ill-advisedness of gratuitous violations of IDENT[F] (32d), thereby protecting the onset labial from devoicing.

(32)

/bʊnd/ 'union'	Max	NOCODA&$_\delta$VOP	IDENT[F]	VOP	NOCODA
a. .bʊn.	*!			*	*
b. .bʊnd.		*!		**	*
c. ☞ .bʊnt.			*	*	*
d. .pʊnt.			**!		*

2.2 Ranking preservation

In (31a), the winning candidate and the losing candidate each violate two of the basic constraints: *.li:p.* violates NOCODA and IDENT[F], and *.li:b.* violates NOCODA and VOP. In the analysis above, the LCC (24) combines structural wellformedness (NOCODA) with segmental markedness (VOP) into NOCODA&$_\delta$VOP, a composite constraint expressing positional markedness. Let us now briefly consider the important question of whether Universal Grammar imposes any kind of limitation on the combinatory freedom of the LCC: Can literally *any* pair of constraints whatsoever form a new conjoined constraint? We will show that there is indeed good reason to impose a fundamental restriction on the operation of the LCC concerning the types of constraints that can be locally conjoined. Structural constraints can be combined with each other (as just seen for NOCODA and VOP), and faithfulness constraints can be combined with each other (resulting, for example, in a kind of maximal distance limit that is useful in the analysis of chain shifts, as shown by Kirchner 1996). However, we propose that UG should not permit the local conjunction of a faithfulness constraint with a structural constraint.

Suppose we restrict the overall theory by imposing a limit on local constraint conjunction, such that Universal Grammar does not permit conjunctive pairings of faithfulness constraints with non-faithfulness constraints.[14] The existence of such a restriction, formulated in (33), is not surprising, given the special role of the faithfulness family of constraints in OT.

(33) **Restriction on Conjoinability:** Faithfulness constraints and structural constraints cannot be locally conjoined with each other by LCC (24).

We will first show that a restriction like (33) must hold by means of a reductio argumentation. For this purpose, let us consider the following scenario that could arise if (33) did not hold. In that case, the LCC could combine structural wellformedness (e.g., NOCODA) with faithfulness (e.g., IDENT[F]) into NOCODA&$_\delta$IDENT[F], a constraint expressing position-sensitive faithfulness.

(34)

NOCODA &$_\delta$ IDENT[F] (composite constraint)

NOCODA IDENT[F] (basic constraints)

This scheme can now be expanded into the following kind of ranking configuration:

(35)

Max

NOCODA &$_\delta$ IDENT[F]

VOP

NOCODA IDENT[F]

The constraint system in (35), if valid, would produce a strange kind of markedness reversal. VOP >> IDENT[F] means that obstruents will in general appear voiceless in outputs, irrespective of input specifications. However, the conjoined constraint NOCODA &$_\Delta$ IDENT[F] outranks VOP, with the consequence that a simultaneous violation of NOCODA and faithfulness (here, by failing to preserve an input candidate's voicing) is avoided, at the cost of VOP. In other words, (35) derives a kind of 'reverse' German where voiced obstruents are admitted only in codas.

(36)a.

/li:b/ *lieb* 'dear'	Max	NOCODA&$_\delta$ *IDENT[F]	NOCODA	VOP	IDENT[F]
☞ .li:b.			*	*	
.li:p.		*!	*		*
.li:.	*!				

b.

/baɪ/ *bei* 'with'	Max	NOCODA&$_\delta$ *IDENT[F]	NOCODA	VOP	IDENT[F]
.baɪ.				*!	
☞ .paɪ.					*
.aɪ.	*!				

It is clear that, by permitting the conjunction of faithfulness constraint with structural constraints, the theory would quite generally open up the possibility of such ‘extra faithfulness’ effects in structurally marked positions, contrary to the facts. This is so because unmarked positions, such as onset vs. coda, do not accrue a structural constraint violation that could combine with a faithfulness violation in the way seen in (36).

Furthermore, if constraint conjunction could mix faithfulness and structural constraints, then the ranking of the two composite constraints NOCODA$\&_\delta$VOP and NOCODA$\&_\delta$IDENT[F] relative to each other must be determined. This leads to another reason why local conjunctions of structural constraints with faithfulness constraints, such as NOCODA$\&_\delta$IDENT[F], must not be allowed by the theory.

First, it is clear that the empirical facts of German devoicing dictate the ranking in (37), which is illustrated in tableau (38). If the ranking of the two composite constraints was the opposite, paralleling that of VOP and IDENT[F], no devoicing would occur (39).

(37) NOCODA $\&_\delta$ VOP
|
NOCODA $\&_\delta$ IDENT[F]
/ \
NOCODA   IDENT[F]
|
VOP

(38)

/li:b/ *lieb* ‘dear, pred.’	NOCODA $\&_\delta$ VOP	NOCODA$\&_\delta$IDENT[F]	IDENT[F]	VOP	NOCODA
.li:b.	*!			*	*
☞ .li:p.		*	*		*

(39)

/li:b/ *lieb* ‘dear, pred.’	NOCODA$\&_\delta$IDENT[F]	NOCODA $\&_\delta$ VOP	IDENT[F]	VOP	NOCODA
✖ .li:b.		*		*	*
.li:p.	*!		*		*

From the perspective of the overall theory, the descriptive success of (15) in (15) is an explanatory defeat, since it is bought at a high price. The ranking of the composite constraints reverses the order of the simple constraints, which is IDENT[F] » VOP (otherwise German would have no voiced obstruents at all). Schematically, we have ended up with the following situation:

(40) $\mathbb{C}_\alpha \&_\delta \mathbb{C}_2$ = VOP

$\mathbb{C}_\alpha \&_\delta \mathbb{C}_1$ = IDENT[F]

$\mathbb{C}_\alpha$ $\quad$ $\mathbb{C}_1$ = IDENT[F]

$\mathbb{C}_2$ = VOP

It is of course not inconceivable that the theory might have to live with this kind of ranking reversal, but in the interest of general considerations regarding the preservation of ranking under local conjunction, this would be a somewhat undesirable conclusion forced on us by purely descriptive considerations. A more stringent argument emerges when we adopt the hypothesis, due to Spaelti (1997, 174-175), that constraint conjunction must indeed preserve ranking, in the following sense: If constraint $\mathbb{C}_1$ dominates constraint $\mathbb{C}_2$, then the conjunction of $\mathbb{C}_1$ with $\mathbb{C}_\alpha$ must dominate the conjunction of $\mathbb{C}_2$ with $\mathbb{C}_\alpha$. Spaelti's proposal appears in (41).

(41) Universal Conjoined Constraint Ranking Hypothesis (UCCRH; after Spaelti 1997):
$\forall\ \mathbb{C}_1, \mathbb{C}_2, \mathbb{C}_\alpha \in \mathit{Con}$: IF $\mathbb{C}_1 \gg \mathbb{C}_2$, THEN $\mathbb{C}_1 \&_\delta \mathbb{C}_\alpha \gg \mathbb{C}_2 \&_\delta \mathbb{C}_\alpha$

Ranking preservation in the sense of (41) is violated in (40), and (37) is a specific instance. But (38) vs. (39) appears to show that rankings in violation of the UCCRH (41) are called for by the facts, presenting us with a conflict between theoretical restrictiveness and empirical necessity. The source of the problem here, we suggest, lies with one of the assumption made at the outset of this section, namely, that constraint conjunction is entirely free to combine all kinds of constraints with each other, including pairs consisting of a faithfulness constraint like IDENT[F] and a structural markedness constraints like NOCODA.

If we adopt the restriction on conjoinability suggested above in (33), the problematic conjoined constraint NOCODA$\&_\delta$IDENT[F] no longer exists, so the ranking issue disappears. We must leave the issue with these few remarks—this is clearly an area deserving deeper investigation.[15]

2.3 Self-conjoined markedness constraints and OCP-effects

With Local Constraint Conjunction (LCC) (24) in hand as an operation on the universal constraint set, we now turn to our main topic, the development of a markedness theory of OCP effects. Our central claim is that *there is no Obligatory Contour Principle* per se in Universal Grammar. In OCP-type dissimilation, the culprit is not the adjacency of identical feature specifications on a tier, but rather the multiple presence of a marked type of structure within the same local domain (see Alderete 1997 for further discussion of related issues). "Multiple presence" here is not the same as the standard OT-calculation of multiple violations of one constraint. Multiple violations of the markedness constraint do not simply add up, but in some sense "interact more strongly", "weigh more heavily", so that a double violation within a given domain is worse than simply the sum of two individual violations.

The remaining task is to theoretically explicate the intuitive idea that two infringements of a given constraint in some domain accrue more than just two individual violation marks. This can now be formally expressed by means of a special case of constraint conjunction (referred to as “self-conjunction of constraints” in Smolensky 1995) where the two constraints are identical (42).

(42) Self-conjunction of constraints: $\mathbb{C}_i \&_\delta \mathbb{C}_j$, with $\mathbb{C}_i = \mathbb{C}_j$
Evaluation of $\mathbb{C}_i \&_\delta \mathbb{C}_i$: $\mathbb{C}_i \&_\delta \mathbb{C}_i$ is violated in domain δ if there is more than one violation of C_i in domain δ.

A theoretical result of Spaelti’s (1997) work is relevant in this context. He shows that given his UCCRH (41), self-conjunction of constraints is ranking-preserving, in the sense that if $\mathbb{C}_1 \gg \mathbb{C}_2$, then $\mathbb{C}_1 \&_\delta \mathbb{C}_1 \gg C_2 \&_\delta \mathbb{C}_2$. The formal proof is summarized in (43). On the basis of the commutativity of local constraint conjunction, Spaelti (1997, 174-175) argues as follows:

(43)	(i)	$\mathbb{C}_1 \gg \mathbb{C}_2$	(by assumption)
	(ii)	IF $\mathbb{C}_1 \gg \mathbb{C}_2$, THEN $C_1 \&_\delta \mathbb{C}_\alpha \gg C_2 \&_\delta \mathbb{C}_\alpha$	(UCCRH, (41))
	(iii)	$C_1 \&_\delta \mathbb{C}_\alpha \gg C_2 \&_\delta \mathbb{C}_\alpha$	((i) and (ii), by modus ponens)
	(iv)	$C_1 \&_\delta \mathbb{C}_2 \gg C_2 \&_\delta \mathbb{C}_2$	((iii), setting α=2)
	(v)	$C_2 \&_\delta \mathbb{C}_1 \ll C_1 \&_\delta \mathbb{C}_1$	((iv), setting α=1)
	(vi)	$C_1 \&_\delta \mathbb{C}_1 \gg C_2 \&_\delta \mathbb{C}_2$	((iv) and (v), by transitivity)

The result is stated in (44).[16]

(44) Ranking preservation under self-conjunction
IF $\mathbb{C}_1 \gg \mathbb{C}_2$, THEN $\mathbb{C}_1 \&_\delta \mathbb{C}_1 \gg \mathbb{C}_2 \&_\delta \mathbb{C}_2$

Self-conjoining the basic markedness constraint **F* yields the composite ‘double’ constraint $*F \&_\delta *F$ (henceforth abbreviated as $F^2{}_\delta$) that prohibits the co-occurrence of *F* with itself in domain δ.[17] For the markedness constraints in (45), self-conjoined counterparts are given in (46).

(45) Basic markedness constraints (*h* = [+spread glottis]
a. **h* No aspirated segments.
b. VOP No voiced obstruents.
c. *HL No falling tone.

(46) a. *h^2 No co-occurrence of aspiration with itself.
b. VOP² No co-occurrence of voiced obstruency with itself.
c. *HL² No co-occurrence of falling tone with itself.

As with all conjoined constraints, the effects of a self-conjoined constraint $*F^2$ becomes tangible only when some other constraint $\mathbb{C}_\alpha$ intervenes in the ranking between the composite constraint $*F^2$ and the corresponding simplex constraint **F*, as indicated in (47). When this ranking scenario obtains, we observe OCP-type dissimilation effects.

(47) $*F^2 \gg \mathbb{C}_\alpha \gg *F$

The most basic and most widespread configuration of this kind obtains when the intervening constraint is a faithfulness constraint relevant for the feature specification ϕ (typically of the IDENT-variety), as in (48). When the local domain δ is a morpheme, this gives rise to OCP-effects in morpheme structure (see McCarthy 1986, 208-219 for the taxonomy of OCP-effects).

(48) $*F^2_\delta$ » Faith(F) » $*F$

As a first example, consider (45a) and (46a). Setting F=h (=[+spread glottis]) and Faith(F)=IDENT[F][18] in the scheme (48), we obtain (49).

(49) $*h^2_\delta$ » IDENT[F] » $*h$

(49) characterizes the morpheme structure restriction on aspirates in Sanskrit roots discussed above (see (13) and (14)), traditionally viewed as OCP-effect on adjacent identical specifications on the aspiration tier (see Borowsky & Mester 1983). As illustrated in (50), an underlying (hypothetical) diaspirate Sanskrit morpheme is never allowed to surface with its two aspirates since the faithful diaspirate candidate (50a) always loses on the highest-ranked self-conjoined constraint to more harmonic deaspirating candidate.

(50)

/$b^h id^h$/ (hypothetical)	$*h^2_\delta$	IDENT[F]	$*h$
a. $b^h id^h$	*!		**
b. ☞ bid^h		*	*
c. ☞ $b^h id$		*	*
d. bid		**!	

The ranking of the faithfulness constraint above the basic markedness constraint ensures that some monoaspirate candidate, either (50b) or (50c), will win over (50d). The diaspirate candidate is thus harmonically bounded by other candidates, in the sense of Prince & Smolensky (1993, 176-178). Further constraints will play a role in determining the choice between (50b) and (50c). The important point here is not which candidate will turn out to be the ultimate winner,[19] but rather the fact that a diaspirate candidate will *never* win. This derives the effects of a traditional OCP-based morpheme structure condition on the aspiration tier.[20]

In a parallel way, the obstruent voicing constraint (46b) is operative in Yamato Japanese in the morpheme structure restriction against multiple obstruent voicing ("Lyman's Law in morpheme structure") illustrated in (51), where "*v*" abbreviates [+voi, −son].

(51)

```
a.                  b.                    c.                  d.
                           v                 v                  *  v     v
                           |                 |                     |     |
C V C V             C V C V              C V C V                 C V C V
k a k i             k a g i              g a k i              (∄ g a g i)
'persimmon'         'sign'               'writing'
```

The same scenario as for aspiration in Sanskrit (see (50)) can be constructed for the Japanese case. This OCP-effect on obstruent [+voice] results from the constraint ranking in (52) (with δ=morpheme), and (53) shows the morpheme-structural blocking effect.

(52) VOP^2_δ » IDENT[F] » VOP

(53)

/gagi/ (hypothetical)	VOP^2_δ	IDENT[F]	VOP
a. gagi	*!		**
b. ☞ kagi		*	*
c. ☞ gaki		*	*
d. khaki		**!	

The interaction of the obstruent voicing constraints with other constraints in the phonology of Japanese is responsible for extended OCP-effects in the language, which will occupy us in the next section.

3. Alternations

3.1 OCP-effects and deaccentuation

A simple example where the ranking scheme in (48) has effects beyond a static morpheme structure condition is the deaccentuation phenomenon in Japanese.[21] Accent consists of a falling tonal contour represented as HL (see Pierrehumbert and Beckman (1988, 121-126) for further analysis and discussion of the differences between the accentual HL and other HL sequences). Roughly speaking, post-accentual material within a word is low, and pre-accentual material is high, except for an unaccented initial mora, which is low. Restricting ourselves here to the most central generalization, we find deaccentuation of accented suffixes after accented stems, with suffixal accent surfacing only after unaccented stems. Illustrative verbal forms appear in (54).

(54)

lexicon:	a. /ire/ 'insert'	b. /ta^{HL}be/ 'eat'	c. /ta^{HL}ra/ 'conditional suffix'

Verbal stems are either unaccented (no underlying tone, as in (54a)) or accented (i.e., with one underlying falling tone, as in (54b)). The accent of (recessive) suffixes (e.g., /-ta^{HL}ra/ 'conditional' (54c)) appears only when combined with underlyingly unaccented verb stems (*ta^{HL}betara* vs. *ireta^{HL}ra*), as shown in (55).[22]

(55)

input:	/ire + ta^{HL}ra/	/ta^{HL}be+ta^{HL}ra/
(phonological) output	H L ire + tara	H L ∅ tabetara
schematic f0-contour:		

The outcome here is in line with the general scheme of Root-Faith » Affix-Faith (see McCarthy & Prince 1995, 364).[23] In (56), the self-conjoined markedness constraint is indexed to the domain δ=PrWd.

(56) (δ = PrWd)

/ire+ta^{HL}ra/ 'insert+cond.'	$*HL^2_\delta$	IDENTTONE (root)	IDENTTONE (suffix)	*HL
☞ [ire ta^{HL}ra]				*
[ire tara]			*!	

(57)

/ta^{HL}be+ta^{HL}ra/ 'eat+cond.'	$*HL^2_\delta$	IDENTTONE (root)	IDENTTONE (suffix)	*HL
[ta^{HL}be ta^{HL}ra]	*!			**
☞ [ta^{HL}be tara]			*	*
[tabe ta^{HL}ra]		*!		*
[tabe tara]		*!	*	

This analysis has several attractive features. First, it makes better sense of the fact that unaccentedness, rather than accentedness, is the default situation in Japanese (Akinaga 1960, Katayama 1995). Accented forms are marked because they violate the constraint *HL ("no complex (falling) tone"), not because they violate the constraint *H (which is also violated in unaccented forms). This adds to Pierrehumbert & Beckman's 1988 arguments in favor of representing accent as a HL-tone (and not as H, as in Poser 1984, among others),

Secondly, the constraint $*HL^2$ ruling out multiple complex (falling) tones requires no specific assumptions about feature-geometric nodes. This is significant because, from the perspective of the classical autosegmental OCP, as in the work of Leben 1973 and McCarthy 1986, a sequence "HLHL" on the tonal tier does not manifest any adjacency of identical autosegments. In order to be able to invoke the OCP at all, further melodic structure has to be created, which can be scanned by the OCP. An obvious move is "$[HL]_\tau$ $[HL]_\tau$", where τ is a tonal node, and the sequence of identical tonal nodes $\tau\tau$ will then fall victim to the classical OCP.

If the analysis is to avoid positing extra melodic structure, representing the accent underlyingly as a simple H is attractive from the perspective of the autosegmental OCP. But, besides the considerations mentioned above, such a move runs afoul of the accent's phonetic characteristics. This was shown by Pierrehumbert & Beckman 1988, who argue that whereas tonally sparsely specified phonological output representations play a central role in a successful phonetic account of Japanese pitch contours, interestingly this does not extend to the representation of the accent itself, which is better represented as HL than as H.

3.2 Prosodic OCP-effects

The basic OCP-scheme in (58) opens up two separate dimensions of variation, determined by what kinds of constraints can occupy the position of $\mathbb{C}_i$, and $\mathbb{C}_\alpha$, respectively.

(58) $\mathbb{C}_i^2 \gg \mathbb{C}_\alpha \gg \mathbb{C}_i$

As a typology of OCP-effects, the two open parameters, $\mathbb{C}_i$ and $\mathbb{C}_\alpha$, translate as: (i) What kinds of phonological properties can OCP-effects be sensitive to? (ii) What kinds of 'processes' can be influenced by OCP-effects?

The preceding section dealt with question (ii) by showing one kind of 'process', namely, accent assignment, that is influenced by OCP effects. It is now appropriate to turn to the first question (i). OCP analyses have traditionally been restricted to segmental features, but viewed as enhanced markedness, there is no reason to expect interactions of the OCP-type to be limited in this way (see also Yip 1988). This predicts that similar dissimilation effects should be found with other marked phonological properties, including prosodic properties such as length (vs. shortness) of vowels and consonants. Constraints dealing with them should be able to occupy the position of $\mathbb{C}_i$ in (58).[24]

Examples of this kind are indeed not too hard to find, and have always been an embarrassment for the traditional feature- and tier-based OCP. Here we discuss two cases of geminate dissimilation, beginning with the 'Lex Mamilla'-effects in Latin (named after the prototypical example). As shown in (59), when affixation leads to two geminates in a word (/mamm+illa/), one of them degeminates (*ma**mm**i**ll**a* → *ma**m**i**ll**a*).[25]

(59)

mamma	'breast'	mami**ll**a	(diminutive)	*ma**mm**i**ll**a
offa	'morsel'	ofe**ll**a	(diminutive)	*o**ff**e**ll**a
saccus	'sack'	sace**ll**us	(diminutive, Vulgar Latin)	*sa**cc**e**ll**us
ob-	'aside'	o-mi**tt**ō	'lay aside'	*o**mm**i**tt**ō

A similar kind of geminate dissimilation is found in Japanese loanwords (Iwai 1989, Wade 1996). Japanese loans from English show geminate plosives after lax vowels in the source language (60).

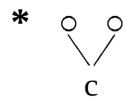
(60)

ǰippaa	'zipper'	beddo	'bed'
rakkii	'lucky'	mobbu	'mob'
purattohoomu	'(train) platform'	baggu	'bag'
hotto	'hot (coffee)'		

This rule is not followed, however, when there is another geminate later in the same word (61). In such cases, the earlier plosive appears ungeminated, even though it follows a lax vowel in the source.

(61)	*kk...tt	čike**tt**o	‘ticket’	*či**kk**e**tt**o
		poke**tt**o	‘pocket’	*po**kk**e**tt**o
				(but cf. the clipped form po**kk**e)
	*čč...kk	ootomači**kk**u	‘automatic’	*ootoma**čč**i**kk**u
	*čč...pp	keča**pp**u	‘ketchup’	*ke**čč**a**pp**u
	*pp...tt	mape**tt**o	‘Muppet’	*ma**pp**e**tt**o
	*pp...kk	maikurosukopi**kk**u	‘microscopic’	*maikurosuko**pp**i**kk**u
	*kk...kk	pikuni**kk**u	‘picnic’	*pi**kk**uni**kk**u

The basic analysis of geminate dissimilation in words related to “double-geminate” source words can be achieved by appealing to both the simple and the self-conjoined versions of the anti-geminate constraint (62), with the mora-preservation constraint IDENT-μ (63) ranked in between, as shown in (64).

(62) NO-GEMINATE: 

(63) IDENT-μ: If xRy, then μ(x)= μ(y) (where μ(α) denotes the moraic value of α, and R any correspondence relation)
“*n*-moraic elements correspond to *n*-moraic elements.”

(64) Ranking: NO-GEMINATE² » IDENT-μ » NO-GEMINATE

A full analysis of gemination in Japanese loanwords, which is beyond the scope of this work, requires some additional details to be worked out.[26] The general outlines of the analysis are clear enough, however, to permit us to conclude that it is an advantage of the new markedness-based conception of the OCP, embedded within Optimality Theory, that it can capture such cases involving the dissimilation of prosodic properties without special pleading, and without making special assumptions about the geometry of phonological representations, which are unlikely to enjoy much independent support.[27]

3.3 Rendaku and OCP-effects on voicing

As an example of another process that is crucially influenced by OCP-effects, we turn to the compound voicing process in Japanese. In chapter 2, we showed how the reduction of the OCP to locally enhanced markedness (65) allows for a succinct analysis of the obstruent voicing restriction in Yamato Japanese.

(65) VOP² (no double obstruent voicing)

This is shown in (66) (repeated after (52), where δ=morpheme; we focus henceforth on the case where the morpheme in question is a stem).

(66) VOP^2_δ (no double obstruent voicing in domain δ)

|

IDENT[F] (no change of feature values)

|

VOP (no obstruent voicing)

For native (Yamato) stems, this constraint ranking captures what is traditionally referred to as Lyman's Law (67).[28]

(67) *Lyman's Law:* "Stems must not contain more than one voiced obstruent."

The account in (66) is in central ways superior to the analysis in Ito & Mester 1986, which is based on the twin assumptions of tier adjacency and underspecification: *[+voi][+voi], on a voicing tier where only obstruent voicing is represented.

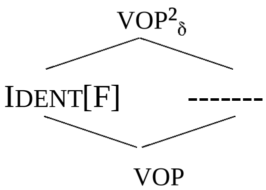
In the new conception of OCP-dissimilation, Lyman's Law is not a constraint on double occurrences of the feature specification [+voice] by itself. Multiple voiced segments do not necessarily lead to an especially marked situation, as any survey of phonological segment inventories (see e.g. Maddieson 1984) and phonological processes reveals. What matters is rather *obstruent* voicing: the feature combination [+voi, −son], which is ruled out by the VOICED OBSTRUENT PROHIBITION (VOB). In a roundabout way, the underspecification-cum-tier-adjacency account manages to home in on obstruent voicing by means of [+voice]: by systematically underspecifying all sonorant voicing, making it transparent for putative general [+voice]-dissimilation. But the underspecification comes at a high price—among other things, it blurs the distinction between contrastiveness and segment markedness (a point emphasized by Steriade 1995, 146-147; see also Smolensky 1993).

Since OCP-type dissimilation, in this new understanding, is no longer based on tier adjacency of feature specifications, but on segment markedness, we do not expect it to be limited to single features (or to distinctive features at all, as opposed to prosodic properties, see section 3.2 above and Alderete 1997). By the same token, there is also no motivation here for abolishing distinctive feature theory as a whole, by importing all kinds of low-level phonetic distinctions involving physiological, aerodynamic and acoustic properties of the human vocal tract directly into the grammar. This much larger set might easily include a single property (such as [+pharyngeally expanded], see Steriade 1995, 156) that could be said to be subject to OCP-dissimilation. However, the search for a single unitary property would be pointless, from the standpoint of the OCP-as-markedness, since for the computations of phonology as a cognitive system., a composite property like [+voi,−son] is entirely sufficient.

In this view, it is not phonology's business to uncover the phonetic bases of markedness, by attempting to answer, for example, the question *why* voiced obstruents are difficult. These are genuinely phonetic questions, ultimately to be answered by the natural sciences. Phonology deals with the grammatical *representation* of this difficulty in terms of markedness (expressed by constraints) and with *computations* based on markedness. This is where constraint ranking, constraint conjunction, and other formal grammatical devices play a central role.

We will now show how the account in (66) of the basic OCP-effect can be further developed to capture extended OCP-effects, as they are encountered in Japanese in the interaction of Lyman's Law with the compound voicing alternation phenomenon known as Rendaku (*ren* 'sequence', *daku* 'voice'). The phonology of Japanese presents us with evidence that another constraint, besides the faithfulness constraint IDENT[F], is intercalated in the ranking between VOP^2_δ and VOP, as informally indicated in (68).

(68)



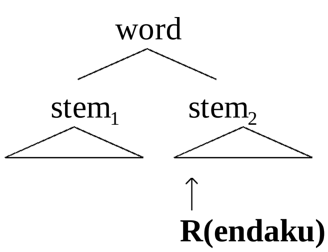
The constraint in question, here stated informally in (69), is responsible for the occurrence of Sequential Voicing (Rendaku) on initials of second compound members, with further morphological restrictions not germane to the discussion here (we return to these issues in chapter 5).

(69) SEQVOI: "Initials of second compound members should be voiced."
(or: "... should not be voiceless.")

We return to the exact nature of SEQVOI (69) at the end of this chapter, but for now we will use (69) as a descriptive stand-in, in order to be able to focus the discussion on its interaction with the markedness effects. We also take the liberty of using the term "Rendaku" and its translation "Sequential Voicing" interchangeably in referring generally to the voicing phenomenon, and use SEQVOI as the name of the constraint.

In a compound word (70), SEQVOI (69) affects stem_2, requiring the initial segment to be voiced, as exemplified in (71).

(70)



(71)	/natsu + sora/	→ natsu + zora	'summer sky'
	/kawa + hata/	→ kawa + bata	'river bank'
	/otome + kokoro/	→ otome + gokoro	'maiden heart'
	/sakura + matsuri/	→ sakura + matsuri	'cherry blossom festival'

In order for Rendaku to take place at all, SEQVOI (69) must dominates VOP, the simple markedness constraint against voiced obstruents, as shown in (73).

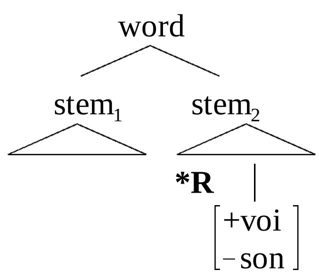
(72) SeqVoi » VOP

(73)

/natsu + sora/	SeqVoi	VOP
☞ [natsu + zora]		*
[natsu + sora]	*!	

Compound voicing shows extended OCP-effects in situations where stem_2 already contains a voiced obstruent (74).

(74)



In such cases, Rendaku Voicing is systematically absent (75) (“is blocked by Lyman’s Law”, in traditional terminology).

(75)	/šima + he**b**i/	→ šima + he**b**i	*šima+**b**e**b**i	‘island snake’
	/mori +so**b**a/	→ mori +so**b**a	*mori+**z**o**b**a	‘soba serving’
	/iwa + ha**d**a/	→ iwa + ha**d**a	*iwa+**b**a**d**a	‘rock surface’
	/onna + koto**b**a/	→ onna + koto**b**a	*onna+**g**oto**b**a	‘women’s speech’

The facts in (75) require the ranking in (76): avoiding two or more voiced obstruents in the domain of a stem is more important than obeying the compound voicing requirement.

(76) VOP^2_δ » SEQVOI

Illustrating the fundamental interactions between these constraints, tableau (77) shows how the double violation of the simple voicing constraint (VOP), ranked below SEQVOI, leads to a violation of the self-conjoined constraint (VOP^2_δ), which in turn forces the violation of SEQVOI.

(77)

/mori +soba/	VOP^2_δ	SeqVoi	VOP
[mori + zoba]	*!		**
☞ [mori + soba]		*	*

Putting together all the constraints so far considered, we end up with (78), where SEQVOI occupies the open position indicated in (68) above. This is responsible for the extended OCP-effects seen in compound voicing.

(78)

$$
\begin{array}{ccc}
 & \text{VOP}^2_{\delta} & \\
\text{IDENT[F]} & & \textbf{SeqVoi} \\
 & \text{VOP} &
\end{array}
$$

3.4 Rendaku as a junctural morpheme

Before concluding this section, we return to the issue that was left unresolved earlier, namely, the Rendaku condition "SEQVOI". What is the status of the constraint (69) (repeated below in (79)) that give rise to Rendaku voicing?

(79) SEQVOI: "Initials of second compound members should be voiced."

(79) simply demands the presence of voicing in a certain morphological context, and there is little doubt that it is only a stand-in, waiting for further analysis (see A.1 in the appendix for a discussion of what is at stake here). For the purposes of this study, we adopt the suggestion in Ito & Mester (1986, 57) to encode Rendaku voicing as a morpheme in itself, occupying a position in the input representation. This is shown in (80) (where the linking [voi] morpheme is mnemonically denoted by 'ρ'):

(80) [yoko] + $[\text{voi}]_{\rho}$ + [tsuna] → yokodzuna 'horizontal rope' (lit.), i.e. 'sumō wrestler of the highest rank'

Treating ρ as a prefix to the second compound member, the input structure looks approximately as follows:

(81)

word

stem_1 stem_2

yoko ρ + tsuna

[voi]

This type of analysis assimilates Rendaku voicing to other junctural phenomena, such as the junctural -*s*- in German compounds.[29] In order to ensure Rendaku voicing in the right circumstances, the morpheme ρ must be parsed (i.e., its voicing specification realized), provided this does not lead to a violation of Lyman's Law, i.e., of $\text{VOP}^2_{\text{Stem}}$. In other words, the constraint REALIZE-MORPHEME (or some other constraint that is violated when a certain morpheme has no output exponent whatsoever) takes the role of the place holder "SEQVOI" in the ranking hierarchy developed in the previous chapter. Instead of (77), the complete analysis is (82):

(82)

/mori + $[voi]_\rho$ +soba/	VOP$^2_{Stem}$	Realize-Morpheme	VOP
mori + zoba $[voi]_\rho$	*!		**
☞ mori + soba		*	*

The compound voicing pattern is morphologically encoded in the input to the phonology—an abstract voicing morpheme located at a specific position.

This line of approach promises to uncover some interesting generalizations along strictly morphological lines—for the case at hand, we might expect to recognize cross-linguistic generalizations about junctural morphemes, expressed in terms of properties of abstract input markers like $[voi]_\rho$. Since the typology of morphemes is not based on phonological properties (an instance of *l'arbitraire du signe*), juncture markers do not constitute a natural class in phonological terms. They include a phonologically heterogeneous class of elements such as segmental features (like voicing), suprasegmentals such as tone and stress (i.e., melodic elements and metrical structure), gemination processes, as in Malayalam (Mohanan 1986), segments identifiable with case markers (German compounds), etc.

For the rest of this study, we adopt the analysis seen in (82). However, in order to avoid unnecessary clutter in tableaux, we will not indicate the voicing morpheme in each input, and as a placeholder for the REALIZEMORPHEME constraint seen in (82), we will continue to use the label "SEQVOI", as before, but now understood as a compact reference to input morpheme + PARSE constraint (for discussion of an alternative, see section A.1 in the appendix).

4. Domains

4.1 Local domains

A phonologically valid conjoined constraint must be linked to a domain in which the violations of the individual constraints interact. For the coda-devoicing case discussed in chapter 2, the local domain for the conjoined constraint "NOCODA&$_\delta$VOP" is the coda consonant. The significance of the local interaction domain is shown in (83). Even though both [li:b] (83a) and [baɪl] (83c) incur a VOP violation and a NOCODA violation, only the former incurs the conjoined constraint violation because the offending voiced obstruent is itself *in* the offending coda position.

(83)

			NOCODA&$_\delta$VOP	IDENT[+voi]	VOP	NOCODA
/li:b/ lieb 'dear, pred.'	a.	.li:b.	*!		*	*
	b. ☞	.li:p.		*		*
/baɪl/ Beil 'hatchet'	c. ☞	.baɪl.			*	*
	d.	.paɪl.		*!		*

The local domain δ that is chosen by a particular conjoined constraint is one of a small number of domains otherwise encountered in phonology. It is either an element of the hierarchy of prosodic categories (phonological phrase, prosodic word, foot, syllable, ending with the segment), or a syntactic-morphological category such as stem or (morphological) word. Self-conjoined constraints are no different in this respect, every self-conjoined markedness constraint $*F^2$ needs to be linked to a domain. For example, a voiced aspirate in a neighboring word does not violate the self-conjoined aspirate constraint in Sanskrit (see (50) above) — it is only when the two aspirates are in the same stem that it becomes relevant.[30]

The domain issue often does not play a major role in OCP-related discussion, because the whole form under evaluation is tacitly assumed to be the default domain. For the analysis of Rendaku, however, the domain of the self-conjoined voicing constraint is critical, because it is crucially *not* coextensive with the whole form under evaluation. Rendaku voicing is precluded by the presence of a voiced obstruent in the second stem (84a), but not by one in the first stem (84b).

(84) a.	/šima + he**b**i/	→ šima + he**b**i	*šima+**b**e**b**i	'island snake'
	/mori +so**b**a/	→ mori +so**b**a	*mori+**z**o**b**a	'soba serving'
	/onna + koto**b**a/	→ onna + koto**b**a	*onna+**g**oto**b**a	'women's speech'
b.	/ta**b**i + hito/	→ ta**b**i + **b**ito		'travelling person'
	/ha**d**a +samui/	→ ha**d**a + **z**amui		'skincold'
	/koto**b**a +tsukai/	→ koto**b**a + **dz**ukai		'speaking manner, wording'

Thus, Lyman's Law is an OCP effect on obstruent voicing *within stems* (compare **šima+**beb**i* vs. *ta**b**i+**b**ito*) — in our terms, the relevant self-conjoined voicing constraint VOP$^2_\delta$ discussed in the chapter 3 chooses the stem as its domain of locality (85).

(85)

		VOP$^2_\delta$, δ=Stem	SeqVoi	VOP
/tabi +hito/	a. ☞ [ta**b**i + **b**ito]			**
	b. [ta**b**i + hito]		*!	*
/šima +hebi/	c. [šima + **b**e**b**i]	*!		**
	d. ☞ [šima + he**b**i]		*	*

Although both (85a) and (85c) incur two violations of VOP, only (85c) incurs a violation of the stem-domain constraint, since neither the first nor the second stem in (85a) contains a double VOP violation by itself.

4.2 Implications of domain indexation

In this section, we will present a significant result of a theory positing multiple domain indexations for conjoined constraints: Different rankings of the individual indexed constraints with respect to other constraints give rise to different grammars.

Empirical support for this approach can be found in a concrete example from the history of Japanese. Citing work by Ramsey & Unger 1972 and Miyake 1932, and referring to Ishizura Tatsumaro's *Kogen seidaku kō* (1801) as the original source of the observation, Unger (1975, 8–9) reports the existence of a strong version of Lyman's Law in Old Japanese, where "[...] *rendaku* also did not take place if the first morpheme contained a voiced obstruent."

This means that the Old Japanese counterparts of (84) (with voiced obstruents in stem$_1$) did not undergo Rendaku. (86) summarizes the Rendaku situation in Old Japanese vs. Modern Japanese.

(86)

In [[stem$_1$] [stem$_2$]]:	no voiced obstruent	voiced obstruent in		
		stem$_1$	stem$_2$	stem$_1$ and stem$_2$
Old Japanese	*Rendaku*	▸*No Rendaku*	*No Rendaku*	*No Rendaku*
Modern Japanese	*Rendaku*	▸*Rendaku*	*No Rendaku*	*No Rendaku*

Some tendencies about Rendaku avoidance noted by Sugito 1965 and by Sato 1988 can be interpreted as remaining lexicalized reflexes in Modern Japanese of such a strong version of Lyman's Law. Rendaku is fairly regularly observed in family names, most of which are lexicalized compounds: Thus *kita* 'north' + *kawa* 'river' yields the name *Kitagawa*, *kuro* 'black' + *ta* 'field' yields *Kuroda*, etc. In names like *kita* 'north'+ *kubo* 'hollow place' → *Kitakubo*, we find the usual lack of voicing due to the presence of *b* in $stem_2$. Besides such expected cases, compound voicing is often absent in names in an apparently idiosyncratic way, as shown by examples like *Hosokawa* 'thin river' (cf. *Kitagawa* above). Such idiosyncratic lack of Rendaku, which is also found in the general vocabulary and testifies to the fact that compound voicing is inherently morphological in nature (a voicing morpheme, see chapter 3), is particularly characteristic of names. Sugito 1965 makes an interesting observation about such apparently idiosyncratic lack of Rendaku in names: It is frequently found in cases where the first part of the name contains a voiced obstruent, leading to contrasts as in (87), where [t] in *Shibata* and *Kubota* (87b) contrast with [d] in *Imada* and *Yamada* (87a).

(87) Reflexes of the strong version of Lyman's Law in names (Sugito 1965):

a.	/ima+ta/	→	ima+da
	/yama+ta/	→	yama+da
b.	/šiba+ta/	→	šiba+ta
	/kubo+ta/	→	kubo+ta

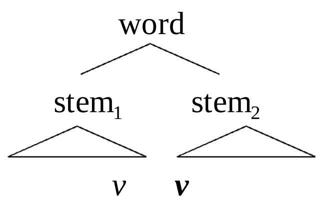
Listed in (88a–c) are other groups of related compounds where lack of Rendaku correlates with the presence of a voiced obstruent in $stem_1$.

(88)a.	/taki+hi/	→	taki+bi	'firewood'	
	/morai+hi/	→	morai+bi	'catch fire'	
but:	/tobi-hi/	→	tobi+hi	'flying sparks'	*tobi-bi
b.	/iči+tsukeru/	→	iči+dzukeru	'put into position'	
	/na+tsukeru/	→	na+dzukeru	'give a name to'	
but:	/kizu+tsukeru/	→	kizu+tsukeru	'give a wound to'	*kizu+dzukeru
c.	/naka+kanna/	→	naka+ganna	'middle plane (tool)'	
	/maru+kanna/	→	maru+ganna	'round plane'	
but:	/šiage+kanna/	→	šiage+kanna	'finishing plane'	*šiage+ganna
	/mizo+kanna/	→	mizo+kanna	'groove plane'	*mizo+ganna

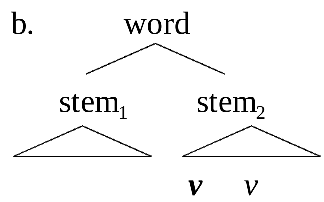
In Modern Japanese, these effects of a voiced obstruent in $stem_1$ are no more than lexical idiosyncrasies that are, historically speaking, remnants of a much more pervasive pattern.
In the modern language, Rendaku is blocked by a voiced obstruent in $stem_2$, but not by a voiced obstruent in $stem_1$ (see (86)). But in Old Japanese, Rendaku-blocking is done by a voiced obstruent either in $stem_2$ or in $stem_1$. It is important to note that the third logical possibility, in which Rendaku would be blocked by a voiced obstruent in $stem_1$ but not by one in $stem_2$, is not attested. In understanding the difference between the applicability of Lyman's Law in Old Japanese and Modern Japanese, this shows that our attention should *not* be grounded on the linear

array of morphemes (i.e., stem_1 and stem_2), but should rather be focused on the hierarchical organization where *stem*s are included in the higher *word* domain.

(89) a.



b.



The crucial point is illustrated schematically in (89), where "*v*" stands for [+voi, −son] and the Rendaku-derived voicing is indicated by bolding. A word-domain OCP violation is incurred when either stem_1 or stem_2 contains a voiced obstruent (89ab) — the situation in Old Japanese; but a stem-domain violation is only incurred with a voiced obstruent in stem_2 (89b) — the Modern Japanese situation. Note that this hierarchical conception immediately explains the nonexistence of the third logical possibility, in which a voiced obstruent in stem_1 (but not in stem_2) blocks Rendaku. Since stems are always included in a word domain, a stem-domain OCP-violation always implies a violation in the word domain.

In these terms, Unger's (1975) 'strong version of Lyman's Law' can be understood as the self-conjoined constraint VOP specified for the domain δ=word in Old Japanese, which blocks Rendaku even when the voiced obstruent is in stem_1.

(90) Old Japanese ranking ('strong version of Lyman's Law')

$\text{VOP}^2_{\text{Word}} \gg$ SeqVoi

Effect: Rendaku is blocked when either stem_1 or stem_2 contains a voiced obstruent.

(91) Modern Japanese ranking (repeated from (76) above)

$\text{VOP}^2_{\text{Stem}} \gg$ SeqVoi

Effect: Rendaku is blocked only when stem_2 contains a voiced obstruent.

The relevant change from Old Japanese (90) to Modern Japanese (91) may appear to be one of domain specification for the self-conjoined constraint from word to stem, but this is not a coherent perspective in OT, where constraints are universal. Both the stem and word version must be part of the grammar of Old Japanese as well as of Modern Japanese. The different domain versions exist in every grammar, and 'inapplicability' only means 'low ranking'. Language change is viewed as reranking of a constraint, which appears to lose or gain its strength.

Thus, more precisely, the relevant change from Old Japanese (92) to Modern Japanese (93) is that the Sequential Voicing is promoted to a position above the word-domain version of the self-conjoined VOP constraint.

(92) Old Japanese constraint ranking

VOP^2_{Stem}

|

VOP^2_{Word}

|

SeqVoi

|

VOP

(93) Modern Japanese constraint ranking

VOP^2_{Stem}

| |

SeqVoi

|

VOP^2_{Word}

|

VOP

The tableaux below illustrate the relevant difference between Old and Modern Japanese, highlighting the position of the word-domain constraint.

(94) /tabi + hito/ 'traveller' /šima +hebi/ 'island snake'
a. Modern Japanese

		VOP^2_{Stem}	SeqVoi	VOP^2_{Word}	VOP
/tabi +hito/	☞ **[tabi+bito]**			*	**
	[tabi+hito]		*!		*
/šima +hebi/	[šima +bebi]	*!		*	**
	☞ **[šima+hebi]**		*		*

b. Old Japanese (hypothetical forms modeled on Modern Japanese)

		VOP^2_{Stem}	VOP^2_{Word}	SeqVoi	VOP
/tabi +hito/	[tabi+bito]		*!		**
	☞ **[tabi+hito]**			*	*
/šima +hebi/	[šima +bebi]	*!	*		**
	☞ **[šima+hebi]**			*	*

4.3 Locality ranking and violation ranking

The constraint system that has been motivated so far includes two hierarchies of intrinsically ranked constraints: (i) violation ranking, in terms of the number of violations (95), and (ii) locality ranking, in terms of the domain (96).

(95) Violation ranking: $\ldots \gg *\phi^{n+1} \gg *\phi^{n} \gg *\phi^{n-1} \gg \ldots$ e.g.,

$$\begin{array}{c} *\phi^3 \\ | \\ *\phi^2 \\ | \\ *\phi^1 \end{array}$$

A basic (or 1-level) constraint is ranked lower than the corresponding self-conjoined (2-level) constraint, which, in turn, is lower than the triply self-conjoined constraint, and so on. The intrinsic ranking holds when the domain is kept constant — a violation of a higher-ranking constraint will always imply a violation of the lower-ranking constraint, but not vice versa.

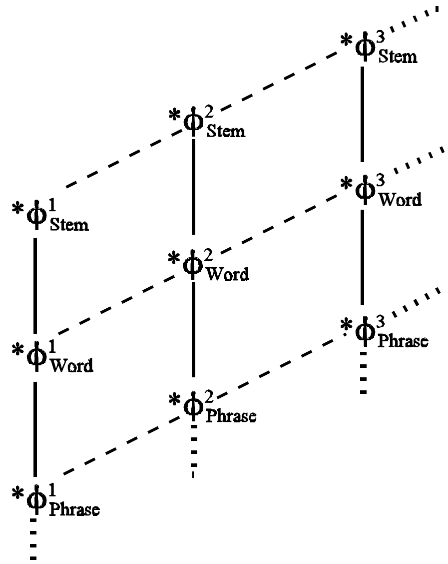
The second kind of intrinsic ranking is locality ranking.[31] Because the relevant domains are in a hierarchical inclusion relation, such as *word* ⊃ *stem*, whenever some constraint $*\phi$ is violated within a stem, it is necessarily also violated within a word, but not vice versa: The smaller the domain, the stronger the interaction. This is captured by the ranking in (96).

(96) Locality ranking: $\ldots \gg *\phi_{\text{domain } n+1} \gg *\phi_{\text{domain } n} \gg *\phi_{\text{domain } n-1} \gg \ldots$ e.g.,

$$\begin{array}{c} *\phi_{Stem} \\ | \\ *\phi_{Word} \\ | \\ *\phi_{Phrase} \end{array}$$

In sum, violation ranking (95) and locality ranking (96) together determine a constraint grid[32] of the following form:[33]

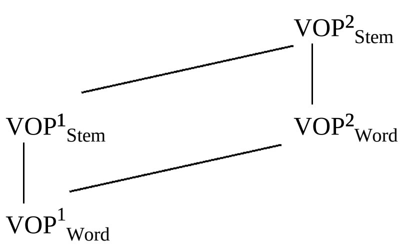
(97)



The constraint grid brings out in a clear way the preservation of constraint ranking under self-conjunction: If C_a » C_b, then $(C_a)^n$ » $(C_b)^n$ (Spaelti 1997).

For the case of Japanese obstruent voicing, we have seen in the previous section that number-of-violations ranking (1 vs. 2) and locality ranking (stem vs. word) visibly interact in intricate but systematic ways. The relevant family of voicing constraints is depicted in (98).

(98)



The constraint that has been referred to as "VOP" is more precisely a 1-level, word domain constraint, namely, VOP$^1_{Word}$ — we will continue to simply refer to it as VOP, assuming 1 as the unmarked default level, and "word" as the default domain (i.e., the whole form under evaluation for the case of Rendaku).

5. Structure

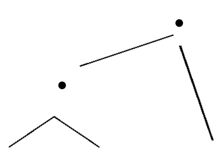
OCP-effects, as results of locally self-conjoined markedness constraints, reflect the markedness inherent in phonetic/phonological content. At the same time, they are intimately linked to grammatical structure through the theory of domains, in which the hierarchy of grammatical constituents (stem, word, etc.) provides one of the crucial ingredients. As we saw in the preceding chapter, details of morphological structure can become relevant for the particular way in which OCP-type dissimilations and related phenomena play out in larger word structures.

In this chapter, we will cast a closer look at some of the issues involved in the assignment and phonological interpretation of morphological structure. On the theoretical side, we present a specific optimality-theoretic version of an economy-based approach to morphological structure assignment. We will find empirical support for the proposal as we continue with the main analytical focus of this work, and turn our attention to issues raised by the phonology of complex compounds in Japanese. We will show that the restrictions on Rendaku in certain types of branching structures bear on important questions regarding theories of word structure, morphological accessibility, analogical relations, as well as the syntax-phonology interface.

5.1 Minimal structures and their phonological consequences: economy vs. uniformity

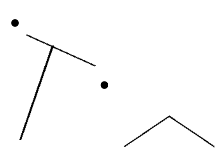
In any theory of word structure, the formation of compounds and other complex morphological objects requires at the very least two pieces of information, namely, (i) the elementary lexical objects, and (ii) their semantic grouping structure, including the head/nonhead distinction. The grouping structure is critical, as shown by the German example in (99) (from (Wiese 1996), where the two grouping structures of the structurally ambiguous three-member compound *stadt-planungs-büro* are shown.

(99) a.



[[stadt - planungs] - büro]
'office for city planning'

b.

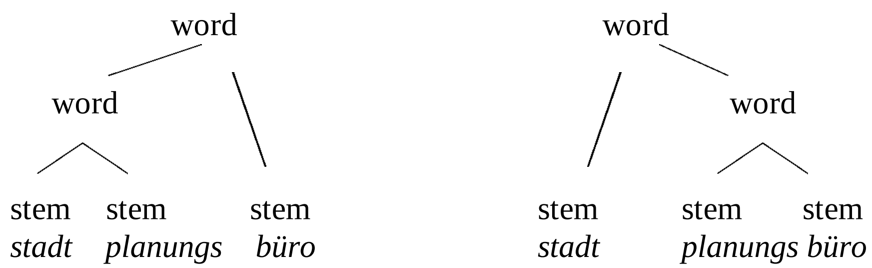


[stadt - [planungs - büro]]
'planning office of the city'

These structures contain two distinct types of objects: terminal elements (*stadt* 'city', *planung* 'planning', *büro* 'office') and nonterminal elements indicated by the dots (i.e, *stadtplanung* (99a), *planungsbüro* (99b), and *stadtplanungsbüro* (99ab)).[34] We will refer to the terminal elements (lexical objects) as "stems", and to the nonterminal elements (the morphologically derived objects) as "words". The labeled structures are given in (101).

(100) "stem" = terminal element (lexical object)
"word" = nonterminal element (morphologically derived object)

(101) a. b.

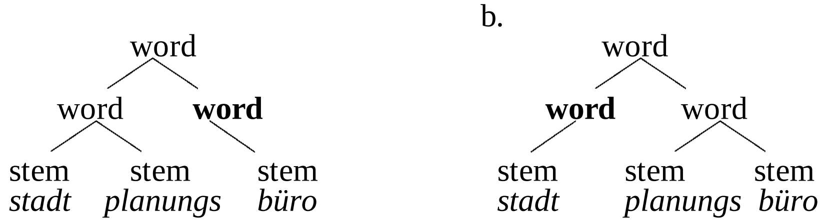


From the viewpoint of a standard theory of word structure (for example, Selkirk 1982, 53), the structures in (101) look anomalous because they violate a widely-held assumption regarding uniformity of compound sisters, here stated as a principle in (102).[35]

(102) UNIFORMITY: Sister constituents in compounds are of the same structural level.

In order to conform to UNIFORMITY, the structures in (101) would have to minimally be changed as in (103), where the bolded *word* nodes are added so that word and stem are no longer sisters.

(103) a. b.



In avoiding a violation of UNIFORMITY, however, the structures in (103) have introduced an extra intermediate nonbranching node that is not warranted by the grouping structure (nor, of course, by the lexical elements). In fact, the structures in (103) now violate a different optimality-theoretic principle, namely, *STRUC (Prince & Smolensky 1993, Zoll 1993), a structural economy principle which bans any structure altogether, with an overall effect of minimizing structure.[36]

(104) *Struc: All structure is disallowed.

If *STRUC » UNIFORMITY holds, then the nonuniform structures in (101) arise, and the opposite ranking UNIFORMITY » *STRUC results in the uniform structures in (103). Illustrated in tableau (105) is the structure-minimizing ranking "*STRUC » UNIFORMITY", which, as will be argued below, must be the correct one for regular compounding in German (as well as in Japanese).

(105) *STRUC » UNIFORMITY

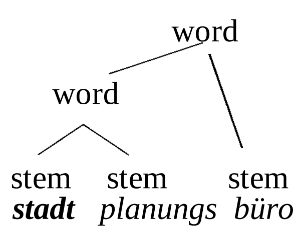
[[Stadt-planungs]-büro] [[‘city’ ‘planning’] ‘office’]	*Struc	Uniformity
a. word ☞ word stem stem stem *stadt planungs büro*		*
b. word word word stem stem stem *stadt planungs büro*	*!	

In (105b) the non-branching non-terminal *word* node (dominating the single stem *büro*) leads to the crucial extra violation of *STRUC,[37] and the UNIFORMITY-violating structure (105a) comes out as the winner: the pressures of structural economy are thus stronger than the preference towards compound uniformity.[38]

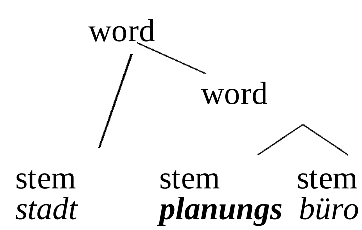
There is no intrinsic reason that *STRUC (104) must be ranked over UNIFORMITY (102), and indeed it appears that the opposite ranking UNIFORMITY » * STRUC is called for in other languages (as in Malayalam and Vedic compounding, see Han 1994).[39]

The evidence for the economy-observing structures in German compounds comes from the stress facts (Giegerich 1985, Wiese 1996). The difference in grouping structure has phonological consequences in that the location of primary stress (bolded in (106)) depends on the internal structure. As Wiese (1996, 298) points out, this is an instance of Liberman & Prince’s 1977 classic branchingness-sensitive generalization on compound stress: “The right node is strong if and only if it branches; otherwise the left node is strong”.

(106) a.

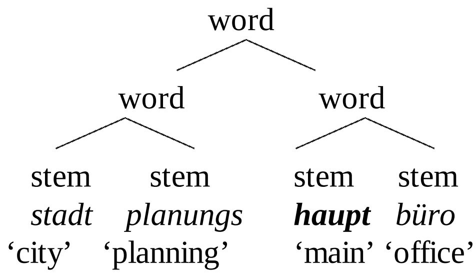


b.



cf. also	[[**fuß** ball] feld]	[regierungs [**ober** rat]]
	‘foot’ ‘ball’ ‘field’	‘government’ ‘higher’ ‘councillor’
	[[**welt** bank] konferenz]	[landes [**zentral** bank]]
	‘world’ ‘bank’ ‘conference’	‘state’ ‘central’ ‘bank’
	[[**rechen** zentrums] leiter]	[universitäts [**rechen** zentrum]]
	‘computing’ ‘center’ ‘director’	‘university’ ‘computing’ ‘center’

(107)



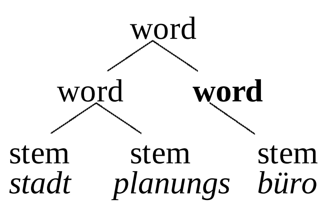
Cf. also [[welt bank][**rechen** zentrum]]
'world' 'bank' 'computing' 'center'
[[recht schreibungs][**blitz** wörterbuch]]
'orthography' 'speed' 'dictionary'

The structures in (106), which result from *STRUC » UNIFORMITY, make it possible to state the generalization regarding main compound stress in edge-based terms by a combination of finality and initiality, as in (108).

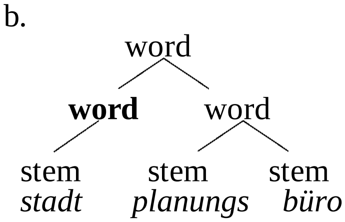
(108) German compound stress falls on the *rightmost* word-*initial* stem.

In (106a) only one stem (*stadt*) occupies word-initial position. In (106b) and (107), two different stems occupy word-initial position, and stress falls on the rightmost one. It is remarkable that this simple statement regarding the compound stress position (108) is not possible with uniform compound structures, which would result from UNIFORMITY » *STRUC, as shown in (109) (repeated from (103)).

(109) a.



b.



In these uniform compound structures, *büro* in (109a) is the sole stem in the second word constituent (hence also occupying word-initial position), and would wrongly qualify as the stress-bearer by being the "rightmost word-initial stem". The condition on German compound stress would have to involve direct reference to branchingness in morphological structure—an undesirable option in a restrictive theory of syntax-phonology interface conditions (see Selkirk 1980, 1984, Nespor & Vogel 1986, and the papers in Inkelas & Zec 1990). The edge-based condition (108), on the other hand, finds an appropriate analysis in Alignment Theory (McCarthy & Prince 1993) along the lines of more recent work on the syntax-prosody interface in Optimality Theory (Selkirk 1995, Truckenbrodt 1995, 1997). Details aside, what is important here is that a simple and explanatory account of compound stress presupposes economy-based compound structures with violations of Uniformity.[40] The next section will show that the same holds for complex compounds in Japanese with multiple Rendaku-induced voicing.

5.2 Structural conditioning of Rendaku in complex compounds

The blocking of voicing, via the OCP, in simple stems is the aspect in Ito & Mester 1986 that attracted most of the attention in the subsequent literature (e.g., McCarthy 1986, Steriade 1987, Mester & Ito 1989, Kenstowicz 1994, among others). In the original paper, however, a second aspect of the operation of Rendaku occupied center stage, namely an apparently unrelated failure of Rendaku in a particular type of longer compounds, namely, right-branching compounds, as first noted in Otsu 1980. In strictly left-branching compounds like (110), Rendaku applies throughout because all the relevant stems are on right branches.

(110)

kawa hata	kawa hata toori	kawa hata toori soi
↓	↓ ↓	↓ ↓ ↓
b	b d	b d z
'river bank'	'(river bank) street'	'((river bank) street) side'

On the other hand, the minimal pair *nise-zakura-matsuri* (111a) and *nise-sakura-matsuri* (111b) shows Rendaku-voicing when *sakura* occupies a right branch at the lowest level of compound structure (111a), but not when it occupies a left branch (111b). Just as in the case of German complex compounds, whether the compound is left-branching or right-branching has phonological consequences.

(111)

	a.	b.
	((nise **s**akura) matsuri)	(nise (**s**akura matsuri))
	↓	↓̸
	z	*z
	'((fake cherry-blossom) festival)'	'(fake (cherry-blossom festival))'
	'festival for fake cherry-blossoms'	'fake festival for cherry blossoms'

Ito & Mester 1986 propose that the branching restriction follows from the general way in which phonology and structure interact in Lexical Phonology (Kiparsky 1982, 1985), with general markedness principles carrying the main burden. More specifically, the cyclicity of Rendaku and Lyman's Law, the latter being an instantiation of the OCP operating on an underspecified voicing tier, is argued to be the crucial operative factor.

In the present context, it is appropriate to take a fresh look at the phenomenon. We will argue, in general agreement with the mainstream of work on the syntax-phonology interface (Selkirk 1980, 1984, Nespor & Vogel 1986, and the papers in Inkelas & Zec 1990) that there is no direct reference in phonology to syntactic/morphological branching, c-command-relations, etc. This fundamental assumption forestalls any analysis, such as the one presented in Otsu 1980, which simply attaches a "right branch" clause (or equivalently, an appropriate c-command clause) to the conditioning of Rendaku voicing.[41]

Viewed from the perspective of the structural conditions governing German compound stress discussed in the preceding section, what (111) shows is that Rendaku does *not* to apply to stems occupying the beginning of a branching subconstituent. We will first illustrate the full generality of this restriction, and its productive application to new cases, by considering the (constructed) four-member compound *nise-kami-tana-tsukuri* in (112).[42] It is assigned the five possible grouping structures in (112a–e), which lead to distinct Rendaku patterns.[43]

(112) nise 'fake'
kami 'god/divine'
tana 'shelf'
tsukuri 'making/construction'

a. (((nise kami) tana) tsukuri) — '(((fake god) shelf) making)'
↓ ↓ ↓
g d dz — "Making of shelves for fake gods"

b. (nise (kami (tana tsukuri))) — '(fake (god (shelf making)))'
↓
dz — "Fake shelf-making by gods"

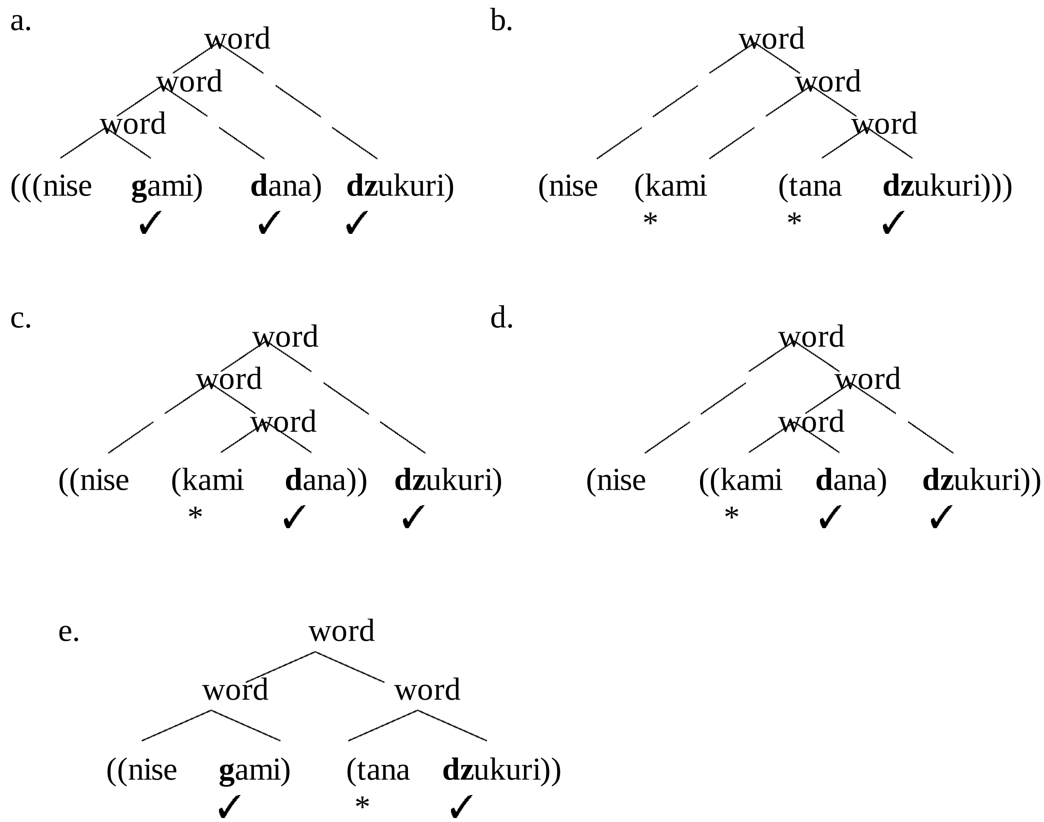
c. ((nise (kami tana)) tsukuri) — '((fake (god shelf)) making)'
↓ ↓
d dz — "Making of fake god-shelves"

d. (nise ((kami tana) tsukuri)) — '(fake ((god shelf) making))'
↓ ↓
d dz — "Fake making of god-shelves"

e. ((nise kami) (tana tsukuri)) — '((fake god) (shelf making))'
↓ ↓
g dz — "Shelf-making by fake gods"

Once we view the minimal structures with *word* nodes in (113) (where [✓] indicates Rendaku-voicing and [*] *no* Rendaku-voicing), a very simple generalization emerges: Rendaku is blocked at the beginning of a *word*.

(113)



(114) Generalization: Rendaku is blocked at the beginning of a **word**.

As in the German compound case, assignment of uniform compound structures would have made it impossible to state this simple generalization in (114), which can be directly translated into position-dependent Voiced Obstruent Prohibition (VOP) as in (115).

(115) WORD-INITIAL VOP: * [+voi, -son]/ $_{Wd}$[_____
"Voiced obstruents are prohibited word-initially"

Ranked above SEQVOI, WORD-INITIAL-VOP chooses the correct winners for the right-branching and the left-branching structures (116).

(116)

	Word-initial VOP	SEQVOI	VOP
$_w$[$_w$[nise sakura] matsuri]		*!	
☞ $_w$[$_w$[nise zakura] matsuri]			*
☞ $_w$[nise $_w$[**s**akura matsuri]]		*	
$_w$[nise $_w$[**z**akura matsuri]]	*!		*

Although attractive in its simplicity, this analysis is problematic in that the environment for the new constraint refers directly to the morphological category ‘Word’. Word-initial VOP, as stated in (115), is thus not a viable constraint within a restrictive theory, where only ‘interface’ constraints (alignment constraints in OT) can refer to both phonological and grammatical information (see the discussion above in section 5.1).

We see two possible way of dealing with this problem. One is an output-output (OO-) faithfulness approach, taken up below in 5.3. The other is a prosodic approach, whereby the morphological word is exactly mirrored by prosodic structure, thereby allowing the condition to be stated in purely phonological terms by referring to, for example, the initial position of the ‘prosodic word’. We sketch this prosodic analysis in the appendix (A.2), pointing out its strengths and weaknesses.

5.3 Output–Output faithfulness

Some of the recalcitrant problems associated with morphologically complex constructions have recently found solutions in terms of OO- faithfulness (see Benua 1995, Kenstowicz 1996, McCarthy 1995, Ito, Kitagawa, & Mester 1996, Steriade 1997, Ito & Mester 1997a, Burzio 1997, among others). Applied to the case here under discussion, the basic idea would be the following: Voicing is blocked in [A [**B** C]] because [BC] is a constituent of type WORD that occurs independently. In its independent occurrence, it does not show compound voicing.

Taking up this line of analysis, we can attribute preservation of word-initial voicelessness to an OO-identity constraint OO-IDENT[WORD] (117), which takes the place of the problematic word-initial VOP constraint (115). We are assuming a general principle giving priority to corresponding free forms (bases) over bound forms.

(117) OO-IDENT[word]: A bound form of type WORD is identical to its corresponding free form.

For the case at hand, the identity required includes identical feature specifications for [voice]. Formally speaking, OO-IDENT[WORD] is a constraint on the correspondence relation holding between the segments of the phonological exponent of every constituent W of type “word” inside a morphological construction and the phonological exponent of the free form of W.

(118) *OO: Ident-Word*

$$\begin{array}{lccl} \text{phonological output:} & x'y'z' & \ldots\quad x''y''z''\ \ldots & \\ & \uparrow\uparrow\uparrow & \uparrow\uparrow\uparrow & \Big\}\ \mathit{IO} \\ \text{morphological input:} & [x\ y\ z]_w & [\alpha \frown [x\ y\ z]_w \frown \beta\ ]_w & \end{array}$$

For example, for (111b), we obtain the following picture:

(119)

```
k  a  s  a  i  r  e        ...   k  a  s  a  i  r  e
↑  ↑  ↑  ↑  ↑  ↑  ↑              ↑  ↑  ↑  ↑  ↑  ↑  ↑
[k a  s  a  i  r  e]w      [nuri ⁀[k  a  s  a  i  r  e]w ]w
```

In terms of the compositionality-oriented approach of Ito & Mester 1997a, OO-IDENT[WORD] is one element of a set of OO-identity constraints through which the overall imperative of compositional computation of complex forms is implemented in an optimality-theoretic grammar, distributed over the constraint system.

(120)

```
OO-IDENT[word]
      |
   SeqVoi
      |
     VOP
```

Recall that "SEQVOI" is a stand-in for REALIZEMORPHEME, as it applies to the junctural morpheme ρ, whose parsing/nonparsing is at issue in the context [$stem_1$ + ρ +$stem_2$] (see section 3.4 above). The crucial interaction between the new constraint OO-IDENT[WORD] and SEQVOI is shown in (121).

(121) OO-IDENT[WORD] >> SEQVOI

Reference output: $_w$[<u>*kasa ire*</u>]		OO-IDENT [word]	SeqVoi	VOP
word (/nuri/ word (/kasa/ /ire/)) [lacquered [parasol case]]	$_w$[nuri $_w$[<u>gasa ire</u>]]	*!		*
	☞ $_w$[nuri $_w$[<u>kasa ire</u>]]		*	

Voiceless [k] in the word *kasa-ire* 'parasol case' embedded within [*nuri* [*kasa ire*]] 'lacquered parasol case' is preserved through correspondence with the voiceless [k] in the independent base output form (*kasa ire*). In the contrasting case (122), the compound element *gasa* is a stem, but it is not a WORD constituent of the whole compound, only *nuri gasa* is. Therefore, the independent word *kasa* is not a reference output for OO-IDENT[word].

(122)

Reference output: $_w$[<u>nurigasa</u>]		OO-IDENT [word]	SeqVoi	VOP
word / word / nuri kasa ire / [[lacquered parasol] case]	$_w$[$_w$[nuri kasa] ire]	*!	*!	
	☞ $_w$[$_w$[nuri gasa] ire]			*

Cases with more than one potential Rendaku site follow straightforwardly, and the output with the correct Rendaku voicing is chosen as the winner by the analysis (123):

(123)

Reference output: $_w$[<u>kamidana</u>]		OO-IDENT [word]	SeqVoi	VOP
i. word / word / /nise/ /kami/ /tana/	a. $_w$[nise $_w$[kami tana]]	*!	**	
	b. ☞ $_w$[nise $_w$[kamidana]]		*	*
	c. $_w$[nise $_w$[gami tana]]	*!	*	*
	d. $_w$[nise $_w$[gamidana]]	*!		**
Reference output: $_w$[<u>nisegami</u>]				
ii. word / word / /nise/ /kami/ /tana/	a. $_w$[$_w$[nise kami] tana]	*!	**	
	b. $_w$[$_w$[nise kami]dana]	*!	*	*
	c. $_w$[$_w$[nise gami] tana]		*!	*
	d. ☞ $_w$[$_w$[nisegami]dana]			**

To complete the overall picture, (124) shows the ranking of the constraint OO-IDENT[stem],[44] which exists alongside OO-IDENT[word] (see Ito & Mester 1997a for evidence from Japanese). Crucially, OO-IDENT[stem] must rank *below* SEQVOI, so that Rendaku can apply in simple compounds, i.e., the free occurrence of the stem *tana* must not block voicing in *kamidana*.

(124)

Reference output: $_{PrWd}$ (*tana*)		OO-IDENT [word]	SeqVoi	OO-IDENT [stem]
/kami/ /tana/	$_{wd}$[kami tana]		*	
	☞ $_{wd}$[kami dana]			*

The overall ranking of the constraints is given in (125).

(125)

OO-IDENT[word]
|
SEQVOI
|
OO-IDENT[stem] IDENT-IO

In the tableaux above, the morphological structure of the candidates is assumed to be the one emerging from the economizing morphological ranking *STRUC >> UNIFORMITY, which takes precedence (either serially, or by ranking) over the phonological constraints.

(126)

reference outputs: $_{w}$[*nisegami*], $_{w}$[*tana*]		*STRUC	UNIFORMITY	OO-IDENT [word]	...
/nise/ /kami/ /tana/	a. $_{w}$[$_{w}$[nise gami] $_{w}$[tana]]	*!			...
	b. $_{w}$[$_{w}$[nise gami] $_{w}$[dana]]	*!		*	...
	c. ☞ $_{w}$[$_{w}$[nise gami] dana]		*		...

5.4 An empirical point of difference

It is appropriate at this point to take stock of what this analysis entails, and offer a comparison with previous analyses. For the case of the Right Branch restriction for Rendaku, Otsu 1980 proposed that a morphological branching restriction must be imposed on Sequential Voicing in Japanese compounds — Rendaku is then explicitly stipulated so as *not* to apply to stems occupying the beginning of a branching subconstituent of the compound.

In Ito & Mester 1986, we argued that such direct reference to morphological structure is undesirable, and in fact unnecessary for Rendaku. Rather, the influence of branchingness is indirect, mediated through *cyclicity* and the *hierarchy of cyclic domains* (cf. also the work in Prosodic Hierarchy Theory: Selkirk 1980, 1984, Nespor & Vogel 1986, and the papers collected in Inkelas & Zec 1990). The morphological branching restriction is derived rather than stipulated, and follows from the cyclicity of Rendaku and Lyman's Law, the latter being an instantiation of the OCP operating on an underspecified voicing tier (Ito & Mester 1986, 71-72). The basic idea is that the right-branch restrictions follow from the general way in which phonology and structure interact in Lexical Phonology (Kiparsky 1982, 1985).

The current proposal concurs with this analysis insofar as there is no Right Branch Condition, hence direct reference to syntactic/morphological branching is unnecessary (and impossible within the overall theory). On the other hand, the analysis differs crucially in that (i) there is no cyclic derivation with floating unrealized [voi] and (ii) the OCP is not literally responsible for the right-branch effects. Instead, a nonderivational structural solution is built on (i) economy-induced non-uniform compound structure and (ii) an output-output faithfulness constraint[45] — made possible through an optimality-theoretic constraint interaction.

There is one class of cases in which the 1986 cyclic OCP-approach and the current account differ empirically. Rendaku voicing is restricted to the native Yamato class and is not found with forms from the other lexical strata of Japanese.[46] However, even among native stem compounding, two types systematically avoid Rendaku-voicing. These are (i) dvandva compounds (127) (coordinate, double-headed compounds), and (ii) deverbal nominals (128) in which the righthand (head) member is a transitive verb stem and the first member is a noun that is its direct object.

(127)

Dvandva compounds		*Modifier-Head compounds*	
oya-ko	'parent and child'	mai-go	'lost child'
eda-ha	'branches and leaves'	waka-ba	'young leaves'
yuki-kaeri	'coming and going'	hi-gaeri	'day trip, i.e., returning in one day'
suki-kirai	'likes and dislikes'	onna-girai	'woman-hater, misogynist'
kusa-ki	'grass and tree, plants'	makura-gi	'pillow-wood, a (railroad) sleeper'
te-aši	'hands and feet, limbs'		

(128) Deverbal compounds:

Direct Object -Predicate		*Adjunct-Predicate*	
sakana-tsuri	'fish-catching, lit., fish fishing' 'catching fish, fishing'	iso-dzuri	'beach fishing 'fishing on a beach'
mono-hoši	'thing-dryer' 'frame for drying clothes'	kage-boši	'shade-drying' 'drying in the shade'
zōkin-kake	'dustcloth hanger' 'place to hang dustcloths'	zōkin-gake	'dustcloth wiping' 'wiping with a dustcloth'
kami-sori	'hair-shaver' 'razor'	saka-zori	'reverse/upwards shaving' 'shaving against the grain'

A complete analysis of these Rendaku-avoiding compounds is beyond the scope of the present investigation.[47] What is of interest here is their behavior as members of complex compounds.

Examples are given below with such compounds as first members (129) and as second members (130).

(129)

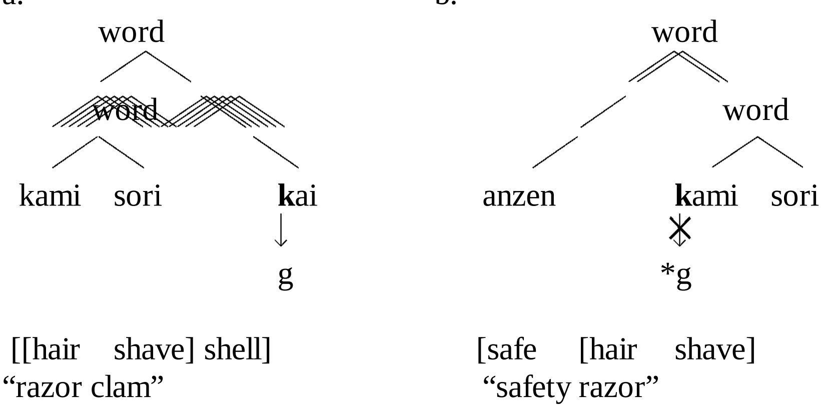
a.	[oya-ko]-**g**enka	'[parent-&-child] quarrel'	(kenka 'quarrel')
	[kusa-ki]-**z**ome	'[grass-&-tree] dyeing, dyeing with plants'	(some 'dye')
b.	[kami-sori]-**g**ai	'[hair-shave]-shell, a razor/jackknife clam'	(kai 'shell')
	[mono-hoši]-**z**ao	'[clothes-dry]-rod, wash-line-pole'	(sao 'rod')

(130)

a.	kinzokusei-[te-aši]	'metallic [hands-&-feet], metal limbs'
	učūjin- [oya-ko]	'alien [parent-&-child], space alien family'
b.	anzen - [kami-sori]	'safe [hair-shaver], safety razor'
	nise - [kane-moči]	'fake [money-holder], fake rich man'

The larger compound is a normal Rendaku-inducing compound, and as expected we find Rendaku-voicing on the second member in (129). The point of difference between the cyclic OCP-approach of Ito & Mester 1986 and the current theory revolves around the non-appearance of Rendaku in (130). We will concentrate on the contrast between (129b) and (130b), both of which contain *direct object + predicate* compounds as constituents. Their structures are diagramed in (131).

(131) a. b.



Under the current structural approach, the nonapplication of Rendaku in (131b) is the expected outcome, since the compound *kami-sori* is a word.[48] On the other hand, the cyclic OCP-approach incorrectly predicts that Rendaku will apply, since [+voi] would not have been inserted on the first non-Rendaku compound cycle (*kami-sori*). If all left-branch blocking of Rendaku is to be reduced to the OCP on [+voiced], a principled account for this kind of example is not possible (see Ito & Mester (1986, 66, note 17) and Han 1994 for further discussion).

We have here an empirical point in favor of the current structural proposal — a reassuring result.

6. Conclusion

6.1 Summary and consequences

In this work, we hope to have shown that within an optimality-theoretic conception of phonology, it is possible to significantly re-interpret the *Obligatory Contour Principle*, one of the cornerstones of modern phonology. It is argued that, rather than being an irreducible principle on representations, the OCP can be understood as *multiply-violated markedness* constraints, *enhanced* by self-conjunction. That is, it is no longer a grand untouchable principle independent of any other elements of the theory, but emerges as a natural byproduct of simple run-of-the-mill phonological markedness constraints and the fundamental OT notion of multiple violations.

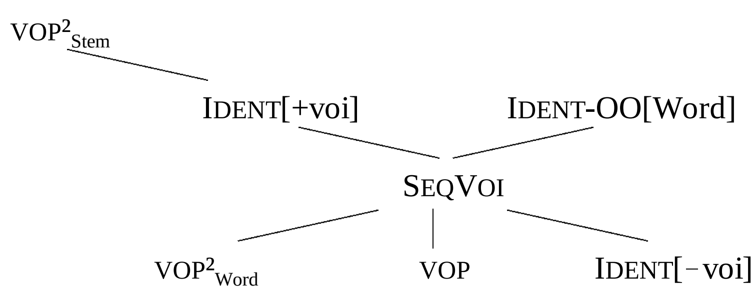
This interpretation bring with it a significant extension of the kinds of dissimilation phenomena that can be accounted for. Going beyond the traditional area of distinctive features, the OCP as enhanced markedness encompasses all markedness constraints, including prosodic ones. Furthermore, it is free from the underspecification-based perspective of phonology on which the original OCP was based, allowing us to explore other areas with the goal of achieving an even higher level of explanation.

The central analytical thread of this work has been the interweaving of the complex of descriptive and theoretical issues surrounding OCP effects in Japanese, in particular, the Voiced Obstruent Prohibition (VOP). By pursuing the details and attendant complexities of the VOP interactions, we have argued for a theory of word structure, explored the hierarchy of domains that determines locality, and developed a full-scale OT analysis of Rendaku voicing.

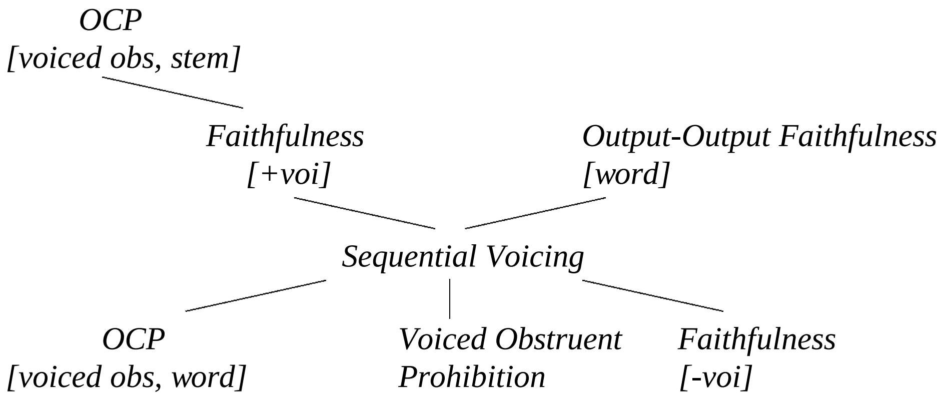
6.2 Overall analysis of Rendaku-related phonology in Japanese

In concluding, we assemble the different pieces of the analysis of the Rendaku-related phonology, and give the overall ranking of the constraints developed in the preceding chapters in (132), followed by intuitive glosses for each of the constraints (133).

(132)



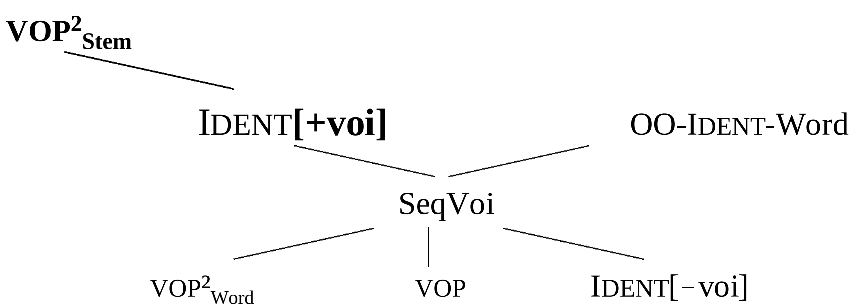
(133)



We now briefly justify the dominance relations in our overall analysis by providing appropriate tableaux. Since the analysis has been discussed and motivated in detail in the preceding sections, we will keep our comments to a minimum.

First, $\text{VOP}^2_{\text{Stem}}$—the OCP on voiced obstruents within the stem domain—must dominate faithfulness to [+voice]:

(134)



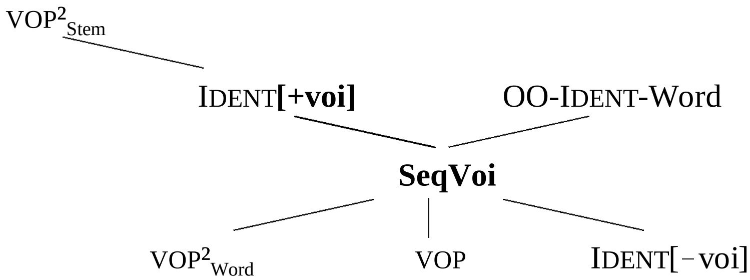
Descriptively speaking, this means that Lyman's Law holds as a morpheme structure condition:[49]

(135)

$_w$[mabuda] *(hypothetical)*	$\text{VOP}^2_{\text{Stem}}$	IDENT[+voi]
$_w$[mabuda]	*!	
☞ $_w$[mabuta]		*

The requirement to parse underlying [+voiced] is stronger than SeqVoi:

(136) Ident[+voi] » SeqVoi



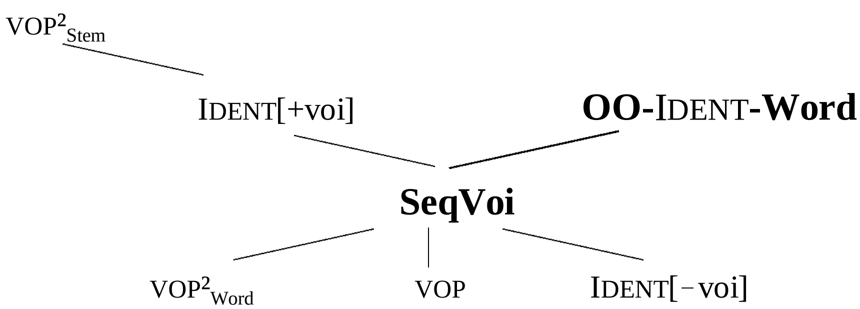
As a result, devoicing of underlying voiced obstruents is not a way of obeying the OCP against the co-occurrence of voiced obstruents within the stem domain. Instead, Rendaku voicing fails to appear.

(137)

$_w$[nuri, fuda] ‘lacquered sign’	$\mathrm{VOP}^2_{\mathrm{Stem}}$	Ident[+voi]	SeqVoi
☞ $_w$[nuri fuda]			*
$_w$[nuri buda]	*!		
$_w$[nuri buta]		*!	*

OO-Ident-Word dominates SeqVoi:

(138)



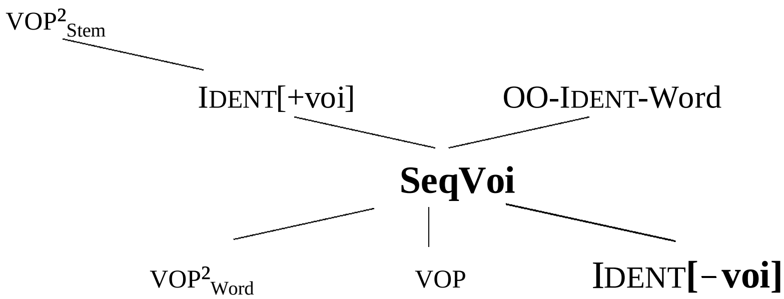
As a result, voiceless initials of complex subconstituents of type “word” respond to independent occurrences of those constituents. This output-output relation is more important than SeqVoi, the requirement to parse the voicing morpheme. Descriptively speaking, Rendaku voicing is blocked on “left branches”.

(139) Reference output: $_w$[sakura matsuri]

$_w$[nise, $_w$[sakura, matsuri]]	OO-Ident-Word	SeqVoi
☞ $_w$[nise $_w$[sakura matsuri]]		*
$_w$[nise $_w$[zakura matsuri]]	*!	

Faithfulness to [−voice] never forestalls Rendaku:

(140) SeqVoi » IDENT [−voi]

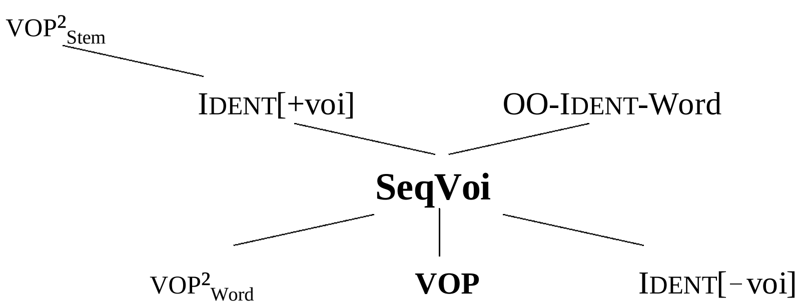


(141)

$_w$[geta, hako] ‘clog cabinet’	SeqVoi	IDENT [−voi]
$_w$[geta hako]	*!	
☞ $_w$[geta bako]		*

Similarly, the markedness constraint against voiced obstruents does not prevent Rendaku:

(142) SeqVoi » VOP

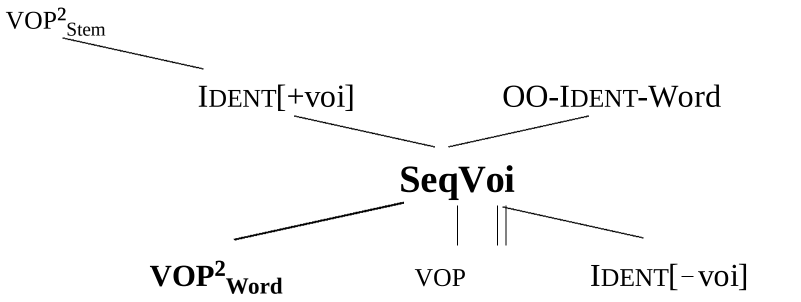


(143)

$_w$[geta, hako]	SEQVOI	VOP
$_w$[geta hako]	*!	*
☞ $_w$[geta bako]		**

In Modern Japanese, the OCP against the co-occurrence of voiced obstruents within the domain of the whole word is dominated by Sequential Voicing:

(144) SeqVoi » $\text{VOP}^2_{\text{Word}}$



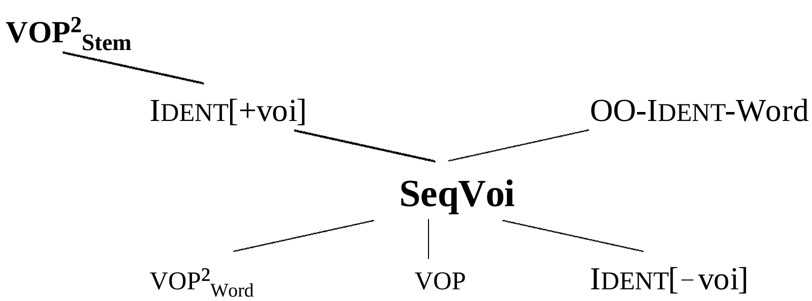
It can therefore not prevent Rendaku:

(145)

$_w$[geta, hako]	SeqVoi	$\text{VOP}^2_{\text{Word}}$
$_w$[geta hako]	*!	
☞ $_w$[geta bako]		*

Continuing with justifications for some indirect dominance relations, the OCP against the co-occurrence of voiced obstruents within the stem domain dominates SeqVoi:

(146) $\text{VOP}^2_{\text{Stem}}$ » ... » SeqVoi



The effect is Lyman's Law in compounds:

(147)

$_w$[mori, soba] 'soba serving'	$\text{VOP}^2_{\text{Stem}}$	SeqVoi
$_w$[mori zoba]	*!	
☞ $_w$[mori soba]		*

Faithfulness to [+voi] dominates the OCP against the co-occurrence of voiced obstruents in the word domain:

(148) IDENT[+voi] » ... » VOP$^{2}_{\text{Word}}$

VOP$^{2}_{\text{Stem}}$

IDENT[+voi] OO-IDENT-Word

SeqVoi

VOP$^{2}_{\text{Word}}$ VOP IDENT[−voi]

As a result, Lyman's Law is only a *morpheme* structure constraint (in the Yamato stratum), not a *word* structure constraint.

(149)

$_{w}$[zoori, geta] 'sandal clogs'	IDENT[+voi]	VOP$^{2}_{\text{Word}}$
$_{w}$[zoori keta]	*!	
☞ $_{w}$[zoori geta]		*

Appendix

In this appendix, we take up two issues that were touched on in the preceding chapters, but not dealt with in any detail. In A.1, an attempt is made to reduce Sequential Voicing to the interaction of elementary phonological constraints; A.2 offers a direct prosodification alternative to the analogical (Output-Output) account of branching effects in complex compounds.

A.1 Sequential voicing and sequential faithfulness

In section 3.4 above, we followed earlier work in treating Sequential Voicing (Rendaku) as a fundamentally morphological phenomenon, namely, as due to the presence of a junctural morpheme. This element consists of the floating feature specification [+voiced], and it is realized by the association of this feature specification to the first segment to its right. The overt phonological effect is perceivable only on voiceless obstruents that change from voiceless to voiced.

One of the strengths of this morphemic account of Rendaku is the ease with which it can account for exceptions and other irregularities. It is well-known that there are many native compounds where Rendaku is idiosyncratically absent (see Ito & Mester 1986 and especially Vance 1987 for discussion and exemplification). Such distributional gaps and irregularities are unsurprising for a linking morpheme appearing at a particular morphological juncture. In addition, even though Rendaku is a characteristic of the native (Yamato) vocabulary of Japanese (see Ito & Mester 1995a, 1995b, to appear; Ito, Mester, and Padgett 1998), it is sporadically found with items belonging to other vocabulary strata, such as the Portuguese loan *karuta* appearing with voicing in *hana-garuta* 'flower card game', or Sino-Japanese *keŋka* 'quarrel' in *oyako-geŋka* 'quarrel between parent and child'. Again, a morphemic analysis encounters no basic obstacle here, such small extensions of a morpheme's distribution beyond a certain stratal limitation are found in many cases. These (fundamentally descriptive) advantages were our main reason for keeping a traditional morpheme-based floating feature analysis.

The central characteristic of this kind of approach, shared with many other floating-feature analyses in the past, is its crucial reliance on input specifications: an underspecified morpheme strategically positioned at points where it will have the right effects in the output. The effects themselves come about by parsing the input, any systematic generalization about them emerges out of this parsing process.

With Optimality Theory, it is natural to ask whether a more direct access to output effects such as Sequential Voicing is possible. What would a radically output-oriented approach look like, an account that directly focuses on the overt phonological effect, namely, the appearance of voicing at the juncture?

One could attack the problem head-on and posit (150) as a constraint.

(150) "Initials of second compound members should be voiced."

Formulated as a blunt instruction demanding the presence of voicing in a certain morphological context, any claim to universal status is of course out of the question. The most obvious objection is that the phenomenon appears irreducibly language-specific: After all, voicing is an idiosyncratic property of (a certain type of) compounds in Japanese, not a universal property of compounds. It is of course true that some constraint might be in a dominant position only in a single or very few languages, and deeply embedded in the ranking system of all other languages, but that is not sufficient to legitimize (150) as a universal constraint.

Acknowledging this point, a position of retreat would be to renounce universal status while still upholding (150) as a constraint, but a language-particular one. Interestingly, this does not by itself remove the problem. The stipulation in (150) uses a mixture of phonological ("voiced") and morphological predicates ("compound member"). This indicates that we are not dealing with a basic constraint, but rather with the effects of the interaction of more basic constraints. This is where (150) fails, quite irrespective of the question of whether the constraints involved are all universal or whether some are language-specific. Even if language-specific constraints are admitted, there should be limits on what such constraints can refer to, and ideally, this should be no more than a mild extension of the universally possible.

The main task will be to find a way of explaining Rendaku, language-particular and idiosyncratic as it may be, as the effect of constraints responsible for other well-established phonological patterns.

If Rendaku is due neither to a language-specific constraint nor, as we are now assuming, to a feature-sized morpheme in the input, something else is needed to trigger the appearance of voicing. In the abstract, the standard optimality-theoretic answer here is clear. Ideally, the appearance of voicing in this position should be an instance of the emergence of universal unmarkedness. The difficulty, of course, is to turn this desideratum into a concrete and workable analysis.

Since Rendaku gives rise to voiced obstruents, a highly marked type of segment, it is clear from the outset that the markedness principles in operation cannot be purely segmental. A natural idea, then, is that the operative factor is *sequential unmarkedness*, namely, voicing in a voiced environment. One version of this approach is formalized in (151), where the relevant sequential markedness constraint rules out changes in glottal state— here, a switch from voicing to voicelessness.

(151) $*[+\ -]_{voi}$ A voiced segment should not be immediately followed by a voiceless segment (i.e., "sequential voicing").

This constraint against voicing contours is related to the general process of intervocalic or inter-sonorant voicing.[50]

In order to have any effect in Japanese, $*[+\ -]_{voi}$ must outrank some relevant faithfulness constraint. The constraint in question is IDENT[−voi], which militates against changing voiceless input segments into voiced output segments. This elementary interaction is shown in (152).

(152)

/nama kome/ 'raw' 'rice'	$*[+\ -]_{voi}$	IDENT[-voi]
nama k ome | | $[+\ -]_{voi}$	*!	
☞ nama gome $[+]_{voi}$		*

As things stand, $*[+\ -]_{voi}$ is too powerful since it eliminates any $[+\ -]_{voi}$ contour whatsoever, irrespective of environment. This runs afoul of the basic point that $*[+\ -]_{voi}$ effects are truly *emergent* in Japanese: They are restricted to a certain environment and do not occur across-the-board. Otherwise the language would not have forms like *mato* in (153), with a morpheme-internal $[+\ -]_{voi}$ contour.

(153) m a t o 'target'
[+ −]

In other words, $*[+\ -]_{voi}$ has effects for $[+\ -]_{voi}$ contours that are derived through morpheme composition (more precisely, stem composition), but is powerless against such contours when they are input-given within a single lexical item. The generalization here is a familiar one from Lexical Phonology, going back to the Alternation Condition of Kiparsky 1973: $*[+\ -]_{voi}$ takes effect only in derived environments, and is blocked in non-derived environments. In other words, we find the emergence of the unmarked in derived environments.[51]

What is needed, then, is a way of capturing 'nonderived environment blocking (NDEB)' (in terms of Kiparsky 1993).[52] Our goal at this point is not to treat this topic in the full generality that it deserves, but rather to propose an account for the case under discussion in Optimality Theory that can hopefully be extended to other cases.

We agree with Kiparsky's 1993 demonstration that NDEB-behavior is not intrinsically connected with cyclicity and strict-cycle behavior. But whereas the lexical-phonological account uses underspecification and structure-building rules as the operative notions, it seems natural, in an optimality-theoretic context, to develop an account built on faithfulness.[53] The main idea is very simple: underived environments are subject to special faithfulness constraints that do not apply to derived environments. This desideratum is informally expressed in (154).

(154)

$$\begin{array}{ll} \text{Faith}_{\text{special}} & \text{(“underived environments”)} \\ \quad | & \\ {*}[+\ -]_{\text{voi}} & \\ \quad | & \\ \text{Faith}_{\text{general}} & \text{(“all environments”)} \end{array}$$

A complete characterization of the class of constraints that can fill the position of Faith$_{\text{special}}$, in (154) is a topic that lies beyond the limits of the present investigation. For the case at hand, and many others like it, it is natural to posit IDENT constraints which are concerned with the feature values of *segment sequences* that are input-given, in the sense that they fall within the domain of an input unit: a single morpheme. For underlying forms, phonological adjacency and precedence relations are defined only within morphemes, not across morpheme boundaries in morphologically complex inputs. The general formulation of such sequential faithfulness constraints is given in (155)

(155) Sequential Faithfulness: IDENT$[\alpha, -\alpha]_{\phi}$
- •Suppose $x_1{}^\frown x_2$ and x_1 is $[\alpha\phi]$ and x_2 is $[-\alpha\phi]$, for some feature ϕ.
- •Suppose further that $R(x_1)=y_1$ and $R(x_2)=y_2$ both exist, and that and $y_1{}^\frown y_2$.
- •Then y_1 is $[\alpha\phi]$ and y_2 is $[-\alpha\phi]$.

The intent of this family of constraints is the preservation of sequential structure, over and above the familiar preservation of the properties of single segments. The environment of preservation is depicted in (156) below, where the sequence *ab* of adjacent tautomorphemic segments is specified $[\alpha\beta]_F$, and this specification is preserved in the corresponding sequence *a′ b′*.[54]

(156)

$$\begin{array}{cc} [\alpha F] & [\beta F] \\ | & | \\ a' & b' \\ |\, R & |\, R \\ a & b \\ | & | \\ [\alpha F] & [\beta F] \end{array}$$

A specific instance of sequential faithfulness for voicing sequences of the form $[+\ -]_{\text{voi}}$ is formulated in (157).

(157) Sequential Faithfulness on Voicing: IDENT$[+\ -]_{\text{voi}}$
- •Suppose $x_1{}^\frown x_2$ and x_1 is [+voi] and x_2 is [−voi].
- •Suppose further that $R(x_1)=y_1$ and $R(x_2)=y_2$ both exist, and that and $y_1{}^\frown y_2$..
- •Then y_1 is [+voi] and y_2 is [-voi].

The crucial point for the limitation of blocking to nonderived environments is the following: Input-given sequences are those that occur in input units, i.e., within morphemes. In other words, IDENT$[+ -]_{voi}$ is a faithfulness constraint based on the morphemic environment of a segment. The rationale for this restriction is that sequential order in inputs is defined only where adjacency is defined. This is the case inside morphemes, but not across a morpheme boundary.[55] Infixation phenomena show that the linear order, e.g., of affix segments with respect to stem segments is itself determined by the interaction of morphological (alignment/anchoring) constraints with phonological constraints (Prince & Smolensky 1993). Similarly, the linear order of compound elements is established only at PF, whereas the rest of the grammar is concerned with grouping structure and headedness, as discussed in chapter 5.

Now we have assembled all the ingredients that are necessary to express Sequential Voicing as a constraint against voicing contours, limited in its force by being restricted to derived environments. As a first approximation, this can be succinctly expressed by means of the following ranking:

(158) IDENT$[+ -]_{voi}$ (sequential faithfulness)

* $[+ -]_{voi}$ (constraint against voicing contours)

We know from (152) that *$[+ -]_{voi}$ must dominate the simple faithfulness constraint IDENT[−voi]. This results in the following ranking configuration:

(159) IDENT$[+ -]_{voi}$

*$[+ -]_{voi}$

IDENT[−voi]

As seen below in (162), *$[+ -]_{voi}$ must also dominate the sequential faithfulness constraint IDENT$[-+]_{voi}$ (since tautomorphemic $[-+]_{voi}$ is changed to $[++]_{voi}$ whenever Rendaku appears). The overall picture is summarized in (160).

(160) IDENT$[+ -]_{voi}$

*$[+ -]_{voi}$

IDENT$[-+]_{voi}$ IDENT[−voi]

(161) illustrates ‘blocking’ in an underived environment, and (162) illustrates ‘application’ in a derived environment.

(161)

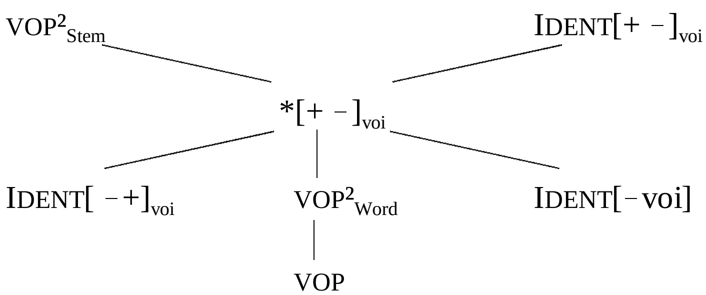
/mato/ ‘target’	IDENT[+ −]$_{voi}$	*[+ −]$_{voi}$	IDENT[−voi]	IDENT[−+]$_{voi}$
☞ m a t o [+ −+]$_{voi}$		*		
m a d o [+]$_{voi}$	*!		*	*

(162)

/nama/, /kome/^{head} ‘raw’ ‘rice’	IDENT[+ −]$_{voi}$	*[+ −]$_{voi}$	IDENT[-voi]	IDENT[−+]$_{voi}$
nama kome [+ − +]$_{voi}$		*!		
☞ nama gome [+]$_{voi}$			*	*

To conclude our investigation of the question whether it might be possible to reduce Sequential Voicing to more elementary constraints, we assemble the various constraints developed in this section the diagram in (163).

(163)



In order for this kind of approach to succeed, many further questions remain to be addressed. Besides the issue of exceptions and irregularities connected with Sequential Voicing (see the beginning of this section), there is the additional point that, quite apart from the merits and problems of a faithfulness-based account of underived environment behavior, distinguishing derived from underived environments is not enough: The class of derived environments must be further narrowed down to the juncture between compound members, etc. etc. We leave the proposal developed in this section at an exploratory stage since it is unclear at this point whether these questions can be successfully dealt with, in particular, in view of the fact that they have straightforward (even though stipulatory) answers under the standard analysis that posits a feature-sized input morpheme.

A.2 Direct prosodification as an alternative to OO-IDENT

In chapter 5, we analyzed the blocking of Rendaku voicing at word junctures within complex compounds as an effect of output-output faithfulness. As shown in (164), the relevant constraint, IDENT-WORD, requires faithfulness of the sequence *kasa ire* in its occurrence as a subconstituent of type “word” to its occurrence as an independent form.

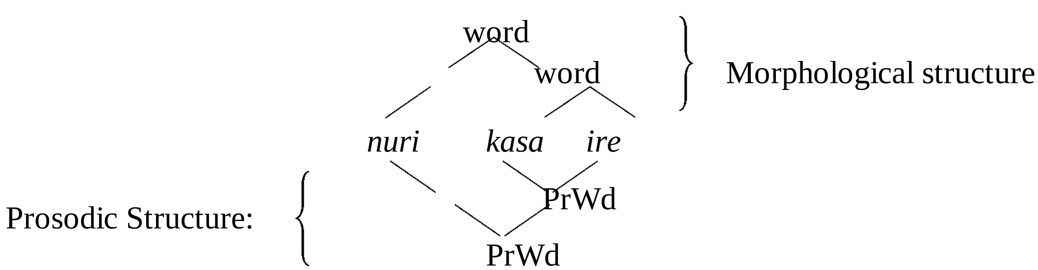
(164) IDENT-WORD >> SEQVOI

Reference output: $_{w}$[<u>*kasa ire*</u>]		IDENT-Word	SeqVoi	VOP
word [/nuri/ word [/kasa/ /ire/]] [lacquered [parasol case]]	$_{w}$[nuri $_{w}$[<u>gasa ire</u>]]	*!		*
	☞ $_{w}$[nuri $_{w}$[<u>kasa ire</u>]]		*	

The mode of explanation here for the blocking of voicing is analogical, the crucial factor being the existence and make-up of a related basic form. An obvious alternative is to pursue a more direct line of analysis and try to identify some tangible phonological property within the form [*nuri* [*kasa ire*]] itself that could be appealed to in order to explain the lack of voicing.

Let us consider an analysis, then, which phonologizes the central morphological factors by positing prosodic structure in a way that directly reflects of word-internal morphological constituency, following the lines of Kubozono 1988, 1993, Han 1994, and (for German compounds) Wiese 1996, who argue that a morphological word is mirrored in the phonological structure by a prosodic constituent, here labeled the *prosodic word*, as shown in (165).

(165)



Given this prosodic structure, the blocking of Rendaku voicing can be ascribed to a positional markedness constraint, as formulated in (166).

(166) VOP/$_{\mathrm{PrWd}}$[— *“No voiced obstruents prosodic-word-initially.”*

(166) is an enhanced version of the basic constraint against voiced obstruents. This version focuses on the initial position in a prosodic word. Such a restriction against word-initial voiced obstruents is phonetically well-motivated in that initial obstruent voicing is notoriously hard to implement. In many languages, plosives are only partially voiced in this position, and often the distinction between the two series of stops is expressed by aspiration instead of voicing. The constraint is also historically well-grounded for Japanese, since there is general agreement that an across-the-board prohibition against word-initial voiced obstruents was in force in Old Japanese (see Unger 1975, among others).

The relevant ranking is given in (167): The word-initial markedness constraint ranks above the Rendaku constraint SeqVoi, which in turn ranks above the simple markedness constraint against voiced obstruents.

(167) VOP/$_{\text{Prwd}}$[— *"No voiced obstruents word-initially."*

|

SeqVoi *"Initials of second compound members should be voiced."*

|

VOP *"No voiced obstruents"*

Note that the two markedness constraints are in a Paninian relationship: the environment specific VOP/$_{\text{Prwd}}$[— ranks above the general VOP. Tableau (168) illustrates the workings of this constraint ranking scheme. When the stem *kasa* is word-initial (168a), the top-ranked word-initial markedness constraint is in charge; otherwise, SeqVoi determines the winner (168b).[56]

(168)

		VOP/$_{\text{Prwd}}$[—	SeqVoi	VOP
a. nuri kasa ire (lacquered (parasol case))	M: [[ ]] ☞ nuri kasa ire P: (( ) ( ))		*	
	[[ ]] nuri gasa ire (( ) ( ))	*!		*
b. nuri kasa ire (lacquered (parasol case))	[[ ]] nuri kasa ire ( )		*!	
	[[ ]] ☞ nuri gasa ire ( )			*

Cases with more than one potential Rendaku site follow straightforwardly, and the output with the correct Rendaku voicing is chosen as the winner by the analysis (168):

(169)		VOP/ $_{Prword}[$—	SeqVoi	VOP
a. /nise/ /kami/ /tana/	M: [[ ]] nise kami tana P: (( ) ( ))		**!	
	[[ ]] ☞ nise kami dana (( ) ( ))		*	*
	[[ ]] nise gami tana (( ) ( ))	*!	*	*
	[[ ]] nise gami dana (( ) ( ))	*!		**
b. /nise/ /kami/ /tana/	[[ ]] nise kami tana ( )		*!*	
	[[ ]] nise kami dana ( )		*!	*
	[[ ]] nise gami tana ( )		*!	*
	[[ ]] ☞ nise gami dana ( )			**

As Kubozono (1988, 1993) points out, there is accentual evidence supporting structures with two prosodic domains for the relevant cases (170).

(170) [[A B] C] → A B C
( ) ← PrWd-phrasing

[A [B C]] → A B C
( ) ( ) ← PrWd-phrasing

(171) [[nihon buyoo] kyookai] → nihon buyoo ky<u>o’</u>okai ‘association for Japanese dance’
‘japan’ ‘dance’ ‘association’ ($)_{PrWd}$

[nihon [buyoo kyookai]] → niho’n buyoo kyo’okai ‘Japan dancing association’
( )$_{PrWd}$( )$_{PrWd}$

The constraints responsible for ensuring the prosodic structuring in (171) are ALIGN-LEFT (MWd,PrWd), forcing alignment of the morphological word to the phonological word, and the violated constraint NONRECURSIVITY (see McCarthy & Prince 1993b, Selkirk 1995, and Truckenbrodt 1995, 1997).[57]

(172) ALIGN-LEFT (WD, PRWD) >> NONRECURSIVITY (PRWD)

	Align-Left (Wd, PrWd)	NONRECURS (PRWD)	VOP / $_{PrWd}$[—	SeqVoi
M: [[ ]] a. nuri kasa-ire P: ( )	*!			*
[[ ]] b. nuri gasa-ire ( )	*!			
[[ ]] ☞ c. nuri kasa-ire (( )( ))		*		*
[[ ]] d. nuri gasa-ire (( )( ))		*	*!	

This kind of approach is attractive in that it focuses directly on the internal prosodification of the forms. On the other hand, the Output-Output (analogical) approach considered earlier (see (164) and section 5) does not depend on the internal prosodic structure of the complex compounds itself. Since the reference output is necessarily a prosodic word, it makes no difference whether the outputs of the complex compounds themselves contain embedded prosodic words, or are simply dominated by a single prosodic word.

The decision between the Output-Output approach versus direct prosodification cannot be made without further investigation. In particular, we need to assess how strong the independent accentual evidence is for recursive prosodic structures. This is where discrepancies between accentual structure and voicing behavior turn out to be important.

Long compounds (four-member and longer), even if strictly left-branching, show a tendency to split into two accentual domains, leading to the (optional) appearance of two accents, as illustrated by the examples in (173) (from Kubozono 1993: 55)).

(173) [[[A B] C] D]

↙ ↘

a. A B C D *or* b. A B C D
( ) ( ) ( )

(174) 'South-East' 'Asia' 'nations' 'union'
[[[toonan azia] syokoku] rengoo]

↙ ↘

a. toonan azia syokoku re'ngoo b. toonan a'zia syokoku re'ngoo
( ) ( ) ( )

(175) 'three' 'shift' 'work' 'system'
[[[san kootai] kinmu] seido]

↙ ↘

a. san kootai kinmu se'ido b. san ko'otai kinmu se'ido
( ) ( ) ( )

According to Kubozono 1993, the (b) structures result from the influence of rhythmic constraints disfavoring long accentual phrases and favoring binary structure. We are here not concerned with a further analysis of these factors. The important observation is the following: In spite of such acccentual variation, strictly left-branching [[[A B]C]D]-compounds whose members are susceptible to Rendaku do not show a comparable variation in their voicing pattern: Sequential Voicing is obligatory throughout. This is shown in (176) '[[[*river bank*] *street*] *side*]'.

(176) [[[kawa hata] toori] soi] [[[kawa hata] ***t**oori] soi]
↓ ↓ ↓ ↓ ↓
b d z b z
( ) ( ) ( )

Left-branching compounds do not break into two separate domains, as far as Rendaku voicing is concerned: There is no initiality-effect in position C in [[[AB]C]D], which is an indication that the direct prosodification approach overshoots the mark, at least as far as the identification of the domains of accent assignment and Rendaku is concerned.[58]

Notes

1. This work was partially supported by faculty senate grants from the University of California at Santa Cruz and by the National Science Foundation under grant SBR-9510868. The names of the authors appear in alphabetical order. For comments on earlier versions of this work, we wish to thank Haruo Kubozono, Jaye Padgett, Alan Prince, Paul Smolensky, Philip Spaelti, Koichi Tateishi, Moira Yip, and the members of the audience at the 1996 Kobe Phonology Forum and WECOL 1996 (Santa Cruz). We are particularly indebted to John Alderete, Joe Pater, and Keiichiro Suzuki, who are independently pursuing approaches to the OCP akin to the proposal made here, and who generously shared some of their findings with us. Portions of this work have also been presented at the 1997 Scandinavian Summer School in Phonology (Iceland), colloquia at the University of Tübingen, Rutgers University, Indiana University, and at the Berkeley Analogy Workshop, and we would like to thank the audience and participants for helpful suggestions and constructive criticisms.

2. The central generalization here was known to Pāṇini (5th or 6th century BC) and appears in the standard handbooks (e.g., Whitney 1889). Allen 1951 provides the first theoretical treatment within modern linguistics, using a nonlinear conception of phonological structure. The OCP-based analysis in (5) is due to Borowsky & Mester 1983; see also Kaye & Lowenstamm 1985, among others).

3. The general idea has been independently developed by Alderete 1997 (see also Suzuki 1995 for a similar approach).

4. (11a) is usually not true of phonetic outputs in such languages: the occurrence of redundant aspiration in certain environments is a different matter.

5. In (12) and throughout this work, we make use of a binary notation for features, following Jakobson 1939 and subsequent work. The choice is mainly expository–mutatis mutandis, privative and other conceptions can be easily substituted.

6. See Steriade 1987 and Mester & Ito 1989 for two statements of the privative approach within Underspecification Theory; and see Cho 1990 and Lombardi 1991 for further developments.

7. The exposition here follows the handout presentation in Smolensky 1997.

8. Presentations of Smolensky's constraint conjunction theory in the published literature include Kirchner 1996 and Suzuki 1995. Hewitt & Crowhurst 1995 propose a similarly named operation with different effects: the derived constraint is violated when *either* (not: *both*) of the individual constraints is violated (this proposal is also made use of in Downing 1998). The potential for terminological confusion stems from the fact that the operation of *local conjunction*, when applying to $\mathbb{C}_1$ and $\mathbb{C}_2$, as in (24a), derives a constraint ($\mathbb{C}_1 \&_\delta \mathbb{C}_2$) which, in terms of standard propositional logic, is equivalent to $\mathbb{C}_1 \vee \mathbb{C}_2$, the *logical disjunction* of $\mathbb{C}_1$ and $\mathbb{C}_2$: false if and only if both disjuncts, i.e. both $\mathbb{C}_1$ and $\mathbb{C}_2$ are false. And conversely, a conceivable operation of (inclusive) *local disjunction*, deriving a constraint ($\mathbb{C}_1 \vee_\delta \mathbb{C}_2$) violated if either $\mathbb{C}_1$ or $\mathbb{C}_2$ are violated in some domain D, is equivalent to "$\mathbb{C}_1 \wedge \mathbb{C}_2$", the *logical conjunction* of $\mathbb{C}_1$ and $\mathbb{C}_2$: false if and only if either $*\mathbb{C}_1$ or $*\mathbb{C}_2$ (or both) are false.

9. Alternatively, it is also possible to view the recombination of two basic constraints into a composite constraint to take place not in UG itself, but within individual grammars. In this approach, the set of universal constraints *Con* is limited to the fundamental constraints. An individual grammar can add to these constraints by recombination, creating the larger set Con_G, and impose a ranking on Con_G. The difference between the two approaches are small, but worth exploring, a task we cannot undertake in this context. We will proceed under the version of the theory given in the main text, regarding combination of constraints as a UG-process.

10. For further development and discussion of the domains that are relevant here, see chapter 4.

11. We are here sidestepping the controversial issue whether the neutralization of the voiced/voiceless contrast in German words with syllable-final obstruents is incomplete (see Port & O'Dell 1985, Port & Crawford 1989) or complete (Fourakis & Iverson 1984 and Manaster Ramer 1996).

12. For a different analysis using positional faithfulness constraints, see Lombardi 1995 and Beckman 1998.

13. Or alternatively, IDENT[+VOI]: Whereas in a more comprehensive analysis of German phonology, with more constraints and higher interactivity, the relevant faithfulness constraint most likely has to be feature-specific, our small illustrative fragment can get by with a single monolithic IDENT-constraint.

14. See Miglio & Fukazawa 1997 for a proposal along partially similar lines. But different from the fundamental separation of faithfulness constraints and all others in terms of conjoinability, these authors pursue the more radical goal of confining constraint conjunction to constraint families. There are some reasons to believe that such a restriction might overshoot the mark, leading to the loss of precisely some of the more interesting explanations built on constraint conjunction, like the one explored in this section. Even though the ingredients of NOCODA $\&_\Delta$ VOP belong to different constraint families (syllable-structure wellformedness vs. segmental markedness, respectively), there is a sense in which the two 'fit together', as a 'top-down' structural constraint meeting a 'bottom-up' segmental constraint. Clearly, the bases and limits of conjoinability are in need of deeper investigation.

15. The argument in (36) above against the free conjoinability of faithfulness and markedness stands in contrast with the interesting proposal in Lubowicz 1998 to capture derived environment effects in phonologically derived environments by means of local conjunction of faithfulness and markedness constraints. Lubowicz's basic idea is to couple a low-ranking markedness constraint M with some faithfulness constraint F_1 and to assign a high rank to the resultant composite constraint $F_1 \&_\delta$ M. Suppose $F_1 \&_\delta$ M and M are ranked differently with respect to some constraint F_2 conflicting with M: $F_1 \&_\delta$ M. >> F_2 >> M. The result is that while M usually loses to F_2, the opposite will happen when violating M goes hand in hand with violating F_1— because in that case, the highest-ranking $F_1 \&_\delta$ M is violated. This scenario arises in a "phonologically derived" environment, where an infringement of F has taken place. Intuitively speaking, the faithfulness violation has 'promoted' M to a rank higher than F_2. This is a very ingenious approach to phonologically derived environments. (35) and (36) show, on the other that just as a faithfulness violation can 'activate' a markedness constraint, a markedness constraint

violation (such as NOCODA) can ‘activate’ a faithfulness constraint (such as IDENT[voi]) as we have seen, an unwanted consequence. Perhaps a weaker version of (33) can be found which preserves Lubowicz’s results while avoiding the negative effects of free conjoinability of faithfulness and markedness.

16. If self-conjunction always preserves ranking, the question arises whether the markedness approach will run into difficulties in cases where dissimilation seems to target only relatively unmarked elements while leaving relatively more marked elements undisturbed. For example, in the Northeast Congo language Alur (Tucker 1969, 126) alveolar and interdental coronal plosives exclude each other in roots:

(i)

wellformed roots	illformed roots
t--t--	*t--t̪--
t̪--t̪--	*t--t̪--
d--d--	*d--d̪--
d̪--d̪--	*d--d̪--
t--d--	*t--d̪--
d--t---	*d̪--t---
t̪--d̪--	*t̪--d--
d--t--	*d--t--

Mester (1986, 27-32) analyzes this as an OCP-effect on [coronal], appealing to multiply-linked (and hence OCP-safe) structures in the cases of total place identity. There is no indication, however, that Alur shows OCP-effects on labials and dorsals. Is this, then, a case where the OCP-as-markedness is faced with a ranking reversal as in (ii)?

(ii) *labial » *coronal
*coronal^2 » *labial^2

For cases like Alur in (ii), where coronal harmony plays a central role, every approach has to take into account the fact that, besides being unmarked, the coronal area is also highly populated, with a variety of subplaces occupied by segments of various manners. It differs in this respect from other places of articulation. What is ruled out in (i) is not just two coronals, but a combination of two place-wise *different* coronals, each one with a complex place specification. We anticipate, pending a more detailed investigation of such cases, that the constraint-conjunctive markedness approach can be extended along such lines without having to admit ranking reversals as in (ii) (which would in the best case achieve no more than a purely descriptive success). In general, we anticipate that further theoretical progress in this area will hinge on contrast-based notions explored in the work of Flemming 1995, NíChiosáin & Padgett 1997, Padgett 1997, and others.

17. We will henceforth often leave out the domain index δ when the identity of the local domain is not under discussion. The self-conjunction scheme extends to ternary co-occurrence of ϕ with itself, where the third violation is the fatal one: *F^3. However, no convincing evidence has been forthcoming to the effect that *F^3 is ever linguistically operative separate from *F^2. Perhaps the genuine contrast in grammars is not “1 vs. 2 vs.3 vs. 4 vs. ...”, but rather “1 vs. >1”.

18. As before (see (30)), the monolithic IDENT[F] constraint is sufficient here, but will probably have to be replaced by a feature-specific instance in a more comprehensive analysis of Sanskrit

phonology.

19. The question is moot in this case since lexicon optimization will weed out input forms like the hypothetical /$b^h id^h$/ (whose output would *always* neutralize with that of some other input, see Prince & Smolensky 1993, 191-196 and Ito, Mester, & Padgett 1995, 588-594).

20. The monoaspiration effect in Sanskrit holds only inside morphemes, not at the word level: words can show two aspirates (such as *dʰanibʰyām* 'rich (instrumental dual)'). An exception is the well-known deaspiration found in reduplication ('Grassmann's Law'):

(i)	3.sg.pres.	3.sg.perf.	
/bʰaj/	**bʰ**ajati	**b**a+**bʰ**āja	'divide'
/cʰid/	**cʰ**inatti	**c**i+**cʰ**eda	'cut'
/hr̥/	**h**arati	**j**a+**h**āra	'take'

Reduplicated forms act here in a quasi-monomorphemic way, different from all other derived environments (see Mester 1986, 241-247 for an analysis capturing this through a reduplication-specific mode of representation). In Optimality Theory, the Grassmann's Law facts are Emergence-of-the-Unmarked effects of the familiar kind (McCarthy & Prince 1995), obtainable through low-ranking IDENT[h]$_{BR}$. Expanding on (50), the ranking is the following: *h^2_δ » *IDENT[h]$_{IO}$ » *h » *IDENT[h]$_{BR}$.

21. This was suggested to us by Koichi Tateishi at the Kobe Phonology Forum, September 1996, where this material was first presented.

22. The output of the phonology, as given here, is simplified in abstracting away from tonal information (mainly especially boundary tones) that is predictable on the basis of the prosodic representation. This information crucially enters into the computation of the f0-contour, see Poser (1984) and Pierrehumbert & Beckman (1988) for details.

23. A perhaps more elegant conception of word/affix faithfulness is due to Truckenbrodt (1997b), who makes use of the pair of constraints "Word-Faith" and "Root-Faith". As he points out, given the inclusion relation holding between words and stems, no intrinsic ranking between the two constraints need be assumed:

(i) a. Root-Faith, Word-Faith » ℂ: ℂ is ineffective everywhere
b. ℂ » Root-Faith, Word-Faith: ℂ is effective everywhere
c. Root-Faith » ℂ » Word-Faith: ℂ is effective only in non-root parts of the word (i.e., in affixes)
d. Word-Faith » ℂ » Root-Faith: = (a), because *Root-Faith implies *Word-Faith

Under these assumptions, tableau (57) in the text appears as (ii):

(ii) /ta^{HL}be + ta^{HL}ra/	*HL²	IDENTTONE(stem)	IDENTTONE (word)	0
[ta^{HL}be ta^{HL}ra]	*!			**
☞ [ta^{HL}be tara]			*	*
[tabe ta^{HL}ra]		*!	*	*
[tabe tara]		*!	**!	

Another line of attack starts with the observation that in Japanese, accentual “leftmost wins” patterns found in derivation and inflection (both suffixal) contrast with the “rightmost wins” pattern in compounds (morphologically right-headed). This contrast might suggest that, rather than “Faith(stem) » Faith(affix)”, we are witnessing the preferential preservation of tones in *head* position (perhaps: Faith(head) » Faith(all)).

24. The issue of local self-conjunction of constraints affecting prosodic properties like stress and length is raised in Kirchner (1996, 346) (cf. also Kager’s 1994 PARSE-2 constraint). It is further explored in Alderete 1997, who takes up proposals in Odden 1994 and develops an articulated theory of adjacency relations.

25. But questions remain regarding the true context of Latin degemination (see Leumann 1977, 184; Sihler 1995, 322): degemination is found not only before another geminate, but also before other kinds of heavy syllables:

canna	‘reed’	canālis	‘channel’	*cannālis
farr- < *fars-	‘spelt’	farīna	‘meal, flour’	*farrīna
currus	‘chariot’	curūlis	‘relating to a chariot’	*currūlis
pollen	‘fine flour’	polenta	‘barley-groats’	*pollenta

If so, the dissimilating marked property might be “heavy syllable”, with dissimilation preferentially affecting geminate consonants.

26. Thus Iwai 1989 notes a directionality effect. Gemination after a lax vowel appears to preferentially affect the rightmost voiceless plosive in a word. In her model of loanword phonology based on Sympathy Theory (McCarthy 1997, Davis 1997, Ito & Mester 1997c, Karvonen & Sherman 1997, Walker 1998, among others). Katayama (1998, 136-140) attributes this to a constellation of factors which include, besides input specification of moras, the results of the Sympathy candidate selection process, which turn out to depend on whether the consonant is word-final or preconsonantal in the source word.

27. As has been pointed out to us independently by several investigators (John Alderete, Joe Pater, Philip Spaelti, and Keiichiro Suzuki), the new conception of the OCP as enhanced markedness makes sense of another case that remained recalcitrant under the classical conception: the dissimilation of NC combinations found in several Austronesian languages (including Manga Mbula and Timugon Murut) as well as in some Australian languages (Gurindji and other languages of the northern desert fringe, as well as in Gooniyandi; see Evans 1995 and work cited there).

28. In its morpheme-structural aspect; see Ito & Mester 1986 and references cited there. Lyman’s Law itself is named after the first explicit statement of the generalization in western literature in Lyman 1894. The discovery of the generalization itself is due to the 17th-century linguistic and literary scholar Motoori in his work on the phonology of Old Japanese, as attested in the *Kojiki* (Record of Ancient matters, 8th century).

29. Fugen-*s* it appears not only after elements where it could be interpreted as a genitive ending (*Tage-**s**- zeitung* ‘daily newspaper’: *der Tag, des Tag-es* ‘day, nom./gen.) but also, by analogical extension, after elements where this is not possible (*Arbeit-**s**-zeit* ‘working time’: *die Arbeit, der Arbeit* ‘work’, nom./gen.). Different from Rendaku voicing (see chapter 5), Fugen-*s* in German is

not restricted to compounds with simplex second members, as shown by examples like [*Bildung*-***s***-[*gesamt plan*]] 'educational overall plan' and [*Rechtschreibung*-***s***-[*blitz wörterbuch*]] 'orthographic quick-look-up dictionary', suggesting a contrast in structure: suffixal in German: [[A-s] B], but prefixal in Japanese: [A [P̄-B]]. Note that Fugen-*s* can also appear after complex first members: [[*Arbeits beschaffung*]-***s***- *massnahmen*] lit. 'work provision measures', i.e. 'measures taken to provide work'.

30. In classical OCP accounts (see McCarthy 1986), domains were established by assuming that the melodic content of each morpheme occupies a separate tier — a separate geometric stipulation in itself whose integration with the geometry of phonological representations raised a number of non-trivial issues (see Schlindwein 1986, McCarthy 1989 for discussion).

31. Some dissimilation facts suggest the continued relevance of a (tier) adjacency-based notion of locality separate from domain locality. A case in point is Latin *l*-dissimilation in the derivational affix /-lis/, which is not easily reducible to a domain account, and appears to need a treatment in terms of (tier) adjacency, as in classical autosegmental theory (see Steriade 1987 for this case).

a.	* l ...... l → l ...... r		lūnā-ris	cf. capābi-lis
b.	✓l ...r...l	(*l...r...r)	plūrā-lis	
c.	* r ...l...l → r...l...r		rēgulā-ris	

Schematically, (a) suggests *l² >> IDENT(LAT), where "stem" is taken as the relevant domain including the derivational affix /-lis/. (b) suggests *r*-dissimilation as the factor blocking *l*-dissimilation in this case (see Steriade 1995 for discussion). It is independently known that *r*-dissimilation was a factor in the phonology of Latin, as shown by the systematic absence of rhotacism in cases like *miser* 'poor' (**mirer*). The resulting ranking would be *r² >> *l² >> IDENT(LAT). However, as Curt Rice and Andrew Dolbey have pointed out, this ranking is incompatible with (c), where /...r...r.../ within the stem is obviously tolerated in case *l* intervenes. In other words, cases like this require an adjacency/intervention notion of locality that is apparently not directly reducible to domain locality, pointing to an important issue that needs further thought and investigation.

32. For another application a constraint grid of the form in (97), see Baertsch 1998.

33. This raises the question whether locality ranking (96) itself can be reduced to constraint conjunction. Recursive application of constraint conjunction then yields the following:

(i) $[*\phi^2_{Stem} \,\&\, *\phi^2_{Word}]_{Phrase}$ i.e.: $[*\phi\&_{Stem}*\phi]\&_{Phrase}[*\phi\&_{Word}*\phi]$

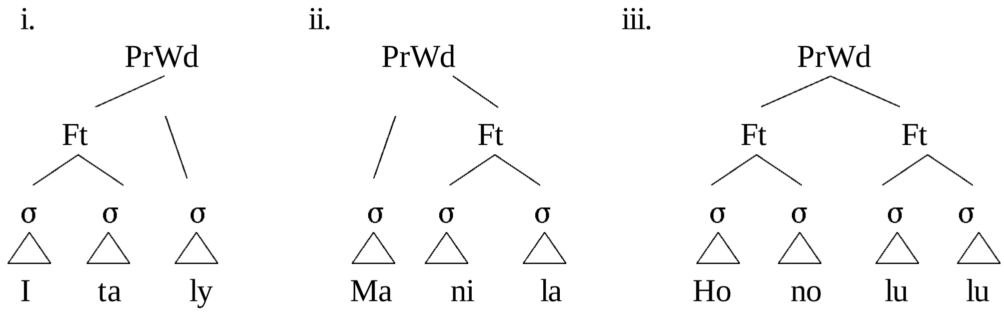
$*\phi^2_{Stem}$ $*\phi^2_{Word}$ $[*\phi\&_{Stem}*\phi]$ $[*\phi\&_{Word}*\phi]$

In (i), a violation of the lower constraint $*\phi^2_{Stem}$ is always echoed by a violation of the higher conjoined constraint $[*\phi^2_{Stem} \,\&\, *\phi^2_{Word}]_{Phrase}$, but this is not so for the lower constraint $*\phi^2_{Word}$. Further investigation along these lines opens up some interesting formal possibilities. On the other hand, the convoluted character of the type of recursive constraint conjunction seen in (i) might be taken to indicate that expressing the strong local interaction of constraint violations by means of a new higher-ranked constraint is not the ideal formal tool for capturing the insight that violation density affects violation weight. We leave these questions open for future exploration.

34. For the moment, we leave aside the question about the status of the [s] in -*planungs*-. See chapter 3, note 29 on Fugen-*s*.

35. Ito & Mester (1996, 35-36) also assume that in Sino-Japanese compounding “stems and words cannot be sisters”.

36. The main thrust of the argument here is in the spirit of the Weak Layering theory of Ito & Mester 1992, where a PrWd can directly dominate a foot and an unfooted syllable as in (i) and (ii). A degenerate foot on the lone syllable (posited to conform to Uniformity, i.e., to the Strict Layering doctrine) would be a superfluous intermediate category, violating the phonological version of *STRUC.

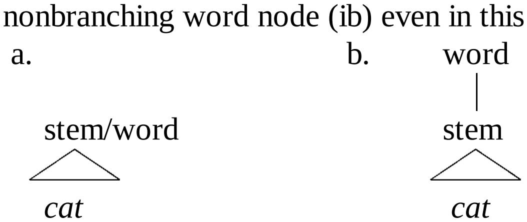


Although *STRUC has been invoked most often in the context of phonological analyses, Prince & Smolensky (1993, 25, note 13) point out some consequences of *STRUC in syntax, such as banning nonbranching X′. Related discussions on phrase structure are found in Grimshaw 1993, 1997, and Chomsky 1995, 241-249. Regarding morphological structures, similar considerations are brought to bear for the proposal of “Level Economy” in Inkelas & Orgun 1995, see also Dolbey & Orgun 1996 and Orgun 1997.

37. I.e., the only one shown in (105), since the two candidates share all other *STRUC violations, which are due to the pressures of higher-ranking constraints dominating *STRUC requiring input elements to be parsed into structure.

38. In the case of a single-stem word such as {cat}, the syntactic demands of the syntax–morphology interface condition “X^0 = word” can be optimally reconciled with the morphological status of *cat* as a stem by a node (ia) with dual stem/word status, there is no need to admit a nonbranching word node (ib) even in this case.

(i)



The same point regarding phrase structure is made in Chomsky 1995, 249: “A consequence [of the bare phrase structure theory] is that an item can be both an X^0 and an XP.”

Extended to phonological structure, a monosyllabic word such as *cat* emerges with a multilabel node σ/Ft/PrWd (iia), instead of the more familiar separate nonbranching nodes as in (iib).

(ii) a. σ/Ft/PrWd
△
cat

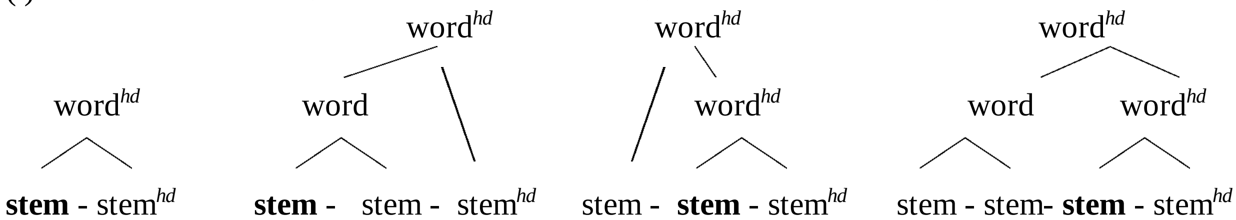
b. PrWd
|
Ft
|
σ
△
cat

Whether there are empirical consequences for such a move must be left for future research.

39. Ito & Mester 1995 propose uniformity in Sino-Japanese root compounding, but Kurisu 1998 argues for an alternative analysis involving crisp edges, which does not rely on compound uniformity. If the Malayalam and Vedic cases are also reanalyzable without uniformity, this suggests that the ranking *STRUC » UNIFORMITY is universal.

40. For the sake of completeness, we sketch here a preliminary analysis of the unmarked German compound stress (the stem containing the main stress is bolded in (i)).

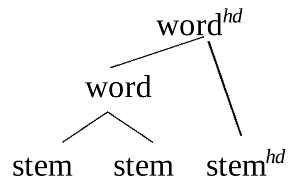
(i) a. b. c. d.



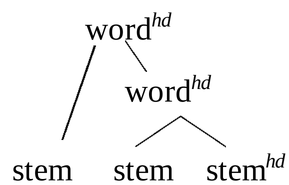
Two properties of such compounds are relevant for our proposed constraints in (ii). First, given that compounds are right-headed (in the unmarked case), the lexical head of the compound is the rightmost stem, and the head word (word^{hd}) of the compound, dominating the head stem (stem^{hd}), contains the main stress (iia). Note that the entire word is also the head word since it dominates the head stem. Second, as extensively explored in Selkirk 1984 and others, compound stress generally falls on the *argument* portion of the compound (namely, its left member) (iib).

(ii) a. Stress Head-Word: The head word must contain the main stress. (Cf. Stress-XP of Truckenbrodt 1995)
b. Argument Prominence: Arguments (here, the left member of a compound) are prominent.

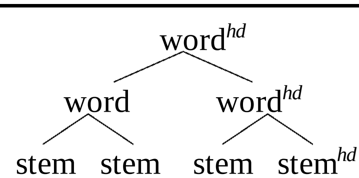
The following tableaux show how these constraints derive the facts under discussion.
(iv)

	Stress-Head-Word	Argument Prominence
☞ **stem** stem stem^{hd}		
stem **stem** stem^{hd}		*!
stem stem **stem**^{hd}		*!

(v)

	Stress-Head-Word	Argument Prominence
stem stem stem^{hd}	*!	*
☞ stem **stem** stem^{hd}		*
stem stem **stem**^{hd}		**!

(vi)

	Stress-Head-Word	Argument Prominence
stem stem stem stem^{hd}	*!	*
stem **stem** stem stem^{hd}	*!	**
☞ stem stem **stem** stem^{hd}		*
stem stem stem **stem**^{hd}		**!

41. See also Tsujimura 1996, 59-63 for this kind of analysis.

42. The compound *kamidana* is a regular word in Japanese: “a household altar; a shelf for the family gods.”

43. Isao Ueda (personal communication) has constructed further examples of four-member compounds illustrating this kind of ambiguity. Here are two of his examples:

(i) ihoo – kome – tonya – kakushi
‘illegal’ ‘rice’ ‘wholesaler’ ‘hiding’

a. [[[ihoo-gome]-donya]-gakushi] 'hiding of a wholesaler dealing in illegal rice'
b. [ihoo-[kome-[tonya-gakushi]]] 'illegal hiding of rice by a wholesaler'
c. [[ihoo-[kome-donya]]-gakushi] 'hiding of an illegal rice wholesaler'
d. [ihoo-[[kome-donya]-gakushi]] 'illegal hiding of a rice wholesaler'
e. [[ihoo-gome]-[tonya-gakushi]] 'hiding of illegal rice by a wholesaler'

(ii) yamato – kawa – sakana – tori
'yamato' 'river' 'fish' 'catch'

a. [[[yamato-gawa]-zakana]-dori] 'catching the Yamato River fish'
b. [yamato-[kawa-[sakana-dori]]] 'catching fish in a river in Yamato'
c. [[yamato-[kawa-zakana]]-dori] 'catching river fish of Yamato'
d. [yamato-[[kawa-zakana]-dori]] 'catching river fish in Yamato' (or, 'in the Yamato way')
e. [[yamato-gawa]-[sakana-dori]] 'catching fish in the Yamato River'

Some further examples due to Isao Ueda:

nise-kane-kakushi-fuutoo 'fake-money-hiding-envelope'
inaka-tukuri-sake-tokkuri 'country-made-sake-decanter'
oo-karasu-saiku-kirai 'big-crow-craft-hating'
natu-kusa-fue-keiko 'summer-grass-flute-practice'

44. OO-IDENT[stem] and OO-IDENT[word] correspond to OO_1 and OO_2-IDENT in Benua 1997.

45. Or alternatively, a independently motivated positional markedness constraint discussed in the appendix (A.2).

46. I.e., Sino-Japanese and Foreign, see Ito & Mester 1995b for a comprehensive picture of the differences between the strata, and Ito & Mester (1995a, to appear) for an analysis within an optimality-theoretic model of lexicon stratification.

47. See Kageyama 1982 and Sugioka 1984; the latter extensively discusses the morpho-syntactic modification properties of such compounds.

48. This explanation also carries over to dvandva formations as second members, as found in (130a).

49. This morpheme structure condition is limited to Yamato Japanese: the IDENT-constraints here and below have to be understood as indexed to the Yamato stratum, as in the theory of the phonological lexicon developed in Ito & Mester (1995a, 1995b, to appear).

50. It would also be possible to use a constraint such as $*[+\ -\ +]_{voi}$ or, in Smolensky's 1993 conception, $*[+\ [-]_{voi}\ +]_{voi,}$ i.e. as a ruling out a [−voi] domain embedded within a [+voi] domain. Further possibilities arise when we take note of the fact that $[+\ -]_{voi}$ and $[+\ +]_{voi}$ are the only two voice transitions to be considered in this context since high-ranking coda-constraints in Japanese (see Ito & Mester 1993, 1998) make it impossible for the first member of a native compound to end in a voiceless segment. This means that, instead of (151), one could also use a general "NoContour" constraint, ruling out any switch of voicing whatsoever: $*[\alpha voi]^\frown[-\alpha voi]$. All of these possibilities are equivalent for our purposes here. In a functionalist perspective, whatever constraint is involved must be a member of the "AvoidEffort" family of constraints studied in Steriade 1995 (see also other work cited there).

51. Cf. also Burzio's (1997) work on the topic of cyclic effects in OT.

52. We note in passing that encoding Sequential Voicing as feature-sized morpheme by itself, strategically positioned at compound junctures, is a way of declaring the phenomenon 'derived-environment-only': by definition, $[+\text{voi}]_\rho$ cannot occur 'inside' other morphemes (it would have to act as an infix). From this perspective, Sequential Voicing as an abstract morpheme is a representational way of encoding the more fundamental NDEB-property.

53. Cf. also the proposal in Lubowicz 1998 to account for blocking in phonologically derived environments by means of highly ranked local conjunctions of a markedness constraint with a faithfulness constraint. See section 2.2 above for some problematic consequences of allowing faithfulness constraints to locally conjoin with markedness constraints.

54. The idea here is somewhat akin to local conjunction of constraints, and it would be worth exploring the question whether the two can be combined under some more general conception.

55. Note that this is different from the approach to derived environment effects in Burzio 1997.

56. In (168) and subsequently, we assume that the resultant prosodic structure consists of two PrWd-domains contained within a larger PrWd-domain: ((....)(....)), and not of a single PrWd-domain embedded with a larger PrWd-domain: (..... (...)). As it stands, the latter structure is unable to account for the occurrence of two accents in the cases discussed later (see (170) and (171)).

57. In the present context, an alternative would be a prosodic version of the *STRUC constraint.

58. In order to avoid some of the difficulties arising out of the different demands imposed on the single category PrWd, one could consider a virtual prosodification analysis, where the structure with two internal prosodic words is used as a reference point, but is not the one assigned to the output candidate. Concretely speaking, a sympathy candidate could be used to provide the rich prosodic structure necessary for the correct computation of compound voicing (for Sympathy Theory and some of its applications, see McCarthy 1997, Davis 1997, Ito & Mester 1997c, Karvonen & Sherman 1997, Walker 1998, among others). In the direct prosodification analysis seen in the text, the alignment constraint, ALIGN-LEFT (WD, PRWD), is a high-ranking constraint that chooses the multiple-PrWd structure as optimal. In a sympathy analysis, on the other hand, the optimal candidate is chosen through sympathetic identity to the best candidate satisfying ALIGN-LEFT (WD, PRWD). This means that the ALIGN-LEFT constraint is ranked below the NONRECURSIVITY constraint, but it still exerts its influence on the output through Sympathy.

(i) NONRECURSIVITY (PrWd) >> Align-Left (MWd, PrWd)

Align-Left is the constraint responsible for the determining the sympathy-candidate ((iic), marked with ❀):

(ii)

	NONRECUR (PRWD)	Align-Left❀ (MWd,PrWd)	IDENT-[voi] ❀O	VOP / $_{PrWd}$[—	SeqVoi
M: [[ ]] ☞ a. nuri kasa-ire P: ( )		*			*
[[ ]] b. nuri gasa-ire ( )		*	*!		
[[ ]] ❀ c. nuri kasa-ire (( )( ))	*!				*
[[ ]] d. nuri gasa-ire (( )( ))	*!			*	

In this sympathy scenario, the blocking effect does not depend on the existence of an actual output—it is enough that there be a sympathetically-related structure where the segment targeted by Rendaku is PrWd-initial. One of the potential problems here is the very fact that the failed candidate is only a virtual form, no independent existence is required. This is, of course, the strong point about sympathy in general, making it a powerful analytical tool. However, for cases of analogical faithfulness such as the one under discussion, sympathy make it look like a mere coincidence that the crucial sympathy candidate is identical with an actual word.

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