1. **Goals and outline of this handout**

Goals:

What does OT have to say about the permitted range of variation between languages? In a theory where all constraints are in principle and in fact violable, how are language universals accounted for? This handout offers some answers.

Outline:

1. Goals and outline of this handout ................................................................. 1
2. Language typology ............................................................................................. 1
3. Language universals .......................................................................................... 3
4. Universals and the basic theory of CON ......................................................... 3
5. Language universals and substantive properties of CON .............................. 5
6. Implicational universals ..................................................................................... 6
7. Universals in GEN? ........................................................................................... 7
8. References ........................................................................................................... 7

2. **Language typology**

Factorial typology:

- Claim: Every permutation of the ranking of CON is a possible grammar of a human language.
- Claim: Every actual grammar of a human language is a permutation of CON.
- Claim: All systematic differences between languages are expressed by the grammar (~ROTB).
- Claim: CON is universal, because it’s innate and/or it’s acquired from universally shared experience.
- Consequence of these claims: If we get CON right, then we have a complete theory of language typology. (Typology = the study of the ways in which languages can and cannot vary.)

If the claims above are dropped or modified in various ways, what happens to the consequence?

Remarks and clarifications:

- The number of permutations of a set with \( n \) elements, \( n! \), increase very rapidly with \( n \). (E.g., 27! \( \approx \) mass of the Earth in grams.)
- Does this mean that, if \( |CON| = n \), there are \( n! \) different possible human languages?
- No, because some constraints never conflict with one another, so their ranking doesn’t matter.
• Does it mean that learners must search through a vast space of \( n! \) possibilities, hoping to find the right grammar before they die?
• No, language acquisition isn’t blind search. The correct ranking is obtained by gradual approximation through a sequence of determinate steps. Handout #5 explains how.

Contents of \( \text{CON} \):
• Obviously, we don’t know everything about \( \text{CON} \) — if we did, then linguists would be out of work!
• We have a reasonably good idea about what faithfulness constraints must do.
• The markedness \( \text{terra} \) is much more \( \text{incognita} \), though some areas of markedness are fairly well understood (e.g., stress).
• The results of factorial typology rely on the assumption that \(|\text{CON}|\) is finite.
• Some theories of \( \text{CON} \) posit constraints based on literal measurement of physical quantities, such as formant frequencies, perceptual distance, or articulatory effort (Boersma 1998, Kirchner 1998). These theories would seem to imply that \(|\text{CON}|\) is non-denumerably infinite, since measurements can in principle be done with arbitrary precision. This problem can be avoided, however, by limiting the constraints to quanta defined by the granularity inherent in such activities, such as the just noticeable difference in perception.

Practical considerations:
• If we don’t have a comprehensive theory of \( \text{CON} \), how can we study factorial typology at all?
• Answer: Even if we don’t know everything about \( \text{CON} \), we can usually say what kinds of constraints must not be in \( \text{CON} \) if our typological results are to hold up.
• The next section presents an example from Timugon Murut.

Example:

Do the problem set on Bedouin Arabic.
Examine the results of permuting the ranking of the constraints involved.
Are some logically possible linguistic patterns predicted to be impossible under this factorial typology?
What constraints, if they existed, would undermine these predictions?
How can we describe nonexistent constraints? In terms of their favoring relations (W vs. L).

Universals and factorial typology:
• “Research in typology, the ways in which languages vary, often overlaps with research in linguistic universals, the ways in which they don't vary.” Wikipedia (!)
• Factorial typology accounts for how languages vary, but it’s equally or even more important as a theory of how they cannot vary.
3. Language universals

Universals:
- Language universals are descriptions of impermissible between-language variation.
- Typically, language universals are not stated outright in OT.
- Rather, language universals are entailed by factorial typology and a specific theory of CON. (Less centrally, explanations for universals may require specific assumptions about representations or GEN.)
- Universals can be usefully classified and studied by what they require of CON, ranging from the very general (CON contains only markedness and faithfulness constraints) to the specific and substantive (CON contains certain specific constraints and not others). (I owe my understanding of this distinction to Prince 1997a.)
- There is a danger in failing to make this distinction. For example, Breen and Pensalfini (1999: 15fn.) claim that the constraints NO-ONSET and CODA “are quite explicitly ruled out in OT”. In reality, this has nothing to do with OT per se; it’s just a specific hypothesis about CON, a hypothesis that could be wrong without undermining the rest of the theory.

Descriptive universals and principles of grammar:
- From an OT perspective, most universals are purely descriptive — they aren’t encoded directly in the theory, but rather they emerge from factorial typology and hypotheses about CON.
- In most other theories, principles of grammar give more or less direct expression to language universals.
- Some early work in OT, particularly OT syntax, proceeded by taking inviolable principles of grammar from other theories and declaring them to be violable constraints.
- In general, this is a poor research strategy: if a principle is inviolable because it describes a true language universal, calling it violable is not going to advance our understanding or improve empirical coverage.
- On the other hand, if a putative inviolable principle is surrounded by codicils and caveats, or is parametrized, or appears not to be universally true after all, then adopting it as a violable constraint in CON can be a sound research strategy.
- The OCP is a good example of this from phonology (see Handout #1 (section 2) and Myers 1997).

4. Universals and the basic theory of CON

The basic theory of CON:
- CON contains markedness constraints, which evaluate output forms.
- CON contains faithfulness constraints, which favor input-output identity.
- There are no other kinds of constraints in CON.

Harmonic ascent (Moreton 2003):
- Further assume a restriction on GEN to the effect that every candidate set contains a fully faithful candidate: GEN(/input/) \(\rightarrow\) chain.
- Since every faithfulness constraint favors the mapping /input/ \(\rightarrow\) [input], only a markedness constraint ranked above a faithfulness constraint could cause some other, less faithful candidate to win. Call that winning but less faithful candidate [winner].
• Result: [winner] is less marked than [input] according to the markedness constraints as they are ranked in the language in question.
• Slogan: you can only get less marked or stay the same. You can’t change to become less marked or even equally marked.

Predictions of harmonic ascent:
• Unless some markedness constraint(s) in $\text{CON}$ assert(s) that [winner] $>$ [input], no language can have the mapping /input/ $\rightarrow$ [winner].
• There can be no circular chain shifts (cf. exchange rules in Chomsky and Halle (1968) and Anderson and Browne (1973).) E.g., /pat/ $\rightarrow$ [pit] and [pit] $\rightarrow$ [pat], or /pra/ $\rightarrow$ [par] and /par/ $\rightarrow$ [pra], or /bili/ $\rightarrow$ [bil] and [bil] $\rightarrow$ [bili], in the same language.
  Why?
• There can be no infinite chain shifts. E.g., augment every word by one syllable.
  Why?

Are these predictions correct?
• The first prediction (existence of /input/ $\rightarrow$ [winner] mapping implies existence of [winner] $>$ [input] markedness constraint(s)) depends on substantive properties of $\text{CON}$, for which see the next section.
• Are there any circular chain shifts? Possible counterexamples:
  o Anderson and Browne (1973) show that known examples of exchange rules (not exactly the same thing) are always morpholexical.
  o Moreton makes a convincing case that Zonneveld’s (1976) Flemish Brussels Dutch example is not a real exchange process.
  o Taiwanese tone sandhi remains problematic, though weird in other ways as well.
  o Fitzpatrick, Nevins, and Vaux (2004) present a possible case from an Armenian dialect: /kov/~/kovar/ $\rightarrow$ [kuv]--[kavar] vs. /tun/~/tunar/ $\rightarrow$ [ton]/[tonar]. (They note that /o/ pattern is only observed before nonnasals, /u/ pattern only before nasals. If this holds up, there’s no argument for a circular chain shift.)
• Why can morphology do what phonology cannot? See Alderete (1998) and Kurisu (2001) for some possible answers, and Anderson (1975) for earlier discussion of this question.
• Are there any infinite chain shifts? Not in phonology, certainly. No phonological process requires mere growth without a target.

Limits on process-specific constraints:
This discussion is based on a proposal by Alan Prince (see Prince 1997b), which was prompted by a question raised by Stuart Davis (see Davis 1995). For more on the topic, see McCarthy (1997) and Bakovic (2000: Chapter 4).

See the handout “Process-Specific Constraints”
5. *Language universals and substantive properties of CON*

Logic of these typological results:
- If no permutation of \( CON \) yields the output structure \( X \) for any input, then \( X \) is predicted to be absent from the inventory of every language. (\( X \) can be a segment, a sequence, a prosodic constituent, or whatever.)
- If every permutation of \( CON \) yields the output structure \( X \) for some input, then \( X \) is predicted to be present in the inventory of every language.
- Implicational universals (any inventory that contains \( X \) also contains \( Y \)) are a little more complicated — see below.

What is the role of ROTB in such arguments?

Example: Basic CV syllable theory (Prince and Smolensky 2004)
- Putative universal: in \( /...VCV.../ \), the C is always syllabified as an onset \( [...VSCV...] \).
- True even in languages that permit syllables without onsets and with codas.
- Assume \( CON \) is limited to the constraints in (1).
- Now look at all their permutations or, better, look at the unranked tableau (2).

What does tableau (2) show?

(1) A hypothesis about \( CON \)

\[
\begin{array}{c}
\text{ONSET} \\
\text{NO-CODA} \\
\text{MAX} \\
\text{DEP}
\end{array}
\]

(2) Unranked tableau attempting to derive \( /...VCV.../ \rightarrow [...VCSV...] \)

<table>
<thead>
<tr>
<th>/...VCV.../</th>
<th>ONSET</th>
<th>NO-CODA</th>
<th>MAX</th>
<th>DEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>\rightarrow [...VCSV...]</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>\sim [...V$CV...]</td>
<td>L</td>
<td>L</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Obviously, (1) is insufficient as a theory of \( CON \). If we want to avoid breaking this argument, what sort of constraints must \( CON \) not contain? Hint: think about faithfulness as well as markedness.

The putative universal was framed as a statement about mapping: \( /...VCV.../ \rightarrow [...VCSV...] \) in no language. What if we framed it as a pure inventory statement: \( [...VC$V...] \) never occurs in the inventory of any language. What would be needed to argue for this more general statement.

If we find a language with \( /...VCV.../ \rightarrow [...VCSV...] \) under specific conditions (e.g., stem-finally or if the preceding syllable is stressed), how do we break harmonic bounding in just these cases?

Example: Reduplicative infixation (McCarthy and Prince 1993)

See Timugon Murut handout from previous class and handout with excerpt from M&P 1993 (135-142).
Example: Direction of iambic parsing (McCarthy and Prince 1993)

See handout with excerpt from M&P 1993 (pp. 162-163).

Splitting vs. lumping in CON

See handout “One or two constraints?”

6. Implicational universals

See Prince and Smolensky (2004) on “harmonic completeness”, especially chapters 8 and 9; various works by Prince (1997b, 1997c, 1998); de Lacy (2002); and other literature cited in ATGtOT on pp. 44 and 181.

What are they?

- Implicational universals take the form “If a language has X, it also has Y”.
- Examples: if a language has CVCC syllables, it also has CVC syllables (simple ⇒ complex); if a language has nasal consonant nuclei, it also has liquid nuclei (marked ⇒ unmarked).

Simple implicational universals:

X ⇒ Y requires that CON contain *X but not *Y. (This doesn’t rule out the equivalent of *[X∨Y] in CON. That is, we can have X ⇒ Y even if not every language has Y.)

Explain why this works.

What about faithfulness? How could faithfulness undermine this result?

Local constraint conjunction:

- Local constraint conjunction (Smolensky 1995 and other references on p. 43 of ATGtOT) combines two already existing constraints to make a third. [A&B]δ is violated once for every domain δ that violates both A and B.
- Local conjunction of markedness constraints defines “worst of the worst” situations. E.g., [NO-CODA&*VCDOBST]Segment is violated by voiced coda obstruents, which are therefore worse than other codas or voiced obstruents in non-coda position.

Multi-tiered implicational universals:

See handout “Constraints and linguistic hierarchies”.
7. **Universals in GEN?**

Universals in GEN?
- Just say “no”!
- GEN is appropriate as a repository for certain formal universals: the distinctive features are [coronal], [round], …; the prosodic hierarchy is PWd > Ft > σ > µ. Perhaps it also contains some universals of a slightly more substantive character: non-terminal constituents have heads; feet contain no more than two syllables.
- But GEN doesn’t and shouldn’t contain universals like those discussed in the preceding section.

Why is it a bad research strategy in OT to dump universals into GEN?

8. **References**


Prince, Alan (1997b) Endogenous constraints on Optimality Theory. Handout from Summer Institute of the Linguistic Society of America, Cornell University, Ithaca, NY. [Course presented at the LSA Summer Institute.]

Prince, Alan. 1997c. Paninian relations. Handout of talk presented at University of Massachusetts Amherst, Amherst, MA.


Bedouin Arabic Problem

(1) Syllabificational Consequences of Guttural Consonants

Negev Bedouin Arabic (hereafter NBA) (Blanc 1970), like most Semitic languages, has a class of consonants called gutturals, articulated in the posterior regions of the vocal tract. In IPA transcription, the gutturals are ḥ, ẓ, ð, ḫ, ʁ, and ʕ, and they are identified by the distinctive feature specification [+pharyngeal].

One way in which the gutturals are singled out in NBA phonology is the following alternation:

<table>
<thead>
<tr>
<th>Plain Consonant</th>
<th>Guttural Consonant</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Color Adjectives</td>
<td></td>
</tr>
<tr>
<td>sawda</td>
<td>‘black’</td>
</tr>
<tr>
<td>baʕaθa</td>
<td>‘gray’</td>
</tr>
<tr>
<td>dahama</td>
<td>‘dark red’</td>
</tr>
<tr>
<td>b. Verb Form X</td>
<td></td>
</tr>
<tr>
<td>ʔistaslam</td>
<td>‘he surrendered’</td>
</tr>
<tr>
<td>ʔistaʕazal</td>
<td>‘he got in a hurry’</td>
</tr>
<tr>
<td>ʔistaʕafar</td>
<td>‘he asked forgiveness’</td>
</tr>
<tr>
<td>c. Verb Form I Passive Participle</td>
<td></td>
</tr>
<tr>
<td>maktuub</td>
<td>‘written’</td>
</tr>
<tr>
<td>maʕaʃuur</td>
<td>‘neglected’</td>
</tr>
<tr>
<td>maʕazuuur</td>
<td>‘invited’</td>
</tr>
<tr>
<td>maʕazuum</td>
<td>‘tied’</td>
</tr>
<tr>
<td>maʕaðuuur</td>
<td>‘excused’</td>
</tr>
<tr>
<td>d. Verb Form I Imperfect</td>
<td></td>
</tr>
<tr>
<td>yaʃrab</td>
<td>‘he drinks’</td>
</tr>
<tr>
<td>yaχadim</td>
<td>‘he serves’</td>
</tr>
<tr>
<td>yahakim</td>
<td>‘he governs’</td>
</tr>
<tr>
<td>yaktbin</td>
<td>‘they f. drink’</td>
</tr>
<tr>
<td>yaχadmin</td>
<td>‘they f. serve’</td>
</tr>
<tr>
<td>yaχadmu:n</td>
<td>‘they m. serve’</td>
</tr>
</tbody>
</table>

Words in the column labeled “Plain Consonants” show the expected form of the different adjectival or verb types mentioned. For instance, adjectives of color or bodily defect have the shape CaCCA, like sawda. This is the underlying form of all such adjectives, including /baʕaθa/ and /dahma/. Since underlying /baʕaθa/ maps unfaithfully as baʕaθa in the output, some markedness constraint must be compelling unfaithfulness. Formulate that constraint, and give appropriate ranking arguments to establish its interactions with MAX and DEP. Try to account for the quality of the epenthetic vowel as well.
(2) Now consider the following data:

a. rawwaḥ ‘he went home’  
rawwaḥna ‘we went home’  
rawwaḥti ‘you (f. sg.) went home’

b. šayyaʕ ‘he sent’  
šayyaʕku ‘he sent you (m. pl.)’  
šayyaʕha ‘he sent her’

c. balah ‘dates’  
balahkin ‘your (f. pl.) dates’

d. manaʕ ‘he prohibited’  
minaʕna ‘we prohibited’

e. difaʕ ‘he pushed’  
difaʕna ‘we pushed’

Are these data compatible with your analysis, or do they have an unexpected property? How will you account for them? State any additional constraint required and give appropriate ranking arguments. Include summary tableaux for one example from each of (1) and (2). (Summary tableau = all constraints and several candidates, needed to verify ranking arguments.)

Notes:

1. Words are syllabified like this: (Ḥa)(ta)(ʕa)(zal), (mak)(tuub), (ya)(ʕad)(min), (raw)(waḥ)(na), etc.

2. There are some other phonological alternations exemplified here. You aren’t given sufficient information to analyze them and shouldn’t try.

References


Process-Specific Constraints

1. The Data and Description: Emphasis Spread in Southern Palestinian Arabic (from Davis 1995)

- Harmonizing feature is [RTR] (retracted tongue root), opposite of [ATR].
- Only /S, T, D, Z/ have underlying [RTR] contrasts.
- [RTR] spreads leftward from underlying [RTR] segments until beginning of word -- see (1).
- [RTR] spreads rightward from underlying [RTR] segments until end of word or high front segment iyʃj -- see (2).

Notation: underlying [RTR] segments are capitalized. Extent of harmony shown by double-underlining

(1) Leftward Spread

ballaaS  haDD
?absaT  baaS
faTšaan  manaafīD
xavyaaT  našaaT
 tamšiiTa  majaSSaSiš

(2) Rightward Spread

Sabaaḥ  ?aTfaal
Tuubak  Twaal
Tiinak  Šayyaad
faTšaan  Dajjaat
Sootak  Seefak

2. The Rule-Based Analysis in Davis (1995)

Background: Agonistic and Antagonistic Effects Between Tongue Root and Tongue Body
(Key element of Archangeli and Pulleyblank's (1994) “Grounded Phonology”)

I. Background
- The tongue is a bag of water, approximately.
- Water is nearly incompressible.
- Pushing one end of the tongue causes it to squirt out at the other end.
II. Articulatory Consequences

(5) $[+\text{high}]$ implies $[+\text{ATR}]$, not $[-\text{ATR}]$

(6) $[+\text{low}]$ implies $[-\text{ATR}]$, not $[+\text{ATR}]$

(10) Implications of tongue root position
  a. $[+\text{ATR}]$ implies $[+\text{high}]$, not $[-\text{high}]$.
  b. $[+\text{ATR}]$ implies $[-\text{low}]$, not $[+\text{low}]$. 
c. $[-\text{ATR}]$ implies $[-\text{high}]$, not $[+\text{high}]$.
d. $[-\text{ATR}]$ implies $[+\text{low}]$, not $[-\text{low}]$.

Associated Constraints:

(3) $\text{ATR/Hi}$ If ATR, then high.
(4) $\text{ATR}/\neg\text{LO}$ If ATR, then not low.
(5) $\text{RTR}/\neg\text{HI}$ If RTR, then not high.
(6) $\text{RTR}/\text{LO}$ If RTR, then low.
(7) $\text{ATR}/\text{FR}$ If ATR, then front.
(8) $\text{RTR}/\neg\text{FR}$ If RTR, then not front.

Process-Specific Constraints in Rule-Based Phonology

Phonetically grounded constraints on co-occurrence of ATR/RTR with tongue-body features are incorporated as “target conditions” (after Archangeli and Pulleyblank 1994) on rules of spreading:

(9) Rightward $[\text{RTR}]$ Spread in Southern Palestinian Arabic (quoted from Davis 1995: 476)

Argument

$[\text{RTR}]$

Parameters
1. Function: INSERT
2. Type: PATH
3. Direction: LEFT TO RIGHT
4. Iteration: ITERATIVE

Structure requirements
1. Argument structure: NONE
2. Target structure: FREE

Other requirements
1. Argument condition: SECONDARY PLACE
2. Target conditions: RTR/$\neg$HI and RTR/$\neg$FR
These target conditions say that the targeted segment, if it were to undergo the process, must satisfy both RTR/¬Hi and RTR/¬Fr. That means that high, front segments (like i or y) block spreading. By comparison, leftward [RTR] spread (in both dialects) is subject to no such target conditions.

3. An OT Analysis

(10) Constraints on RTR Alignment
   a. RTR-LEFT
      Align([RTR], Left, Word, Left)
      “Any instance of [RTR] is aligned initially in Word.”
   b. RTR-RIGHT
      Align([RTR], Right, Word, Right)
      “Any instance of [RTR] is aligned finally in Word.”

Rankings

Tableau 1
RTR-LEFT >> IDENT-ATR

<table>
<thead>
<tr>
<th></th>
<th>/ballaaS/</th>
<th>RTR-LEFT</th>
<th>IDENT-ATR</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>ballaaS</td>
<td></td>
<td>****</td>
</tr>
<tr>
<td>b.</td>
<td>ballaaS</td>
<td>* ! ***</td>
<td></td>
</tr>
</tbody>
</table>

Tableau 2
RTR-RIGHT >> IDENT-ATR

<table>
<thead>
<tr>
<th></th>
<th>/Sabaah/</th>
<th>RTR-RIGHT</th>
<th>IDENT-ATR</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
<td>Sabaah</td>
<td></td>
<td>****</td>
</tr>
<tr>
<td>ii.</td>
<td>Sabaah</td>
<td>* ! ***</td>
<td></td>
</tr>
</tbody>
</table>

(11) Ranking of Core Constraints in Southern Palestinian
RTR-LEFT, RTR-RIGHT >> IDENT-ATR

Tableau 3
RTR/Hi&Fr >> RTR-RIGHT

<table>
<thead>
<tr>
<th></th>
<th>/Sayyaad/</th>
<th>RTR/Hi&amp;Fr</th>
<th>RTR-RIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Sayyaad</td>
<td></td>
<td>***</td>
</tr>
<tr>
<td>b.</td>
<td>Sayyaad</td>
<td>* !</td>
<td></td>
</tr>
</tbody>
</table>

Remark: RTR/¬Hi&¬Fr is local conjunction (in the sense of Smolensky 1995) of RTR/¬Hi and RTR/¬Fr. Only the worst of the worst is ruled out.
Tableau 4
RTR-LEFT >> RTR/¬Hi&¬Fr

<table>
<thead>
<tr>
<th></th>
<th>/xayyaaT/</th>
<th>RTR-LEFT</th>
<th>RTR/¬Hi&amp;¬Fr</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>xayyaaT</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b.</td>
<td>xayyaaT</td>
<td></td>
<td>* ! **</td>
</tr>
</tbody>
</table>

(12) Full Ranking for Southern Palestinian
RTR-LEFT >> RTR/¬Hi&¬Fr >> RTR-RIGHT >> IDENT-ATR

4. Discussion

General results (McCarthy 1997; Prince 1997; Prince 1998):

• Process-specific constraints are indeed possible in OT (*pace* Davis 1995).

• But the thesis that constraint ranking is a total ordering limits the kinds of process-specificity that are possible:

(13) General Schema for Process Specificity
L >> M_i >> C >> M_j >> F

M_i >> F and M_j >> F are two “processes”. The markedness constraint C can block the M_j >> F process, but not the M_i >> F process. The markedness constraint L can block both processes. In general, there is no way to guarantee that C and L can each block exactly one process (unless, of course, the two processes are so different that C and L are each only relevant to one process).

“Relatedly, how would Optimality Theory analyze a possible dialect in which rightward spread of emphasis is subject to one grounded condition whereas leftward spread of emphasis is subject to a different grounded condition? If such a dialect were reported, it would be potentially problematic for an Optimality Theory account.” (Davis p. 495)

(14) Mutually Incompatible Constraint Rankings Required in Davis’s Hypothetical Case

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. RTR/Hi &gt;&gt; RTR-RIGHT</td>
<td>High segments block rightward harmony.</td>
</tr>
<tr>
<td>b. RTR-RIGHT &gt;&gt; RTR/Fr</td>
<td>Front segments don’t block rightward harmony.</td>
</tr>
<tr>
<td>c. RTR/Fr &gt;&gt; RTR-LEFT</td>
<td>Front segments block leftward harmony.</td>
</tr>
<tr>
<td>d. RTR-LEFT &gt;&gt; RTR/Hi</td>
<td>High segments don’t block leftward harmony.</td>
</tr>
</tbody>
</table>
Conclusion

This argument shows that constraint ranking, which is the central element of OT, has highly restrictive consequences for the character of process-specific constraint interactions. Related processes are ranked for a kind of robustness that may be seen from the subset relation among any constraints that limit their effect. In contrast, parametric rule-based theories make no such prediction. If arbitrary process-specific constraints are included as parameters in the processes themselves, as in (9), then any process can be governed by any constraint, without regard to other processes coexisting in the grammar.

And to what aqueous receptacle do we compare the tongue?

References

For the purposes of this exercise, you are to assume universal CON includes the following constraints:

1. **ONSET**
   - Vowel-initial syllables are prohibited. Assign one mark for each [oV].

2. **NO-CODA**
   - Syllable-final consonants are prohibited. Assign one mark for each C].

3. **MAX**
   - Assign one mark for each input segment that lacks an output correspondent.

The goal of the homework exercise is to determine the typological consequences of two different theories of the anti-epenthesis constraint.

**Theory A**
There is a single anti-epenthesis constraint in CON, and it is defined as follows:

4. **DEP**
   - Assign one mark for each output segment that lacks an input correspondent.

**Theory B**
There are two anti-epenthesis constraints in CON, and they are defined as follows:

5. **DEP-V**
   - Assign one mark for each output vowel that lacks an input correspondent.

6. **DEP-C**
   - Assign one mark for each output consonant that lacks an input correspondent.

Show what grammars these two distinct DEP theories predict under ranking permutation, and explain what sort of data would in principle help decide between them. (You do not need to present actual linguistic data, which may be hard to come by, but it should be clear from your description what sort of data would be relevant.)
1. Linguistic Hierarchies

Human language is full of what are called *implicational universals*. The general form of an implicational universal is “in any language where A does X, B also does X”. The implications are asymmetric: there are some languages where B does X but A doesn’t. In every human language, then, B is somehow more congenial or more strongly attracted to X than A is.

Examples:

Syllable nuclei:
- Every language has vowel nuclei.
- Some languages have liquids and vowels as nuclei.
- Some languages have nasals, liquids, and vowels as nuclei.
- Etc.

Subjects:
- Some languages permit only human subjects.
- Some languages permit only animate subjects.
- Etc.

Many implicational universals are of this type: there is a structural position (a ‘slot’) and there is a hierarchy of preferred fillers for that slot.

2. Linguistic Hierarchies from Fixed Rankings

Prince and Smolensky (2004) address the problem of implicational universals by proposing that there can be hierarchies of fixed (i.e., non-permutable) rankings in CON. One of their examples is the Peak Hierarchy:

(1) The Nucleus (Peak) Hierarchy

\[ *\text{VCLS\text{STOP}/NUC} > *\text{VCD\text{STOP}/NUC} > *\text{VCLS\text{FRIC}/NUC} > *\text{VCD\text{FRIC}/NUC} > *\text{NAS/NUC} > *\text{LIQ/NUC} > *\text{HIGH\text{VOC}/NUC} > *\text{LOW\text{VOC}/NUC} \]

(The naming convention for these constraints is *Filler/Slot.)

Since the ranking of the Peak Hierarchy is fixed, it says that voiceless stops are the worst nuclei in any language, *ceteris paribus*, and low vowels are the best nuclei. The fixed ranking means that we will never find a grammar where, for example, \( *\text{NAS/NUC} > *\text{VCD\text{FRIC}/NUC} \), though we may (and often do) find grammars where \( *\text{VCD\text{FRIC}/NUC} > C > *\text{NAS/NUC} \), where C is some other constraint (often, faithfulness).

The Peak Hierarchy is related to a linguistic *scale*, the sonority scale. Higher sonority \( \Rightarrow \) better
nucleus, and the fixed ranking reflects this. Since fixed rankings threaten to undercut factorial typology, it’s best to impose some kind of restriction on their use. A plausible restriction: CON can only contain fixed hierarchies whose ranking is determined by an independently motivated linguistic scale.

Questions:

Suppose CON contains the Peak Hierarchy and the familiar faithfulness constraints MAX and DEP. Show that this entails the following implicational universal:

(2) If α and β are segments of some language L, if the sonority of α is greater than the sonority of β, and if β is a possible nucleus of L, then α is a possible nucleus of L.

By “possible nucleus” I mean some segment that is parsed as a nucleus sometimes (though perhaps not always).

Imdlawn Tashlhiyt Berber (ITB) allows any segment to be a nucleus under the right conditions. Using the Peak Hierarchy, can you account for the syllabification of the following forms? (Nuclei have been capitalized.)

<table>
<thead>
<tr>
<th>Nucleus Type</th>
<th>Example</th>
<th>Morphology</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>voiceless stop</td>
<td>.RA.tK.tl.</td>
<td>ra-t-kti</td>
<td>1985: 113</td>
</tr>
<tr>
<td>voiced stop</td>
<td>.BD.dL.</td>
<td>bddl</td>
<td>1988: 1</td>
</tr>
<tr>
<td></td>
<td>.ma.ra.tGt.</td>
<td>ma=ra-t-g-t</td>
<td>1985: 113</td>
</tr>
<tr>
<td>voiceless fricative</td>
<td>.TF.tKt.</td>
<td>t-ftk-t</td>
<td>1985: 113</td>
</tr>
<tr>
<td></td>
<td>.tX.zNt.</td>
<td>t-xzn-t</td>
<td>1985: 106</td>
</tr>
<tr>
<td>voiced fricative</td>
<td>.txZ.nAkk^&quot;</td>
<td>t-xzn#nakk^&quot;</td>
<td>1985: 113</td>
</tr>
<tr>
<td>nasal</td>
<td>.tZMt.</td>
<td>t-zmt</td>
<td>1985: 112</td>
</tr>
<tr>
<td></td>
<td>.tM.zh.</td>
<td>t-mzh</td>
<td>1985: 112</td>
</tr>
<tr>
<td>liquid</td>
<td>.tR.gLt.</td>
<td>t-rgl-t</td>
<td>1985: 106</td>
</tr>
<tr>
<td>high vowel</td>
<td>.II.dI.</td>
<td>i-ldi</td>
<td>1985: 106</td>
</tr>
<tr>
<td></td>
<td>.rAt.IUlt.</td>
<td>ra-t-lul-t</td>
<td>1985: 108</td>
</tr>
<tr>
<td>low vowel</td>
<td>.tR.bA.</td>
<td>t-rba</td>
<td>1985: 106</td>
</tr>
</tbody>
</table>

Source: (Dell and Elmedlaoui 1985, 1988)
Analysis: (Prince and Smolensky 2004)
3. A Single Constraint?

What if the Peak Hierarchy were replaced with a single constraint that, say, assigns 7 *s to any voiceless stop nuclei, 6 *s to any voiced stop nuclei, and so on, assigning 0 *s only to low vowel nuclei? (This constraint is called HNUC in Prince and Smolensky.) Will this constraint work in Berber? Will it work generally, and does it provide a model for how to incorporate linguistic scales into CON?

4. Stringency Relations

There is a way to achieve almost exactly the same results without fixed rankings. The crucial move is to define the constraints in such a way that the desired entailments follow from how the constraints assign violation-marks.

Two constraints S and G stand to one another as specific to general if every violation assigned by S is matched by a violation assigned by G, but not vice-versa. For instance, NO-HIATUS and ONSET stand in a specific/general relation: every instance of hiatus involves an onsetless syllable, but there can be onsetless syllables that don’t involve hiatus. The special/general relation is also known as a stringency relation: G is the more stringent constraint because it assigns a superset of S’s violation-marks.

What are the possible tableaux when two constraints stand to one another as S to G?

If two constraints stand to one another as S to G, are they directly rankable?

Are they indirectly rankable? Construct an example to illustrate.

Define a set of constraints in a nested specific/general relation that are sufficient to replace the Peak Hierarchy. Show that they produce similar results with Berber.

Very, very hard question: In grammars of the form ... >> G >> ... >> S >> ..., will S ever have any work to do? That is, will S ever crucially decide between a winning and a losing candidate?

References

In (39b), the two candidates tie on ONSET, since each has a single onsetless syllable. As usual, the decision passes to the next constraint, ROOT-ALIGN, which selects the infixed candidate over the prefixed one.

The complete hierarchy of constraints relevant to infixation in Dakota is ONSET >> RT-ALIGN >> LEFTMOSTNESS. Like the Axininca constraint hierarchy, the Dakota one follows the P >> M schema in a fine-grained way. At the extrema are constraints that are purely within the P or M domains: ONSET and LEFTMOSTNESS. In between is a constraint that governs the interface between prosody and morphology, ROOT-ALIGN. Thus, within the P-block, we distinguish a sub-block Φ of phonological constraints from a sub-block I of interface constraints, with the relation Φ >> I. From this ranking schema and three constraints, each of which represents a banal observation about Dakota grammar, we obtain a pattern of surprising subtlety, in which something that is nominally a prefix is infixed after the first syllable, unless phonotactic considerations demand that it be prefixed. It is the interaction of the constraints, rather than the statement of the constraints themselves, that supplies the intelligence behind this patterning.

To obtain a further, unexpected set of consequences from the P >> M perspective, we turn to examine yet another infixation pattern. In a remarkably wide variety of languages, there is a type of reduplication that can be described as copying the first CV sequence of the word, skipping over an initial onsetless syllable. This pattern is found in the Sanskrit aorist and desiderative (Kiparsky 1986; McCarthy and Prince 1986; Janda and Joseph 1986:89), the Austronesian languages Pangasinàn of Luzon, Philippines (Benton 1971:99, 117) and Timugon Murut of Sabah, Malaysia (Prentice 1971), and the non-Austronesian languages of Papua New Guinea Yareba (Weimer and Weimer 1970, 1975:685), Orokaiva (Healey, Isoroembo, and Chittleborough 1969:35-36), Flamingo Bay Asmat (Voorhoeve 1965:51), and undoubtedly many others. The Timugon Murut reduplication in (40) is a typical example, showing that initial onsetless syllables are systematically skipped over:

(40) Timugon Murut Infixing Reduplication

\[
\begin{array}{lll}
\text{bulud} & \text{bu–bulud} & \text{‘hill/ridge’} \\
\text{limo} & \text{li–limo} & \text{‘five/about five’} \\
\text{ulampoy} & \text{u–la–lampoy} & \text{no gloss} \\
\text{abalan} & \text{a–ba–balan} & \text{‘bathes/often bathes’} \\
\text{ompodon} & \text{om–po–podon} & \text{‘flatter/always flatter’}
\end{array}
\]

Descriptively, a light syllable (σ,µ) template is infixed after an initial onsetless syllable, otherwise it is prefixed.

Though it might be possible to construct a circumscriptional analysis of facts like these (McCarthy and Prince 1991b), the result is quite unsatisfactory. For one thing, negative

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88Some examples of Sanskrit aorist and desiderative reduplication:

(i) Aorists
\[
\begin{array}{llll}
\verb|\bar{a}rc| & \text{aar–gi–c–am} & \verb|\bar{u}bj| & \text{aub–ji–j–am} \\
\verb|\bar{a}rh| & \text{ar–ji–h–am} & \verb|\bar{r}dh| & \text{ar–di–dh–am} \\
\verb|\bar{k}s| & \text{ai–gi–ks–am}
\end{array}
\]

(ii) Desideratives
\[
\begin{array}{llll}
\verb|\bar{a}rh| & \text{ar–ji–h–isa} & \verb|\und| & \text{un–di–d–isa} \\
\verb|\bar{r}dh| & \text{ar–di–dh–isa}
\end{array}
\]
The arguments from the nonstressing of word-initial onsetless syllable in Arandic languages (Davis 1988b, Halle and Vergnaud 1987, Archangeli 1988) suggest the imposition of syllabic well-formedness conditions on the stress-peak, as suggested in Prince and Smolensky (1991a, 1993). As noted in the discussion of Dakota, if underlying onsetless syllables are parsed with epenthetic consonants, the P-constraint relevant here may be FILL rather than ONSET.

Kiparsky (1986:74-75) proposes that the Murut (and Sanskrit) pattern of infixation is a consequence of extrametricality of initial onsetless syllables. He suggests in a footnote that infixation after the extrametrical syllable is a way to avoid violating the Peripherality Condition on extrametricality. This interesting idea has certain abstract similarities to our approach.

The tableaux (41, 42) show how the correct result devolves from this ranking, assuming a set of candidates where the Reduplicant exactly matches the light syllable template:

(41) Timugon Murut \( \sigma_\mu \)- Reduplication. C-initial Words.

<table>
<thead>
<tr>
<th>Candidates</th>
<th>P (ONSET)</th>
<th>M (LEFTMOSTNESS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>bu.bu.lud</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bu.lu.lud</td>
<td></td>
<td>bu !</td>
</tr>
</tbody>
</table>

Both candidates obey ONSET, so they are referred to LEFTMOSTNESS, which selects \( \text{bu–bulud} \), whose prefix is perfectly prefixal.

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89The arguments from the nonstressing of word-initial onsetless syllable in Arandic languages (Davis 1988b, Halle and Vergnaud 1987, Archangeli 1988) suggest the imposition of syllabic well-formedness conditions on the stress-peak, as suggested in Prince and Smolensky (1991a, 1993).

90As noted in the discussion of Dakota, if underlying onsetless syllables are parsed with epenthetic consonants, the P-constraint relevant here may be FILL rather than ONSET.

91Kiparsky (1986:74-75) proposes that the Murut (and Sanskrit) pattern of infixation is a consequence of extrametricality of onsetless initial syllables. He suggests in a footnote that infixation after the extrametrical syllable is a way to avoid violating the Peripherality Condition on extrametricality. This interesting idea has certain abstract similarities to our approach.
(42) Timugon Murut σµ-Reduplication. V-initial Words.

<table>
<thead>
<tr>
<th>Candidates</th>
<th>P (ONSET)</th>
<th>M (LEFTMOSTNESS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>u.u.lam.poy</td>
<td>* ! *</td>
<td></td>
</tr>
<tr>
<td>μ u.la.lam.poy</td>
<td>*</td>
<td>u</td>
</tr>
</tbody>
</table>

But in (41) there is a crucial ONSET violation in *u–ulampoy that is absent in u–la–lampoy. Since ONSET is ranked higher, it alone determines the outcome, though LEFTMOSTNESS would give the opposite result.

This argument relies on one tacit assumption, which we must make explicit to assure its validity. The assumption is that the Reduplicant, underlined as usual, is no more or less than a light syllable. This strict (=undominated) templatic requirement excludes candidates where the relation between the Reduplicant and syllabification is more indirect: from /σµ + ulampoy/ we could otherwise get *u.l-ulampoy, with pure prefixation of the Reduplicant ul-, of which the u is syllabified in the templatic prefix and the l is accounted for by the first syllable of the root. Such patterns are not uncommon; Mangarayi (above, §7.2) is a close-by example, and McCarthy and Prince (1986) discuss similar configurations in Oykangand (Sommer 1981 and §7.4 below), Mokilese (Harrison and Albert 1976), and, with suffixing reduplication, Tzeltal (Berlin 1963, Kaufman 1971).

Below in §7.4 we will suggest a general approach to templatic requirements in terms of alignment constraints. The clear difference between Timugon Murut and the Mangarayi type lies in the alignment of morpheme-edge and syllable-edge, as can be seen in the following contrast:

(43) a. *|u.l|-u.lampoy b. u-|la|-lampoy

In Timugon Murut, the edges of RED must exactly coincide with the edges of a light syllable, as in the form on the right. Timugon Murut, then, has an undominated templatic constraint RED=σµ. In contrast, the templatic constraint is dominated in Mangarayi and the other languages cited, leading to violation, as evidenced by trans-junctural syllabification in reduplicative contexts.

For Timugon Murut, the relevant constraints must be ranked as follows:

(44) ONSET, RED=σµ >> LEFTMOSTNESS

The effects of this hierarchy are seen in the following tableau:
Since we have introduced alignment considerations into the discussion, it is worthwhile considering what effect they would have on the parallel process of -\textit{um} - infixation in Tagalog. Though not obviously active in Tagalog infixation, which would not usually be described as templatic, they need do no harm to the analysis, so long as they are subordinate to the more purely phonological constraints, NO-CODA in particular. The affix -\textit{um} - is always misaligned as -\textit{u.m} -, but this is forced by NO-CODA. Tagalog, then, makes it clear that the non-ranking of syllabic constraints and the relevant interface constraints in Timugon Murut must be resolved in favor of the syllabic constraints. As in Axinica Campa or Dakota, the P-block distinguishes a sub-block Φ of purely phonological constraints from a sub-block I of interface constraints, with the relation Φ >> I. We note that there is some restricted freedom of movement among the constraints of the I-block, whereby certain I constraints can escape to dominate Φ constraints, ALIGN-L >> ONSET being a typical example. Similarly, certain I constraints may be dominated by M constraints, as in the languages like Mangarayi, Oykangand, Mokilese, and Tzeltal which syllabify across the Reduplicant-Base juncture, where we must have EDGEMOSTNESS or MAX (or both) dominating the relevant templatic constraint. It is clear, however, that the scheme Φ >> I is commonly obeyed, preserving syllabic well-formedness in the face of morphological distinctness, forcing VC+V to syllabify as mis-aligned V.C+V, for example.

Back to Timugon Murut. Unlike accounts based on circumscription, this analysis does not require that the onsetless syllable be recognized as a type of prosodic constituent. Indeed, the Optimality account is free of parochial mention of any constituent or configuration. All previous accounts call on some kind of rule that examines and parses the input; these rules must mention details of shape of the affix and of the shape of the base: infix morphemes VC past initial C-cluster; infix morphemes σ_μ past a V-initial syllable. The Optimality-Theoretic approach, by contrast, treats the grammar of, e.g., Tagalog and Timugon Murut as exactly identical, and the principles involved are only the recognized, entirely general constraints whose force is felt throughout phonology and morphology.

Even more remarkably, this mode of analysis explains why only reduplicative prefixes, and never segmental prefixes, are subject to infixation after initial onsetless syllables. The core of the explanation is apparent from *u-\textit{ulampoy} in (41b). In such purely prefixing candidates, the Reduplicant copies an ONSET violation; but a segmentally-fixed morpheme cannot have this kind of pathological interaction with the Base. To make the claim perfectly clear, we will divide it up into its constituent parts and demonstrate it carefully. First, we define the relevant distribution:
(46) **Dfn.** Post-Initial Onsetless (PostIOS) Distribution.

If a morpheme $\alpha$ is a *prefix* before C-initial stems and an *infix* falling immediately after an initial onsetless syllable, we say that $\alpha$ has the PostIOS distribution.

This distribution is exactly that predicted by circumscription of an initial onsetless syllable. The first result concerns nonreduplicative morphemes.

(47) **Theorem I. Infixation of Segmental Specified Prefixes.**

Under the Optimality Theory schema $P \gg M$, no morpheme of fixed segmental content may have the PostIOS distribution.

**Proof.** To establish this, we do not need to examine the fate of every possible Base CV pattern; we need only exhibit one pattern which $P \gg M$ cannot force into the PostIOS scheme of infixation. This Base serves as a witness that the PostIOS distribution can’t be uniformly enforced in Optimality Theory.

Such a Base pattern is #V.C~. It turns out that there is no possible increase in harmony that can be achieved by positioning a prefix $\alpha$ as #V$\alpha$CV. The fundamental problem is that this placement exposes the initial $V$, incurring an ONSET violation for which there is no compensation. To see this in detail, we can simply review the possibilities, where what’s crucial is the segmentalism at the edges of $\alpha$. Here are the cases:

- If $\alpha = cxv$, infixation trades one ONSET violation for another
  
  #cxv-V.C… vs. #V-cxv-C…

- If $\alpha = vxv$, infixation trades 2 ONSET violations for 2 more.
  
  #vxv-V.C… vs. #V-vxv-C…

- If $\alpha = cxc$, infixation adds an ONSET violation & a NOCODA violation
  
  #cxc-V.C… vs. #V-cxc-C…

- If $\alpha = vxc$, infixation adds an ONSET violation and a NOCODA violation.
  
  #vxc-V.C… vs. #V-vxc-C…

In sum, if $\alpha = XV$, infixation as #V$\alpha$C~ maintains the level of ONSET violation; if $\alpha = XC$, it adds an ONSET violation and a NOCODA violation.\(^{92}\) In no case is the infixed form syllabically superior; the decision must go to LEFTMOSTNESS, and a classical prefix results. Observe that the proof deals with a completely ordinary Base and not some special arrangement of C’s and V’s: if a language allows onsetless initial syllables at all, it must have words beginning #V.C~. □

The other side of the argument consists of showing that a reduplicative morpheme with the PostIOS distribution does in fact exist. This might seem obvious, since we have just reviewed several actual cases where Optimality-Theoretic grammars yield reduplicative infixation. But the actual is often more cooperative than the ideal.

\[^{92}\text{To get the NOCODA violation, we need to assume that there is no syllabification } \sim x.c-CV \text{ across the infix-Base juncture. Though not absolutely mandated by the theory, the assumption is pretty secure, given the usual ALIGN-mandated preference for sharp syllabic junctures over mere maximization of a filled onset. As is clear from the proof, NOCODA violation is not essential to the argument anyway, so long as ONSET is at play.}\]
Under the schema $P \gg M$, reduplication of an onsetless syllable will fatally decrement the harmony of a candidate, so long as any superior alternative exists. This applies not only to Bases like Timugon Murut .u.lampoy and .om.podon, which begin with a single onsetless syllable, but even more forcefully to any Base, like hypothetical .u.o.e.a.pata, which begins with a string of such syllables. In such cases, the prediction is that a reduplicative infix like $\sigma_{\mu}$ will lodge before the first C it can find: so, .u.o.e.a.-pa-pata. No language we have seen offers such Bases, and the prediction has never been tested. To get a general theorem, though, we modify our statement of the desired distribution:

(48) **Dfn.** Pre-First Onset (PreFO) Distribution.

If a morpheme $\alpha$ is positioned immediately before the first C-initial syllable of the Base (and as a strict prefix before Bases consisting entirely of onsetless syllables) we say that $\alpha$ has the PreFO distribution.

The parenthesized clause is added to clarify the prediction of the theory; no language with the relevant morphology has words consisting entirely of onsetless syllables, as far as we know. Note that no fixed-content morpheme can have the PreFO distribution; the argument just given for PostIOS applies equally well to PreFO:

(49) **Corollary (Theorem I).**

Under the Optimality Theory schema $P \gg M$, no morpheme of fixed segmental content may have the PreFO distribution.

**Proof.** By the argument for Theorem I, no fixed-content prefix $\alpha$ can be placed as #V$\alpha$CV~. □

The result we want, of course, is that there are indeed patterns of reduplicative infixation that follow the PreFO distribution.

(50) **Theorem II.** Reduplicative Infixation (Prefixing).

Under the Optimality Theory schema $P \gg M$, there can be reduplicative morphemes with the PreFO distribution.

**Proof.** To show this, it suffices to establish that some one reduplicative template can be PreFO-distributed. For concreteness, let us take $\sigma_{\mu}$. We assume that the templatic constraint RED=$\sigma_{\mu}$ is undominated. We also assume that PARSE and FILL belong to the $P$ block.

---

93Bella Coola core syllable reduplication provides a potential parallel. Bagemihl (1991) reports that the reduplicative prefix lodges before the first CV of the word, where V means sonorant rather than strictly vocalic. Thus it skips over initial sequences of obstruents CCC…, as in /qpsta/- qps-ta-ta- ‘taste–iterative(actual)’, much in the way reduplicative affixation is posited to skip over sequences VVV… . Phonetically, the obstruents get syllabified as syllable heads, according to many observers; Bagemihl demonstrates that such syllables do not count for reduplication, and proposes that they are absent from the phonology. Optimality Theory allows us to reopen the question, and consider that this might be a case of prosodically compelled infixation, where the forcing constraint is ‘obstruents are not nuclei’, which is violated in the language at large, but asserts itself when possible.
To show that a morpheme is truly PreFO-distributed, we must review its placement in all possible circumstances. Fortunately, there are only four Base patterns to consider:

1. \((.V)^*\).CX \(\ (X \neq \emptyset)\)
2. \((.V)^*\).VC.CX \(\ (X \neq \emptyset)\)
3. \((.V)^*\).VC.
4. \((.V)^*\)

The syllabifications shown are those that the Base would receive in isolation.

The first observation to make is that in no case will RED be planted inside an initial sequence of syllables \(.V\). This adds a single ONSET violation. But simple prefixation also adds a single ONSET violation, and succeeds better (i.e. completely) on LEFTMOSTNESS. Therefore, since simple prefixation is superior, internal placement can never be optimal.\(^{94}\) From this, it follows immediately that case 4 will yield prefixation, in accord with PreFO. Let us now deal with the remaining three cases:

**Case 1.** RED+(\((.V)^*\).CX. \(\ (X \neq \emptyset)\)

By what has just been said, the contest is between simple prefixation and pre-first-C placement, as in \((.V)^*\).\(\sigma\).CX. With the pre-C placement, the affix lies in the leftmost position that incurs no ONSET violation, so the form is optimal.

**Case 2.** RED+(\((.V)^*\).VC.CX. \(\ (X \neq \emptyset)\)

Here there is a choice between locating the affix before the first C and locating it before the first onsetted syllable. Infixation before the first onset incurs only a LEFTMOSTNESS violation. The pre-first-C placement, as in \((.V)^*\).\(V\)-\(\sigma\)\(C\)\(-\)\(CX\), is not viable despite its superior leftmostness. Under CONTIGUITY, there can be no nucleus for the Reduplicant copied from the Base, so a nuclear FILL violation is inevitable in the Reduplicant. With FILL in the \(P\) block, this is sufficiently fatal.\(^{95}\)

**Case 3.** RED+(\((.V)^*\).VC.

Here there are really three choices: prefixation, pre-C placement, and post-C placement or pseudo-suffixation. Prefixation introduces a new ONSET violation. Post-C placement results in a null Base, yielding FILL violations in the exponent of the morpheme RED, because it has nothing to parasitize for its melody; and even worse, violation of CONTIGUITY, which demands that material in the Reduplicant be indexed to corresponding material in Base. Pre-C placement has the same effects as in case 2: it must result in at least one FILL violation (nucleus of the

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\(^{94}\)This argument holds even if simple prefixation is itself suboptimal. In the terms of Prince & Smolensky (1993:§9), internal placement into a V-string is *harmonically bounded* by prefixation: there is always a better alternative candidate, so that internal placement can never be the best. We do not need to know what the best candidate actually is to make this argument, just what the better one is.

\(^{95}\)The pre-first-C placement is beset with other problems as well, each individually fatal. What is to become of that first C? If it is syllabified into the affix as a coda, the reduplicative template RED=\(\sigma\) is violated; even if the affix is merely \(\sigma\), a template violation results, since the exponent of RED does not end up occupying an entire syllable. If the C is left unsyllabified, a PARSE violation results. If the C is supported by epenthetic structure, yielding \((.V)^*\).\(V\)-\(\sigma\)\(CA\)\(-\)\(CX\), a second FILL violation results. By contrast, locating the affix before the first onsetted syllable yields a Reduplicant that satisfies the templatic constraint, leaves nothing unparsed, introduces no empty structure, and itself has an onset. Its only defect is violation of LEFTMOSTNESS, but the extent of violation is the minimal one that makes it possible to satisfy the phonological and interface constraints.
Reduplicant), plus \textsc{parse} or \textsc{red}=$\sigma$, violation. Since absolute prefixal placement violates only \textsc{onset}, there will be a number of domination relations, for example \textsc{fill} $\gg$ \textsc{onset}, which will suffice to secure prefixation. Thus, as claimed, it is possible to force prefixation in this circumstance.

The essential correctness of this perspective is confirmed by the existence of a near mirror-image of the Timugon Murut pattern, in which the reduplicant follows a word-final vowel (V+\textsc{red}#) but is infixed before a word-final consonant (\textsc{red}+C#). Cases of this sort can be found in Kamaiurá (Everett and Seki 1985, who however offer a different analysis) and Chamorro (Topping 1973:183, 215-6):

\begin{itemize}
\item (51) Kamaiurá Infixing Reduplication, \textsc{red}=$\textsc{ft}$
\begin{itemize}
\item o–huka \hspace{1cm} ohuka–\textit{huka} \hspace{1cm} ‘he laughed/kept laughing’
\item o-mo–tumunŋ \hspace{1cm} omotumun–\textit{tumunŋ} \hspace{1cm} ‘he shook it/repeatedly’
\item je–umirik \hspace{1cm} jeumiri–\textit{miri}–k \hspace{1cm} ‘I tie up/repeatedly’
\item o–je–ʔapah”at \hspace{1cm} ojeʔapah”a–pah”a–t \hspace{1cm} ‘he rolls himself up/repeatedly’
\item o–etun \hspace{1cm} oetu–\textit{etu}–n \hspace{1cm} ‘he smells/keeps on smelling’
\item a–pot \hspace{1cm} apo–\textit{apo}–t \hspace{1cm} ‘I jump/repeatedly’
\item o–ekij \hspace{1cm} oek–\textit{eki}–j \hspace{1cm} ‘he pulls/repeatedly’
\end{itemize}
\end{itemize}

\begin{itemize}
\item (52) Chamorro Infixing Reduplication, \textsc{red}=$\sigma$
\begin{itemize}
\item dánkolo \hspace{1cm} dánkolo–\textit{lo} \hspace{1cm} ‘big/really big’
\item buníta \hspace{1cm} buníta–\textit{ta} \hspace{1cm} ‘pretty/very pretty’
\item nálaŋ \hspace{1cm} nála–\textit{la}–ŋ \hspace{1cm} ‘hungry/very hungry’
\item métgot \hspace{1cm} métgo–\textit{go}–t \hspace{1cm} ‘strong/very strong’
\end{itemize}
\end{itemize}

Infixation of the Kamaiurá/Chamorro Reduplicants also involves the general \textsc{p} $\gg$ \textsc{m} schema, but with the responsible \textsc{p} constraint being \textsc{p} = \textsc{no-coda} (9a) and the \textsc{m} constraint being \textsc{rightmostness}, which controls suffixation. Here again, there are no known cases of a segmental infix with this distribution. It is possible to show that prosodic constraints can never force a segmentally-specified morpheme to sit before a final C. To establish this, let us proceed as before, carefully stating the distribution, then examining the relevant cases.

\begin{itemize}
\item (53) \textsc{dfn}. Pre-Final C (PreFC) Distribution.
If a morpheme $\alpha$ is positioned immediately before the final C of the Base, and as a strict suffix after V-final Bases, we say that $\alpha$ has the PreFC distribution.
\end{itemize}

This description is exactly that predicted by circumscription of a final consonant. We have the following result.

\begin{itemize}
\item (54) \textsc{theorem III}. Infixation of Segmentally Specified Suffixes.
No segmentally-specified morpheme can have the PreFC distribution under the schema \textsc{p} $\gg$ \textsc{m}.
\end{itemize}

\textbf{Proof.} We consider only words ending in a single consonant. As before it is sufficient to show
one pattern that cannot be compelled to admit the PreFO distribution. Consider ~CVC#. The question is, how can ~CVαC# possibly be superior to ~CVCα#?

- Suppose α = vx. Infixation introduces a new NOCODA violation, and very likely an ONSET violation as well.
  ~CV.Cvx. vs. ~CVvxC.
- Suppose α = cx. Infixation maintains the level of NOCODA violation.
  ~CVC cx vs. ~CV cxC.

Since infixation is either worse or the same on P, rightmostness from M compels suffixation.

We need to establish now that a reduplicative morpheme can have the PreFC distribution, or something much like it, so that patterns like those of Kamaïurâ and Chamorro can be generated. As above, the picture is enriched by the possibility of strings of onsetless syllables. As noted in the proof of Theorem II, reduplication under P >> M will not position σ amid V-strings, leading to gratuitous copying of ONSET violations. The distribution we actually seek, then, is not ‘before the final C’ but ‘after the last CV’. We want to place α as ~CVαV*C.


If a morpheme α is placed right after the last CV sequence in a word (and as a suffix in words with no CV) then we say that α has the PostLCV distribution.

The proof just given for Theorem III applies as well to the PostLCV distribution:

(56) Corollary (Theorem III).

No morpheme of fixed segmental composition can have the PostLCV distribution.

Proof. By Theorem III, no such morpheme can be inserted before the final CV in words of the form ~CVC#.

Now we state the result for reduplicative morphemes:

(57) Theorem IV. Infixation of Reduplicative Suffixes.

Under P >> M, there are reduplicative morphemes with the PostLCV distribution.

Proof. Suffixation requires a little more work than prefixation because of asymmetries in syllable structure. We proceed by developing a constraint hierarchy that will yield the result for a Chamorro-like system where the template is given by RED=σ. Notice first that the template itself must be violated to a degree in C-final forms:

(58) Template Violation

a. .met.go-.go-t. R= go, σ = .go-t.
b. .pá.la-.la-ŋ. R= la, σ = .la-ŋ.
The template is \( \sigma \) but the Reduplicant does not fill it entirely; it is jostled in \( \sigma \) by a stem consonant. (By contrast, with infixation after V there is little chance that the initial V will join the reduplicated syllable.) With the template violable in this way, another candidate presents itself:

(59) Template Violation

\( a. *\text{ met.go.t-ot} \quad R=ot, \sigma=.t-ot. \)
\( b. *\text{ ...á.la.ŋ-an.} R=\text{ an}, \sigma=.ŋ-an. \)

Here a root consonant intrudes into the template from the other side. This form of reduplication is attested in Mayan languages like Tzeltal (Berlin 1963, Kaufman 1971, McCarthy & Prince 1986) and in various Salishan languages. It has the not inconsiderable virtue of being fully suffixal. Since both infixation (58) and suffixation (59) violate the \( \sigma \) template, apparently equally, the question arises as to how they are to be distinguished. We suggest that the difference lies in the extent to which the Reduplicant mirrors the Base. In the infixing version (\textit{metgogot}), there is exact correspondence between syllabic roles of Reduplicant and Base; in the suffixing form (*\textit{metgotot}), there is an inevitable mismatch: the final C of the Reduplicant is moraic but its image in the Base is a weightless onset. Let us assume that the maximality of the copying relationship between Base and Reduplicant is evaluated over all structure that the Reduplicant carries; this is clearly a function of \textit{MAX} or of a \textit{MAX}-related constraint. For concreteness let us name the relevant condition \textit{STROLE} for ‘Structural Role’. The constraint \textit{STROLE} must dominate \textit{RIGHTMOSTNESS} so that the more faithful copy, though infixed, is chosen over the strict suffix. Putting the central \textbf{P}-constraints \textit{ONSET} and \textit{NOCODA} in place, we will have the following rankings:96

(60) Chamorro-type Suffixal Infixational Constraint System

\textbf{ONSET, NOCODA >> STROLE >> RIGHTMOST >> RED= \( \sigma \)}

To see how this works on the crucial C-final example, examine the following tableau (we omit \textit{ONSET} as it does no work here):

(61) /pálaŋ/ + RED

<table>
<thead>
<tr>
<th>Candidates</th>
<th>NOCODA</th>
<th>\textit{STROLE}</th>
<th>\textit{RIGHTMOST}</th>
<th>RED=( \sigma )</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.  \textit{...pá.la-ľa-ŋ.}</td>
<td>*</td>
<td>ŋ</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>c.  \textit{...pá-ŋa-ľaŋ.}</td>
<td>*</td>
<td>laŋ</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>b.  \textit{...pá.la.ŋ-an.}</td>
<td>*</td>
<td>*!</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>d.  \textit{...pá.ľaŋ-.ľaŋ.}</td>
<td>**!</td>
<td>*!</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

---

96 \textit{NOCODA} and \textit{STROLE} cannot be ranked with respect to each other; either order gives the same results. We follow the \textbf{P} \( \gg \textbf{M} \) schema in placing \textit{NOCODA} up with \textit{ONSET}, which (as we will see) must be crucially ranked above \textit{STROLE}.
Simple whole-syllable suffixation (d) copies a NoCoda violation, which disqualifies it immediately. Suffixation with partial copy (c) is as syllabically successful as any of the remaining candidates, but it entails a syllable-role mismatch, fatal because other candidates are well-matched. Candidate (b) copies an open syllable, but the same overall success on NoCoda is achieved in (a), which achieves superior rightmostness. Thus, placing the σ-affix right after the last CV — the PostLCV distribution — is required for C-final stems.

In the case of stems ending in CV, like /bunita/, it is clear that pure suffixation is optimal, since every constraint of prosody, morphology, and interface is completely satisfied.

Suppose now that the word is shaped ~CV.V#, so that the last CV is separated by a string of onsetless syllables from the edge. Under our assumption that the P block is complete and contains Onset, it is clear that the affix cannot be placed amid the V-string. Placement after the last CV assures syllabic well-formedness at the expense of subordinate Rightmostness. Once again the PostLCV distribution is guaranteed.

The final remaining situation is one in which there is no CV substring at all in the entire word. The pattern must be #V'(C)#. If the word is all vowels, suffixation results in Onset violation, but infixation offers no advantages in this respect.97 If the word ends in a consonant, suffixation is optimal because the suffixed form #V'.C-vc.# has but one NoCoda violation, and any infixed form, e.g. #V'.vC.# will match it in that respect and add an Onset violation. The suffixed form has, however, the disadvantage of violating StRole and Red=σ, both of which are satisfied by the infixing form. This shows that to get the result we must add the requirement Onset >> StRole, which is of course expected under the P >> M format. With this, the demonstration is complete. □

The PostLCV distribution can, then, be attained under the schema P >> M, where P comprehends both Onset and NoCoda, and M consists of a mini-hierarchy that ranks the reduplicative constraint StRole, the affixal placement constraint Rightmostness, and the templatic constraint Red=σ.

The P >> M schema leads to a considerably sharpened understanding of the nature and typology of affix placement. Previous theory offers no insight at all into the interactions between prosodic well-formedness and affixation, and consequently provided no account of the relation between affix shape and affix placement, and, further, had no means to predict differences in inflexibility between reduplicative and segmentally-specified affixes. Earlier functionalist commentary, on the other hand, spotted important factors but had no means to advance beyond the post hoc to fashion them into real predictions. The current theory is a first step which opens the area to investigation and, as such, can claim some basic successes but hardly completeness. The rawest prediction of the reduplicative theory is that an affix like σ should, under prosodic compulsion, move inward to the edgemost position where copying does not multiply syllabic flaws that would otherwise be incurred; this allows, in principle, a variety of aggressive placements beyond those discussed here. The rawest prediction of the segmental theory is that the segmentalism of an affix can lead it to be placed in an edgemost position where it alleviates some syllabic problem; again, this leads to the possibility of some aggressive placements beyond those discussed here.

The theory makes correct and unprecedented predictions in the central

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97Note that we are assuming no VV coalescence involving the reduplicative morpheme. Strictly speaking, this ought to be added to the hypothesis of the theorem.
Apparently closed (i.e., CVN) syllables are analyzed as heavy in the stress system, though there is no evidence for heaviness of closed syllables elsewhere in the language. Indeed, there is positive evidence for the lightness of closed syllables in the genitive suffix allomorphy phenomenon (v. section 6), since a root like /chiŋki/ ‘eel’ patterns as bimoraic in selecting the -ni allomorph of the genitive. We do not address this problem, nor do we consider here an odd sort of extra-weak syllable, whose onset is s or c.

In summary, the mapping between the output of Suffix level and the input to Word level necessarily calls on two kinds of reductions in structural complexity. The PrWd-internal instances of Ft and PrWd are leveled out to a single, superordinate PrWd by Bracket Erasure (4). And the unfilled syllable positions of the Suffix-level output are cashed in for full vowels and consonants, identical to underlying a and t. (As we observed in §3, this phonological realization of FILL and PARSE violations is independently required in the Prefix-level/Suffix-level interface as well.) Henceforth, we will adopt the convention of using virgules to indicate the input to the Word level in this sense, since it is underlying with respect to the Word-level constraint system. We will reserve italics for candidate outputs of the Word level.

A.2. Stress and Related Phenomena

Our goal in this section is to provide a comprehensive account of the prosodic aspects of the Axininca Campa stress system. We will not attempt to deal with the various complications in the prominential aspects of Axininca stress (for which see Payne, Payne, and Santos (1982:185-195), Spring (1990a:58-68), and Hayes (1991:246-253)), since they are extraneous to our main concerns.

In Axininca Campa, the basic stress pattern is iambic (as usual, of the “left-to-right” variety). In accordance with universal stress theory (McCarthy and Prince 1986, Hayes 1987, Hayes 1991), iambic feet are of the form Light-Heavy, Light-Light, or Heavy. (All stress data come from Payne, Payne, and Santos 1982.)\(^{108}\)

(11) Basic Stress Data

\[
\begin{align*}
\text{hinó} & \text{ki} \quad \text{‘arriba (por el río)} \\
\text{ičhi} & \text{(kaki)na} \quad \text{‘él me ha cortado’} \\
\text{iráa} & \text{(waná)ti} \quad \text{‘su caoba’} \\
\text{apà} & \text{(níroi)ni} \quad \text{‘solo’} \\
\text{añàa} & \text{(wái)(tiri)ka} \quad \text{‘cuando hablamos con él’}
\end{align*}
\]

The most significant departure from iambicity comes from the fact that final syllables, except those containing diphthongs, are always unstressed (12a). As a consequence, disyllabic words actually have trochaic stress (12b).

\(^{108}\) Apparently closed (i.e., CVN) syllables are analyzed as heavy in the stress system, though there is no evidence for heaviness of closed syllables elsewhere in the language. Indeed, there is positive evidence for the lightness of closed syllables in the genitive suffix allomorphy phenomenon (v. section 6), since a root like /c̩iŋki/ ‘eel’ patterns as bimoraic in selecting the -ni allomorph of the genitive. We do not address this problem, nor do we consider here an odd sort of extra-weak syllable, whose onset is s or c.
(12) Final Syllable Stresslessness

a. kimítaka ~ kimítàka ‘quizá’
   hotítana ~ hotítâna ‘él me metió’
   irániri ‘su cuñado’
   čh’ookiro ‘hormiga de árbol’
   c’irinink’okâsanâkaná ’la noche les sobrevino’

b. círi ‘brea de árbol’
   máto ‘polilla’
   c’hími ‘colpa’

In long words with trailing even-parity sequences of light syllables, like (12a), a secondary stress on the penult is variably realized under complex conditions (Payne, Payne, and Santos 1982:193). We will assume that it is authentically present in the phonology, though it is not always expressed in impressionistic prominence.

Prince and Smolensky (1992, 1993:§4) argue that final stresslessness effects do not reflect extrametricality (as in Hayes 1991:253), but rather the appearance of a truly trochaic foot in final position. Thus, a word like máto is a single bimoraic foot, not an otherwise impossible monomoraic foot plus a loose syllable, *má(to). Similarly, all even-parity forms will end on a trochee: (kimí)(tàka), and so on for the others in (12a). This requires that a trochaic foot be optimal under some conditions even within a fundamentally iambic system. Thus, even the constraint of foot form — iambic here — is in principle (and in fact) violable.

This basic pattern of iambic stress with final stresslessness can be obtained, as in Prince and Smolensky (1992, 1993), from the interaction of FTBIN with three other constraints, pertaining to the foot type, the exhaustivity of foot parsing, and the special status of final syllables:

(13) FT-FORM
Feet are iambic.

(14) PARSE-SYLL
Syllables are parsed by feet.

(15) NONFINALITY
The PrWd-final syllable is unstressed.

FT-FORM simply establishes as a formal (and violable) constraint the prominential and quantitative properties of iambic feet in universal stress theory. PARSE-SYLL is also a familiar requirement from stress theory (e.g., Liberman and Prince 1977:266, 294; Prince 1980:535; Halle and Vergnaud 1987; Hayes 1987). We assume that syllables are optimally parsed by Ft, in accordance with PARSE-SYLL, but failing that they are parsed by PrWd (cf. Itô and Mester 1992). Finally, NONFINALITY is the constraint proposed by Prince and Smolensky that does work in the stress domain similar to that previously associated with a notion of extrametricality (e.g.,

These three constraints plus FtBIN are almost fully rankable, though establishing all of the details of the ranking requires some scrutiny of the situation. Short, even-parity words like ciri have trochaic stress; thus, iambic Ft-FORM is subordinated to final stresslessness:

(16) NONFINALITY >> Ft-FORM, from ciri

<table>
<thead>
<tr>
<th>Candidates</th>
<th>NONFINALITY</th>
<th>Ft-FORM</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ciri)</td>
<td>* !</td>
<td></td>
</tr>
<tr>
<td>(círi)</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

With the opposite ranking, NONFINALITY would have no effect. Since Ft-FORM applies to every foot, and NONFINALITY only to a proper subspecies of them, this is the typical relation of a specific and a general constraint in Optimality Theory, following from Pāṇini’s Theorem (v. §5.2 and §7.2 above and Prince and Smolensky 1993:§7).

Long words like kimitàka, with an even-parity light syllable sequence, show that PARSE-SYLL also dominates Ft-FORM. In the failed candidate, final stresslessness is achieved by non-exhaustive Ft-parsing:

(17) PARSE-SYLL >> Ft-FORM, from kimitàka

<table>
<thead>
<tr>
<th>Candidates</th>
<th>PARSE-SYLL</th>
<th>Ft-FORM</th>
</tr>
</thead>
<tbody>
<tr>
<td>(kimí)(tàka)</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>ki(mítá)ka</td>
<td>* ! *</td>
<td></td>
</tr>
</tbody>
</table>

Both candidates in (17) satisfy NONFINALITY, since they do not have final stress. But the failed candidate has multiple violations of PARSE-SYLL, while the optimal candidate is fully parsed at the expense of positing a final trochee.

So far we have only looked at even-parity words, which show that NONFINALITY and PARSE-SYLL dominate Ft-FORM, subordinating the requirements of iambicity to final stresslessness and completeness of the foot-parse. The treatment of odd-parity words like hinóki shows that PARSE-SYLL is itself dominated by FtBIN:
(18) FTBIN >> PARSE-SYLL, from hinóki

<table>
<thead>
<tr>
<th>Candidates</th>
<th>FTBIN</th>
<th>PARSE-SYLL</th>
</tr>
</thead>
<tbody>
<tr>
<td>(hinó)ki</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>(hi)(nóki)</td>
<td>*</td>
<td>!</td>
</tr>
</tbody>
</table>

The failed candidate in (18) also posits a non-optimal trochee, but irrelevantly, because FT-FORM is ranked below PARSE-SYLL (v. (17)). As in the Suffix-level phonology, Word-level FTBIN is undominated and therefore unviolated in Axininca Campa.

On the evidence presented so far, the Word-level phonology of stress is as follows:

(19) Ranking of Stress Constraints (Preliminary)

FTBIN >> PARSE-SYLL >> FT-FORM
NONFINALITY >> FT-FORM

This system of constraints will determine all aspects of Axininca stress that we have discussed up to this point. A particularly striking result is that the apparent left-to-right directionality of Ft-parsing — a familiar feature of iambic prosody — emerges as a consequence of satisfying both NONFINALITY and FT-FORM, rather than from a rule of iterative foot assignment. To see this, consider first words which consist of strings of light syllables. If the string is of even length, right-to-left (RL) and left-to-right (LR) parsing agree with PARSE-SYLL that all syllables are simply paired off in the only way possible: (LL)(LL).... The interesting distinction shows up in odd-length strings. This is seen in (20), where the typical effect attributed to directionality is visible:

(20) Apparent Directionality, from hinóki

<table>
<thead>
<tr>
<th>Candidates</th>
<th>NONFINALITY</th>
<th>PARSE-SYLL</th>
<th>FT-FORM</th>
</tr>
</thead>
<tbody>
<tr>
<td>(hinó)ki</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>hi(nóki)</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>hi(nóki)</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

All odd-length candidates respecting the undominated constraint FTBIN necessarily violate PARSE-SYLL, leaving one syllable out of the foot-parse, as (20) exemplifies. Candidates with the initial syllable unfooted — equivalent to right-to-left parsing — violate either NONFINALITY or FT-FORM. Candidates with the final syllable unfooted meet both of these constraints, violating only PARSE-SYLL, but violating it no more than any other binary parse. This reasoning clearly holds for all words L^m, m odd. For these, then, the given hierarchy yields the effect of LR− parsing, without however parsing in any direction.

To establish that the result holds true for all words, no matter what their array of heavy and light syllables, we observe that any string can be analyzed into segments L^m, L^mH, H, where
these are chosen to be of maximal size, so that a segment $L^mH$ is not preceded by $L$, and any segment $L^n$ is neither preceded by $L$ nor followed by $L$ or $H$ (in the latter case, we’d go for the $L^mH$ analysis). Thus, a segment $L^n$ must be the last syllable string in the word, so that we are looking at #$L^n#$ or #$HL^n#$. For such an $L^n$, an argument like that just given for (20) establishes that the $L$-string is parsed in the “left-to-right” fashion, leaving a final $L$ loose if and only if $m$ is odd. So $L^m# = Ft^k(L)#$. Consider $L^mH$ now. If $m$ is even, the $L$-string will always be paired up completely, in satisfaction of PARSE-SYLL, paralleling LR$\rightarrow$ parsing and contradicting $\neg$RL parsing. Furthermore, the $H$ at the end will be a monosyllabic foot. This shows that $L^mH$ is prosodically closed: $L^mH = Ft^k$, $m$ even. Suppose now that $m$ is odd. Here LR$\neg$, $\neg$RL, and PARSE-SYLL all agree: in $L^mH$, the final $H$ captures the $L$ that precedes it, and the remaining even-length sequence $L^{m-1}$ is completely paired up. Here again the sequence is prosodically closed: $L^mH = Ft^k$. It remains to account for the syllables analyzed as belonging to segments $H$; these are not preceded by $L$, so they must be monosyllabic feet. Hence, they are prosodically closed as well. Putting all this together, we have shown that any word can be analyzed into segments that, excepting possibly the last $L^n$, consist of an integral number of feet. Each such segment, and therefore the whole word, is parsed by the constraint hierarchy into a structure identical to that achieved with LR$\rightarrow$ directional parsing. Thus, final stresslessness and the requirement of exhaustive footing lead to the appearance of left-to-right directionality in iambic systems.

Following the Optimality-Theoretic imperative to derange all the senses of ranking,$^{110}$ consider what happens when FT-FORM dominates NONFINALITY. The only case where this will make a difference is $L^n$, which is the same as $L^n#$; this is the segment where nonfinality comes into play. If $m$ is odd, both FT-FORM and NONFINALITY are satisfied by leaving the final syllable unfooted, so $L^n = L^{m-1}(L)$, in the LR$\rightarrow$ manner. If $m$ is even, then PARSE-SYLL wants complete pairing, and the dominance of FT-FORM over NONFINALITY ensures that the last foot, like all the others, is iambic. A language like this is Creek (Haas 1977, McCarthy 1979b). Thus, if we uphold FTBIN and PARSE-SYLL as undominated, so that feet are minimally bimoraic and the rhythm is as tightly packed as possible, we may vary the ranking of FT-FORM and NONFINALITY to generate the iambic systems. There is no directionality of parsing, and only the “left-to-right” pattern is obtained. We have, then, a new explanation for iambic left-to-rightness, making crucial use of Optimality Theory and of the LH foot.$^{111}$

In the examples discussed so far, the final syllable is light, so stresslessness is unproblematic. But heavy syllables have a strong universal association with stress, incorporated into the Weight-to-Stress Principle (WSP) of Prince (1991):

(21) WSP

A heavy syllable is stressed.

The tension between final stresslessness and WSP is an important force in the phonology of many languages (Prince and Smolensky 1992, 1993; Hung 1992; Itô and Mester 1992), Axininca Campa among them.

$^{110}$Vulgo: in OT, permuted rankings should also give possible languages.

$^{111}$Contrast this account with that of Kager (1992c), who argues for strictly bimoraic feet and directionality.