Topics in OT: Class 3: Harmonic Completeness, AP order; Chain Shifts

Alan Prince/ LSA Institute 1997: 6/30

(1) Recap of **Activity Inhibition Property** (from class 2).
Let G stand in a stringency relationship to S on some input i.
Let G sit in some hierarchy H_1GH_2....
Let us say that G is **active** on i in such a hierarchy when G splits $H_1(i)$ into 2 or more violation classes, so that $H_1(i) \neq H_1G(i)$. Write C+ for 'C is active', C^- for 'C is inactive'.
Then we have:

If G>>S, $G+ \Rightarrow S^-$.

(2) **Harmonic Completeness** (cf. Chapter 9, Prince & Smolensky 1993). The notion of 'harmonic completeness' is a version of the Praguian notion of implicational markedness. The basic Praguian idea there was that the presence of a more marked element in the inventory implied the presence of a less marked element (ö ⇒ ü, nasal ⇒ corresponding oral, voiced obsruent ⇒ voiceless, etc.)

(3) **Inventory completeness.** Suppose we have a scale of markedness on elements of structure: eg

CV ≺ CVC ≺ CVCC

Then we say that a language's inventory L of elements (present in the output!) drawn from that scale is *harmonically complete* if whenever $\alpha \in L$ and $\beta \prec \alpha$, then $\beta \in L$ also. (Extending to general products of scales with the coordinate-wise order, we say HC iff $\forall \alpha \in I$, $\downarrow\alpha \subseteq I$.)

So, if a harmonically complete language admits CVCC, it also admits CVC (and CV).

(4) **Map Completeness**. Because, post-Prague, we are dealing with maps as well as inventories, we also have a notion of harmonic completeness wrt to IO (or other mapping) relations.

Thus if CVCC ↦ CV, we expect (all things being equal) CVC ↦ CV.

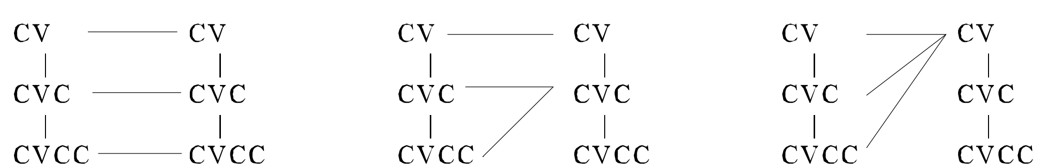
Why? Broadly, because if a Faithfulness constraint (here: MAX-C) can be violated *twice* to achieve a target (here: CV), it ought to be able to be violated *once* to achieve the same target.

Dfn. Map completeness.
Let G be a grammar that maps between S_1 and S_2 (e.g. Input, Output; Base, Reduplicant).
Say $\alpha,\beta \in S_1$ and $\beta \prec \alpha$, then we say that G is map-complete if $G(\beta) \preceq G(\alpha)$.

(5) Exx.. From basic complex coda subgrammar of class 2.

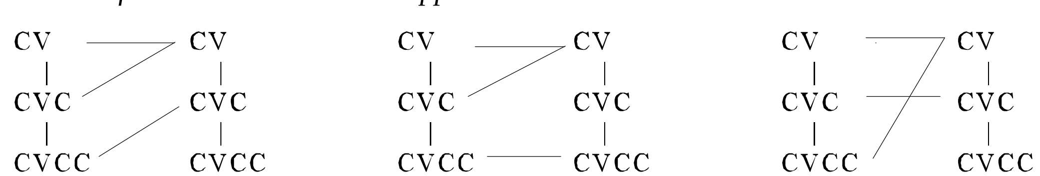
Admitted maps in CVC/CVCC/Max system

Faithful *No CC]* *No C]*



Missing maps

Chain Shift *Gapped* *Cross-over*



(6) We take Harmonic Completeness to be a fundamental property (though not a simple property) of language. Therefore we seek grammars that provably sustain it. (At the same time, we must be alert to its empirical limits, and to those aspects of grammar where it fails, and to those proposals about grammatical form that undermine it.)

(7) **Effect of Paninian rankings on HC.** Consider hierarchies of the form S>>T>>G:

M_1>>F>>M_2 type: eliminates elements of type M_1 from repertory via violation of F, but not elements that are only of type M_2 ("less marked")

*CC] >> Max-C >> *C] eliminates doubly closed syllables, but not all closed sylls.

Thus with Paninian ranking of the FM_1M_2, M_1FM_2, M_1M_2F, types we get an implicational hierarchy:

I. Elements of both kind in a language;

II Elements the relatively unmarked kind only;

III Only elements that are completely unmarked wrt M_1 and M_2, violating neither constraint.

F_1**MF_2** type: eliminates type M elements, but only in circumstances mandated by F_2 —
So, postional faithfulness: F(rnd)/#σ >> *[rnd, front] >> F(rnd) à la J. Beckman
"round front vowels only in initial syllables". With other rankings — round-front everywhere; no round-front. Thus with F/R **-** M **-** F , where F/R means 'F restricted', we have, under Paninian order

I. Maps violating F to handle M everywhere. (M>> F/R, F)

II. Maps violating F handling M only outside R. (F/R >> M >> F)

III. No map violating F (F/R, F >>M)

(8) **An endangering species.** Consider a fixed markedness hierarrchy

*p>>*k>>*t ≡ *{p} >> *{p,k} >> *{p,k,t}

(9) If we interpose F(place), à la Ch. 9, Prince & Smolensky, we get the following systems:

F(place) >> *{p} >> *{p,k} >> *{p,k,t}	Out:	[p, k, t]
*{p} >> **F(place)** >> *{p,k} >> *{p,k,t}		[k, t]
*{p} >> *{p,k} >> **F(place)** >> *{p,k,t}		[t]
*{p} >> *{p,k} >> *{p,k,t} >> **F(place)**		? — depends on choices available: {t} if only {p,k,t} can be chosen from.

(Note: rankings between the adjacent markedness constraints are of course not crucial, but they are shown to emphasis the Paninian character of the rankings.)

(10) But suppose F(place) is fragmented, as F(p), F(k), F(t). Then we can easily generated a gapped system...

<u>F(p) >>*{p}</u> >> <u>*{p,k} >> F(k)</u> >> F(t) >> *{p,k,t} Out: [p, t]

Indeed, we can generate any system we want! — since the individual rankings *α vs. F(α) are completely independent of each other. So although the **markedness** scale is represented in its pure Paninian form, the HC property is gone.

(11) Thus, supporting the HC property requires strong hypotheses about the nature of possible faithfulness constraints. For example, if F(α) must hold for *every member* of scale, then the HC destroying fragmentation cannot occur.

More generally, Vieri Samek-Lodovici has noticed that the pathology comes in when F(x) >> F(y) where x is more marked than y (*x >> *y). This allows us to manipulate a scale internal M(y)~F(y) relationship, while holding onto x by F(x)>>M(x). Thus if we force F to follow the markedness order, or in terms of inclusion hierarchies, to refer to segments anchored at the unmarked end, as F(t), F(t, k), F(t,k,p), then HC will be preserved.

(12) Anti-Paninian rankings on inclusion hierarchies (like IV of Class 2).

FtBin >> *C] >> Max-C >> *CC]

#CVCC# ↦ CVCC, #CVC# ↦ CVC

CVCCta ↦ Cvta   CVCta ↦ CVta

(13) Basic Generalization: AP allows a more complex system in a subdomain — but the more complex system is still HC.

(14) Contrast Ranking V, Class 2, which is Paninian.

```
  FtBin
    |
  *C]      *CC]
     \      /
      Max-C
```

Still get only CV internally, but only CVC in monosyllables. This gets us only minimal deviation from the language's basic system (CV) under compulsion of FtBin, and doesn't allow a full subsystem.

(15) How can a crucial AP ranking order come about? The natural first cut is simply

G >> T >> S

But this won't work. G is undominated. Surely every constraint divides Gen(i), for every i. Therefore G sees the whole candidate set of every input, and is active. But the Activity Inhibition Property, it must be that S is **de-**activated on every input. So there can be no crucial ranking argument T>>S.

(16) So we need (at least one) dominating constraint D:

D >>G >> T >> S

D must also deactivate G on some inputs so that S can threaten activity and be in conflict with T.

D+ ⇒ G^{-} for some i

(17) Thus we can see that the T/S battle will be played out in a subdomain of the grammar to which D is relevant, and over which G is necessarily violated. More to be said, but this will suffice for the flavor.

(18) **AP order and scales**. From handout for Class 2, (20ff).

An element hierarchy *a >> *b >> *c .... is equivalent to a Paninian inclusion hierarchy *a >> *{a,b} >> *{a, b, c} ...., so long as a∩b=Ø.

(19) Any fixed universal element hierarchy, a la Prince & Smolensky 1993, can be reinterpreted as a Paninian hierarchy of inclusion. (The basic idea of using such inclusion hierarchies was first put forth in Kiparsky 1993, 1994, though the assumption there may have been that they were descriptively equivalent to fixed element hierarchies, due to an overhasty application of "Panini's Theorem".)

(20) What are the consequences of so doing? The Inclusion Hierarchy theory is much richer, since it replaces a fixed k-element hierarchy with many distinct rankings.

‣What do the additional Anti-Paninian rankings look like?

(21) Consider the interaction between Align-Peak-L (main stress on first syllable) and a peak prominence hierarchy: 1′ ≺ *2′ ≺ *3′≺ ... where 1, 2, 3,... name degrees of intrinsic prominence of syllables from weakest (1) to stronger..., as e.g. $|\sigma_{\mu}| < |\sigma_{\mu\mu}| < |\sigma_{\mu\mu\mu}| <$ .... (Cf Hayes 1995 for extensive discussion, Prince & Smolensky 1993, Walker 1996, Baković 1996, 1997 for disc.)

(22) The conflict is between initial stress (Pk-L) and stressing the weightiest syllable, which need not be initial. (Isomorphic to McCarthy's discussion of Nakanai reduplication 6/24/97, where the conflict is between copying the first vowel and copying the most prominent vowel.)

(23) The crucial cases: those with weight contrast, with heavier element in noninitial position.
Limiting ourselves to bisyllables, and a 3-way scale:

12 ↦ **1′** 2 *or* 1 **2′**
23 ↦ **2′** 3 *or* 2 **3′**
23 ↦ **2′** 3 *or* 2 **3′**

(24) The Paninian Rankings
(25) Pk-L >> *{1′} , *{1′, 2′} . Clearly Stress is always initial.
(26) *{1′} >> Pk-L >> *{1′, 2′}. Stress flees from initial 1 to heavier σ if such there is, else initial.

	*{1′}	Pk-L	*{1′, 2′}
1′ 2	* !		*
☞ 1 **2′**		*	*
1′ 3			
☞ 1 **3′**		* !	
☞ **2′** 3			*
2 **3′**		* !	

(27) *{1′}, *{1′, 2′} >> Pk-L. Both 1 and 2 yield stress to stronger σ, else initial.

	*{1′}	*{1′, 2′}	Pk-L
1′ 2	* !	*	
☞ 1 **2′**		*	*
1′ 3	* !	*	
☞ 1 **3′**			*
2′ 3		* !	
☞ 2 **3′**			*

(28) **Anti-Paninian Ranking.** 3 beats 1 and 2. Else initial.

	*{1′, 2′}	Pk-L	*{1′}
☞ **1′** 2	*		*
1 **2′**	*	* !	
1′ 3	* !		
☞ 1 **3′**		*	
2′ 3	* !		
☞ 2 **3′**		*	

(29) Paninian: 1 2 3

```
3   2          3
 \ /           |
  1            2
               |
               1
```

(30) Anti-Paninian:

```
  3
 / \
2   1
```

(31) Extended to 4-scale.

a. Paninian: 1 2 3 4

```
2 3  4        3   4        4
 \ | /         \ /         |
   1            2          3
                |          |
                1          2
                           |
                           1
```

b. Anti-P

```
  4            4            4          4  3
 /|\          / \           |           \ /
2 3 1        2   3          3           / \
              \ /          / \         2   1
               1          2   1
```

(32) Non pathology of AP rankings. All rankings **respect the scale**. — in this sense:

if k > j, then n>k ⇒ n > j.

if k > j , then m < j ⇒ k > m.

(33) Thus, strict domination and inclusion hierarchies fit together surprisingly well. Though free ranking increases the number of predicted systems (= variant implementations of the same underlying scale), they all have the desirable basic property of preserving the basic sense of the scale.

(34) **Chain-Shifts.** /a/ ↣ b, /b/ ↣ c, ..., *etc*. Ex.

a. Bedouin Arabic Vowel Raising & Loss (McCarthy 1993, Kiparsky 1994)

/a/ ↣ i, /i/ ↣ Ø (in nonfinal open syllables)

b. Finnish Consonant Gradation (noninitial, _VC.)

/tt/ ↣ t , /t/ ↣ d

c. Nbɛzi Vowel Raising (Kirchner 1996)

/a/ ↣ ɛ , /ɛ/ ↣ e , /e/ ↣ i (before certain suffixal -i)

(35) **General Format**: a ↣b, b ↣ c . *Question:* how could these coexist in the same hierarchy?

Loose Line of Thought (LLT): a ↣ b implies **a** ≺ **b**. And b ↣ c implies **b**≺ **c**.

So **a** ≺ **c,** *and we should have instead* a ↣ c .

(36) What's right about LLT. Under very general conditions, if G: a ↣ b, then **a**≺**b** (with respect to the hierarchy of Markedness constraints within G).

(37) **Harmonic Ascent in M/F-OT mapping**. If G: a ↣ b, then **a**≺**b**, (a≠b). (Moreton 1996)

Assume that there is a completely faithful candidate. (As, e.g. if { inputs}={ outputs}.)

Assume that there are only Faithfulness and Markedness constraints (M/F-OT).

•Consider the map a↣a. It is completely faithful, unlike a↣b.

•If a↣a loses to a↣b, it can *only be* on grounds of Markedness: a ≺ b .

(Indeed, there must be a Markedness constraint M preferring **b** to **a** that dominates **all** of a↣b's Faithfulness violations. Note that a↣a has no F-violations to do the work of dominating a↣b's F-marks .)

(38) **Moreton's Thm.** There are no circular chain shifts in M/F-OT.

Pf. If a↣b ↣c ↣...↣z, then by HA (13), a≺ b ≺ c ≺ ... ≺ z. So z ≠ a !

(39) **Q**: But, given HA, how do we have any chain shifts at all?

(40) **ANS**: The following crude picture portrays necessary conditions the existence of any map:

```
          *a              'some constraint disfavoring a wrt c'
        /    \                       dominates
   {*c}   {F_i(a,c)}    every M-constraint against c and every F-constraint against a↣c.
```

/a/	*a	{*c}	{F_i(a,c)}
a↣a	*!		
☞ a↣c		*	*

(41) In short, a successful map a↣c requires not only a≺c, but also that *every* Faithfulness constraint F_i(a,c) militating against a↣c be subordinated appropriately.

To see this, imagine an escaped F(a,c) dominating the highest *a.

/a/	...	F_k(a,c)	*a	*c	...
☞ a↣a	...		*		...
a↣c	...	* !		*	...

(42) **Chain-Shift Criterion.** For there to be a chain-shift a ↦b, b ↦ c , there must be at least one Faithfulness constraint F_i(a,c), dominating {*b} and {F(a,b)}. (where {C} = every constraint of type C.)

Pf. We know a≺ b≺ c. So **a↦b** cannot win by virtue of Markedness. Its failures {*b} will kill it vis-a-vis a↦c, unless they are dominated. By what? Some F(a,c) is the only hope. Similarly, the failures {*F(a,b)} of a↦b will be fatal vis-a-vis a↦c without the domination of **F_k(a,c)**:

/a/	*a	**F_k(a,c)**	F_i(a,b)	*b	*c
a↦c		***!**			*
☞ a↦b			*	*	

(43) Schematically, to successfullysuperimpose a ↦b , b ↦ c in one hierarchy, we must have —

```
        *a, Fk(a,c)
         /      \
      {*b}     {F(a,b)}
       /      \
  {*c}     {F(b,c)}
```

(44) **Antifaithfulness.** Neither Moreton's result nor the Chain-shift Criterion holds when antifaithfulness is introduced: F(a,a) = "do not map a to a". To see this, consider the following example: a↦b, b↦a. The language is {a,b}, and Gen(a) = Gen(b) = {a,b}.

/a/	*a↦a	*b	*a	*...whatever*
a↦a	*!		*	...
☞ a↦b		*		...

/b/	*a↦a	*b	*a	*whatever...*
b↦b		*!		...
☞ b↦a			*	...

(45) **No guarantees that chain shift can be accomplished.** To have the shift, F(a,c) must exist in CON and be separately rankable. Although constraints with the effect F(a,c) surely exist (else, given a≺c, **a** will simply disappear in favor of **c**), they need not be distinct from e.g. F(b,c). Thus in the basic complex coda theory of class 2, there was no separate F constraint banning CC ↦ Ø distinct from C ↦ Ø .

(46) **Yupik** (Baković 1996, Hayes 1995)

$\sigma_{\mu} \mapsto \sigma_{\mu\mu}$, $\sigma_{\mu\mu} \mapsto \sigma_{\mu\mu\mu}$ (in the head of a disyllabic iambic foot)

If RHYTHMIC HARMONY compels lengthening in this circumstance, then DEP(μ) or *μ or WEIGHT-IDENT should be multiply violable to achieve the ultimate length. To stop it, we'd need F(μ, μμμ) in the dominant position required by the CSC (16).

(47) Antifaithfulness. Baković's solution involves antifaithfulness:

FtHarm: For every disyllabic foot G, increase H(G). (The harmony of G).

Any increase in harmony (= lengthening of iambic head) satisfies the constraint. Therefore, the degree of lengthening is controlled by the one Faithfulness constraint.

(48) Baković's Iambic lengthening: FTHARM >> DEP-μ

/CVCV/	FTHARM	DEP-μ
$(\sigma_\mu\ \sigma_\mu)$	*!	
☞ $(\sigma_\mu\ \sigma_{\mu\mu})$		*
$(\sigma_\mu\ \sigma_{\mu\mu\mu})$		**!

(49) **General conclusion**: The intrinsic structure of M/F-OT places strong limitations on the coexistence of maps within a single hierarchy. Chain-shift phenomena in which the blocking "F(a,c)" cannot be separately distinguished require exploring new vistas that affect fundamentals (rather than incidentals) of the theory.

(50) Nbɛzi. (Kirchner 1996: LI, p.341ff.) . Nb zi has a upward chain-shift of vowels before a suffixal -i (which, however, is only pronounced in very careful speech).

i	u		+ HIGH	
e	o	+ATR	HIGH	
		↓ ATR		LOW
	a			+ LOW

(51) What is the driving constraint? (Always a tough call in chain shift situations!) Perhaps something along the lines of *V i , with violation assessed for every shared feature. So attracts V i to i, whose features we imagine spread to the preceding vowel.

(52) By the Chain Shift Criterion, the all-the-way maps a, ↦ i can only prevent by specific F constraints, which do not obviously exist. F(ATR), F(HI), F(LO) are individually insufficient.

(53) Kirchner (1996) proposes that the relevant F-constraints **do** exist — by virtue of *Local Conjunction* (Smolensky 1993):

Thus: F(LO) & F(ATR), F(HI) & F(ATR).

Thus, above, for Yupik, [DEP-μ & DEP-μ]. Gnanadesikan 1997 explores another avenue of attack via the representational theory. McCarthy (1997, this event) develops a novel line on enriching the notion of Faithfulness.