



24.901/931, 2026

Introduction to Phonology

Lecture 12

2 reminders

- Problem set 3 due tomorrow
Explain your choices of UR, rules, direction of application, ...
- Midterm Thursday 4-2.
- Will send the midterm data and guidelines for analysis in 2 days.

Today

- Opaque rules: whether they are learned; significance of learning for choices of linguistic theory
- OT

Review: types of rule interactions

	Rule A > Rule B	Rule B > Rule A
If Rule A can create extra inputs to B	<i>A feeds B</i>	<i>A counterfeeds B</i>
If Rule A can eliminate inputs to B:	<i>A bleeds B</i>	<i>A counterbleeds B</i>

Review: transparent and opaque rules

A rule is transparent iff:

(a) It is *surface true*:

No string corresponding to the rule's Structural Description (SD) is present in surface forms. (= no data appears to contradict the rule)

(b) Each one of its applications is *surface-apparent*:

Each surface context where the rule is known to have applied corresponds to the rule's SD.

(= the SR context justifies each known application of the rule)

A rule is opaque otherwise:

The rule is not surface apparent or not surface true or both.

Connection between counter-feeding/bleeding and opacity

- Counter-feeding/counter-bleeding interactions produce opaque rules; feeding/bleeding interactions generally do not.
- Most counterfeeding $R1 > R2$ cause $R1$'s SD to appear on surface, so $R1$ will not be surface true. (e.g. **Catalan** $den < /dent/$)
- All counterbleeding $R1 > R2$ cause $R1$ to be non-surface apparent: $R2$ removes a factor from $R1$'s SD. (e.g. **Kinyarwanda** $c\#a < ci\#a$)
- (Further complexities: some *feeding* orders $R1 > R2$ result in $R1$ being non-surface apparent. And some rules are opaque not due to order being counter-feeding/counter-bleeding. But the broad tendencies are as above. See full slides from 3-17 class.)

We expect that the opaque rules are harder to learn: they seem to be contradicted; their application not always justified.

Two cases suggest this below.

Such evidence could mean that learners do not acquire the opaque rules at all, or do but more slowly. This is not known.

Counterbleeding, opacity and learning in Polish

Evidence for one rule

Singular	Plural	gloss	
trup	trupi	corpse	
klup	klubi	club	Also: snɔp/snɔpi,
kɔp	kɔpe	shuck corn	nɔs/nɔsi,
trut	trudi	labor	kɔʃ/kɔʃe,
kɔt	kɔti	cat	psɔts/psɔtʃe
wuk	wugi	lye	
wuk	wuki	bow	

[-son] → [-voice] / __#

Evidence for another rule

Singular	Plural	gloss	and note these
bur	bɔri	forest	snɔp/snɔpi,
ʒur	ʒuri	soup	nɔs/nɔsi,
vuw	vɔwi	ox	kɔʃ/kɔʃe,
buj	bɔji	fight	psɔts/psɔtʃe
sul	sɔli	salt	kɔp/kɔpe
			kɔt/kɔti
			trup/trupi
			trut/trudi

[+round] → [+high] / __ [+voice] #

Interaction of Devoicing and Raising

Singular	Plural	gloss
rup	rɔbe	do
lut	lɔdi	ice
ʒvup	ʒvɔbi	cib
nuʃ	nɔʒe	knife
ruk	rɔgi	horn

Derivations

UR	rɔb	rɔb-e	kɔp	klub
Raising	rub	n/a	n/a	n/a
Devoicing	rup	n/a	n/a	klup
SR	rup	rɔb-e	kɔp	klup

Counterbleeding: Devoicing could have bled Raising, had Devoicing come first

Loss of ɔ-Raising in loanwords (Sanders 2002)

Singular	Expected	Plural	Gloss
glɔp	*glɔp	glɔbɪ	‘globe’
snɔp	*snɔp	snɔbɪ	‘snob’
ɛpizɔt	*ɛpizɔt	ɛpizɔdɪ	‘episode’
kɔt	*kɔt	kɔdɪ	‘code’
nɛkrɔɔk	*nɛkrɔɔk	nɛkrɔɔgi	‘obituary’
prɔɔk	*prɔɔk	prɔɔgi	‘prologue’
kɔɔr	*kɔɔr	kɔɔrɪ	‘card suit’
xɔl	*xɔl	xɔɛ	‘lobby’
parasɔl	*parasɔl	parasɔɛ	‘umbrella’
kɔvbɔj	*kɔvbɔj	kɔvbɔjɛ	‘cowboy’

ɔ-Raising doesn't apply
Final Devoicing does

Testing Raising rule with nonce (*wug*) words (Sanders 2002)

- Stimuli: nonce plurals containing ɔ+voiced C+suffix, in context:
Bardzo ładne cztapody [tʃtapod-i] dały Janowi kawę,
‘the very pretty **cztapod-s** gave Janek coffee’
- Responses elicited: say the corresponding unsuffixed singular
Jeden bardzo ładny ____ pozyczył Jankowi i pieniądze i koszulę,
‘one very pretty (**cztapod**) lent Janek both money and a shirt’
- Will Voicing and/or Raising apply?
~~cztap[ut]~~ or cztap[ot]? or ~~cztap[ud]~~ or ~~cztap[od]~~?
- Devoicing (transparent) always applies. Raising (opaque) never does.

Speculation

- Polish Raising doesn't exist as a productive rule any more
- Opaque interaction with Devoicing could have made Raising harder to learn. (But raising fails before sonorants too: **parasɔl**, **kɔvbɔj**.)
- For a firmer conclusion: compare historical development of larger numbers of Polish-like opaque rules with comparable transparent ones.

Canadian (and North Eastern US) Raising

aɪD		ʌɪT	
tribe	[t ^h raɪb]	tripe	[t ^h rʌɪp]
ride	[ɹaɪd]	right	[rʌɪt]
live	[laɪv]	life	[lʌɪf]
rival	[ɹaɪvəl]	rifle	[ɹʌɪfəl]
tiger	[t ^h aɪgə]	hiker	[hʌɪkə]
pie	[p ^h aɪ]	pipe	[p ^h ʌɪp]

T = [-son, -voice], D = [-son, +voice]
 ʌ = [-low, -high, +back, -round]
 a = [+low, -high, -back, -round]
 ɪ, ʊ = [+syll, +high]

Pig Latin (one dialect):

pie → [ʌɪpeɪ]

buy → [aɪbeɪ]

More data in Hayes 2009 Phonological Alternations II
 Much more data on US dialects in Vance 1987.

Canadian Raising Rule

[+syll] → [-low] / _[+high][-voice]

Note: [+high]][-voice] (2 segments) vs. [+high,-voice] (1 segment).

Stress effects: *cíte* [Λit], vs. *citátion* [ait]; *bícycle* [Λis] vs. *bicúspid* [aik]

Low frequency inhibits rule: *colítis*, *nítrate* [Λit] ~ [ait], some US speakers

Interaction of Flapping and CR

1. write	[rʌɪt]	writing	[rʌɪrɪŋ]	writer	[rʌɪrə]
2. ride	[raɪd]	riding	[raɪrɪŋ]	rider	[raɪrə]
3. cite	[saɪt]	citing	[saɪrɪŋ]		
4. side	[saɪd]	siding	[saɪrɪŋ]		
5. white	[waɪt]	whiter	[waɪrə]		
6. wide	[waɪd]	wider	[waɪrə]		

Flaps are [+voice]. Order of Flapping vs. CR?

CR is transparent or opaque?

Is either rule not surface true/not surface apparent?

Order

UR	raid-ə	rait-ə
CR Flap SR		

- Flapping counterbleeds CR.
- CR is not surface-apparent:
no apparent justification for [ɹɹ] in [rɹɹɹə]
- CR is opaque

An alternative to analysis with opaque order

- CR in [ɹ] in *writer* could be due to the fact that *writer* [ɹɹɪtə] = *write-er* [ɹɹɪt] + [ə]
- When a word occurs in unaffixed and affixed form, the unaffixed form (*the base*) tends to influence the stem of the affixed word (*the derivative*) (Class 20), independently of how the rules are ordered. Cf. stress in words like *pórcupin-ish-ness*.
- This effect is known as the *phonological cycle* (mentioned when discussing Galab):
Phonological rules apply to base words: *write* [ɹɹɪt]
Their effects are inherited unchanged by derivatives: *writ-er* [ɹɹɪtə]
Then more rules apply to the newly created word: *writer* [ɹɹɪtə].
- The opacity of CR in interactions with Flapping could be attributed to the cycle.
- The Kinyarwanda apparent counterfeeding and counterbleeding interactions of Palatalization and V-Elision could also be due to the cycle.

Extensions of [ʌɪ] to other contexts

- In most English words, [ʌɪ] found in words where CR could have applied.
- Including in some unsuffixed words: *titan*, *mitre*, *title*, *vital*.

The cycle cannot explain [ʌɪ] before $r < t$ in *titan etc.*

This could be evidence for an ordering analysis.

- There are also words $r < t$ before b, g, in CR dialects:
sp[ʌɪ]*der*, *c*[ʌɪ]*der*, *Sn*[ʌɪ]*der*, *c*[ʌɪ]*ber*, *t*[ʌɪ]*ger*, *t*[ʌɪ]*dal*. Mostly -*ər*, -*əl* words.

- These can't come from CR > Flapping

Speculation: [ʌɪ] has been extended from words like *wr*[ʌɪ]*ter*, from *wr*[ʌɪt], to other words in əR (R=liquid)

Because people didn't learn CR > Flapping but a different rule: [aɪ] → [ʌɪ] / _CəR

This rule it is not conditioned by [-voice]. Doesn't interact with Flapping, not opaque.

Canadian Raising before voiced Cs.

Philadelphia speakers: Fruehwald 2008; more noise in this data

Word	Speakers
spider	11/11
cider	11/11
beside	6/11
cyber	6/11
tiny	6/11
idol	5/11
tidal	5/11
dinosaur	4/11
Heinz	4/11
nine	4/11
Snyder	4/11
tidy	4/11

Rate of pronunciations with [ʌɪ]
among Philadelphia speakers.
Note [ʌɪ] extension beyond context
where CR + Flapping could have
applied. Most frequent context is in -er
words, like *writer*.

More speculation

- Perhaps grammars of Canadian and NE dialects contained an original counterbleeding interaction, CR > Flapping. We lack evidence for this, but it's possible.
- But most data available *today* suggests that this is not learned as a counter-bleeding interaction, CR > Flapping.
- It is learned as several rules:
Raising in monosyllables (*wr*[Λ ɪt]); cyclic preservation of [Λ ɪ] in *writer*; er-Raising (in *spider*, *tiger*, *writer*, *cyber* etc.)
- Maybe all counterbleeding and counterfeeding interactions are eventually mis-learned in this way. We don't know yet.

Significance of rule orders

- Optimality Theory (Prince and Smolensky 1993), in its original version, can model most feeding and bleeding interactions.
- Some counterfeeding and some counterbleeding interactions can be modeled indirectly, with new constraint types.
- Some counterfeeding, counterbleeding interactions can't be modeled.
- That's a possible disadvantage for OT analyses.
- But not if the opaque interactions are not learned at all.
- Or if the learning mechanism is different in those cases.

OT

Evidence thus far for 2 types of constraints

- Type 1 constraints include:

Each Tone is realized on some V

Association lines don't cross

Versions of the Obligatory Contour Principle:

No adjacent identical feature values:

[+round][+round]

[α active articulator] [α active articulator]

No adjacent (or close) identical or similar segments:

/T-d/ as in *mint-ed*, *mind-ed*

/l...l/ or /r...r/ as in *simil-ar*, *flor-al*

Trigger of Vowel Harmony processes

No feature disagreement for some Fs: [$\pm$ round], [$\pm$ front]

These type 1 constraints could be constraints on SRs

- That would explain why repeated action is taken to ensure they are satisfied, not just at one point in the derivation, but in all SRs.
 - VH keeps applying: it iterates, it applies after language games, after epenthesis, after affixation, *until all feature disagreements are eliminated*.
 - VVs are eliminated via multiple strategies until no VV is left (Margi):
 - turn a V into a glide; if there's still some VVs, delete V_1 or V_2 .
 - Floating tones are reassociated (Mende, Lomongo) until none is left floating.

A 2nd constraint type preserves UR properties

- *Don't change the 1st V of the word's UR*

Explains why VH in Turkish applies RL onto inserted Vs.

Why preserve 1st V? First CV is one of a word's 3 most memorable properties.

(*Tip-of-the-tongue* phenomenon: first CV, last segment, stress. Brown and McNeil 1966 JVLV)

- *Don't change root Vs: in Galab vowel harmony*
- *Don't lose tones by leaving them floating*

These 2 constraint types can conflict

- Harmony constraint: No disagreeing values for $[\pm\text{front}]$, $[\pm\text{round}]$
- Preservation constraint: Don't change the 1st UR root V
- Can satisfy both in suffixed/prefixed words
- Can't satisfy both in compounds: e.g. Tuvan *çam-çevi*.
- Need to *prioritize* satisfying some constraints over others

2 constraints, ranked; leftmost has priority
 3 ways to realize this compound (3 SR *candidates*)

UR çam, çevI	Preserve 1 st root V	Harmony	Comment
☞ çam#çevi	✓	*(aC ₀ e)	Satisfies top constraint; violates minimally the lower
çam#çavi	* (e→a)	✓	Violates higher constraint
çem#çevi	* (a→e)	✓	Violates higher constraint

More conflict: Turkish [o,ø]

- **Preservation constraint:** Don't change the 1st UR root V
- **Harmony constraint:** No disagreeing values for [$\pm$ round]
- **Inventory constraint:** No [+round, -high] V (no [o, ø])*

UR odA-lAr	Preserve 1 st root V	Inventory	Harmony
☞ odalar	√	*(o)	* (oda)
odolor	√	***	√
odolar	√	**	* (ola)
adalar	*(o→a)	√	√

*Recall: Turkish native words have **no o,ø except in 1st syll.** We're looking to explain that 'except' part.

*A frequent property of vowel inventories: **u, y exists but no o, ø, ɔ, ɒ**; never (as far as I know) the converse.

Optimality Theory: grammars consisting of ranked constraints

- A theory of how static constraints (the 2 types discussed) interact to generate linguistic patterns, and behaviors in general.
- Current linguistic applications are mostly to phonology.
- Alan Prince and Paul Smolensky 1993 (2004).
- A basic idea (a) and an empirical hypothesis (b):
 - a. The function of grammar is to resolve conflicts that arise between constraints on SRs and constraints on UR preservation.
 - b. The constraints are universal. What is language-specific is ranking.

Optimality Theory

- Develops older ideas (Kisseberth 1970, Sommerstein 1973, Stampe 1978): rules implement solutions to linguistic problems.
- A grammar records the *problem* (potential SR violations) that a language seeks to solve
- Separately, it records *deviations from UR* permitted as solutions (= *repair strategies*).
- It records *relative priorities* between SR problems and SR deviations from UR; + others
- No instruction to change URs, no rule. No aim to change URs, but to solve problems some URs pose for SR.
- Unlike rule-based grammars, OT-grammars can answer basic questions:
 - why rules exist: because URs violate conditions on SR.
 - why harmony iterates, rather than just apply once: wouldn't remove all SR violations.
 - why it iterates in certain directions, or in all directions: see slide 6.
 - why phonological rules/systems are similar, yet distinct: same pieces, differently ranked

Elements of OT as applied to phonology

Constraints

- Functions from classes of linguistic structures to violation marks (*).
- E.g. a *HH constraint assigns 1 * to each High tone sequence, HH.
- A form that violates a constraint is assigned a * for *each instance* of the structure that any given constraint penalizes.
- ba da ga gets ** from *HH (*distinct Hs on adjacent syllables)
| | |
H H H
- Two main constraint classes: Markedness and Faithfulness constraints.

Markedness constraints (M*)

- Evaluate properties of SRs
 - a. *VV against adjacent Vs.
 - b. * $[\alpha \text{ round}] [-\alpha \text{ round}]$
- UR sources of SRs are irrelevant to evaluation of M constraints
 - e.g. SR $[b\Delta s\epsilon z] < \text{UR } /b\Delta sz/$ doesn't get a * for *strident-strident.
only hypothetical SR $[b\Delta sz]$ (from any UR) does.

*Why call the M constraints *Markedness*? It's a reference to Chomsky and Halle's (1968) *Theory of Markedness*, which distinguishes between structures that are cross-linguistically widespread, preferable(*unmarked*) and less preferred ones (*marked*). The aim was to explain why certain structures recur cross-linguistically. The Theory of Markedness is not in use now but the term remains.

Faithfulness (aka *Faith*, or *F*, or *Correspondence*)

- Faith constraints evaluate how faithfully each SR preserves its UR.
They penalize UR-SR mismatches.
- Example 1: constraint against any SR that loses a UR tone.
MAX TONE: a violation for each UR tone that's absent from SR
- Example 2: constraint against an SR that loses some UR segments
MAX V(or C): a violation for each UR V (C) that's absent from SR
- Example 3: constraint against any SR containing a sound absent from UR
DEP V(or C): a violation for each SR V(C) that's absent from any UR

Why MAX, why DEP? UR must be **MAX**imally preserved in SR, SR is maximally **DEP**endent upon the UR

Conflict and violability

- Constraints conflict w. other constraints, esp. when stated most generally.
E.g. the constraint that causes VH conflicts with preservation of 1st root V.
- C_1 conflicts with C_2 = not possible to satisfy C_1 without violating C_2 in some forms



/çam-çevi/	Don't change root V1	*[α back][-α back]
çam-çavi	* (çev → çav)	
çem-cevi	* (çam → çem)	
çam-çevi		* (çamçevi)

More complex constraints can replace ranking: e.g. ***[α back][-α back] *inside 1 word***.
That can also exclude VH in compounds.
But ranking, as above, allows the more general statement ***[α back][-α back]**.

The grammar is a constraint hierarchy, H

- A priority order, or ranking, over the entire constraint set

$$C_1 \gg C_2 \gg \dots \gg C_n,$$

where $\gg$ = “outranks, has priority at being satisfied, over _”

/UR/	C ₁	C ₂	C ₃
SR1	...	...	...
SR2	...	...	...

SR1 = one candidate SR realization of this UR
SR2 = another candidate for same UR
H determines which SR is chosen

- All constraints, M and F, are violable.
- Each violation is assessed a * mark. Marks determine how viable a form is, compared to other candidates.
- All constraints could be ranked; not all rankings are discoverable in the data.

Constraints turn URs into SRs via 2 functions

- *Generation* (**Gen**): maps any UR to a set of potential SRs, or *candidates*.
- *Evaluation* (**Eval**): selects the best candidate according to the language's Hierarchy.
- Short Eval: the best candidate for a given UR violates lower ranked constraint(s) than other candidates; or, if it violates the same constraints as other candidates, it does so less than the others.

A first informal illustration of Gen and Eval

- We consider the case of a learner who knows the URs of some words, their actual SRs, and all the constraints, but not yet their rankings.
- The learner discovers rankings by comparing what Eval provides as the optimal SR (= the *winning candidate*) with the SR known to be right.

Example: Margi /hù-árì/ → [hwǎ̀rì]
 First, we illustrate what Gen does

The UR

hù -árì L HL	H, constraint hierarchy, goes here			
hù -árì L HL				
hù -tárì L HL				
hw -árì H L				
hw -ǎ̀rì /\ LHL				

The faithful
SR

Some SR
candidates

Actual SR

How to select candidates relevant to discovery of rankings

- Lots and lots of candidates. Very few are relevant to discovering rankings.
- Always consider as a candidate the *faithful* candidate = unmodified UR. We need to understand *why the UR doesn't surface intact*, if that's the case.
- Always consider the SR. Needed to verify that an existing, preliminary grammar is producing the right SRs.
- Consider also any other modification of the UR that satisfies the M constraints considered, esp. if it satisfies any M constraint better than the known SR.

Now we illustrate informally Eval.

The UR	hù -á rì L HL	*VV	DEP C	MAX TONE	MAX V
The faithful candidate	hù -á rì L HL				
Other SR candidates	hù -tá rì L HL				
The actual SR	hw -á rì H L				
	hw -ǎ rì / \ LHL				

Step 1: record constraint violations

The UR	hù -á rì L HL	*VV	DEP C	MAX TONE	MAX V
The faithful SR	hù -á rì L HL	*(u-a)			
Some SR candidates	hù -tá rì L HL		*(t)		
The actual SR	hw -á rì H L			*(L→Ø)	
	hw -ǎ rì /\ LHL				(satisfied: u=w)

Step 2: compare candidates. A winner emerges

The UR <hù -áàrì<="" h1=""> L HL </hù>	*VV	DEP C	MAX TONE	MAX V
The faithful SR <hù -áàrì<="" h1=""> L HL </hù>	*			
Some SR candidates <hù -táàrì<="" h1=""> L HL </hù>		*		
Perfect! ...given this constraint set <hw -áàrì<="" h1=""> H L </hw>			*	
<hw -ǎàrì<="" h1=""> /\ LHL </hw>				(satisfied: u=w)

Actually, winner isn't perfect: contour tones are avoided, $*T_1T_2$

The UR	hù -áàrì L HL	*VV	DEP C	MAX TONE	MAX V	*T ₁ T ₂
The faithful SR	hù -áàrì L HL	*				
Some SR candidates	hù -táàrì L HL		*			
The actual SR	hw -áàrì H L			*		
	hw -ǎàrì /\ LHL				(satisfied: u=w)	* 47

We add a ranking (= solid line)

The UR

The faithful
SR

Some SR
candidates

The actual SR.
Imperfect, but
the best, given
this H

hù -á rì L HL	*VV	Equally ranked at the top		MAX V	Lower ranked
		DEP C	MAX TONE		*T₁T₂
hù -á rì L HL	*				
hù -tá rì L HL		*			
hw -á rì H L			*		
hw -ǎ rì / \ LHL				(satisfied: u=w)	*

Winner violates a 2nd constraint

The UR

hù -á rì L HL	*VV	Equally ranked at the top, for now			*T ₁ T ₂	Violated if V → glide
		DEP C	MAX TONE	MAX V		
hù -á rì L HL	*					
hù -tá rì L HL		*				
hw -á rì H L			*			*
hw -ǎ rì /\ LHL				(satisfied: u=w)	*	*(u→w)

The faithful
SR

Some SR
candidates

Actual SR.
imperfect, but
best, given
this H

Eval less informally. Presupposes known rankings.

- Take two candidates, c_x and c_y + their scores for all constraints.
- Find the *highest ranked constraint C that differentiates* c_x from c_y . Circled below.
- If c_x violates C fewer times than c_y , c_x is better than c_y ($c_x \succ c_y$)

(i)	C₁	C ₂	C ₃	C ₄
c _y	*			
c _x		*		

(iii)	C ₁	C₂	C ₃	C ₄
c _y	*	*		
c _x	*		*	*

(v)	C ₁	C ₂	C ₃	C₄
c _y		**		***
c _x		**		**

(ii)	C ₁	C₂	C ₃	C ₄
c _y	*	*		
c _x	*			

(iv)	C₁	C ₂	C ₃	C ₄
c _y	**	*		
c _x	*			

c_y is eliminated. Now repeat comparison, between c_x and c_z , and continue until all candidates are compared.

With graphic aids

- Critical violation (marked *!): first violation that causes a candidate to lose to another. Winning candidate is marked by .
- LR order of constraints mirrors rankings (highest leftmost), unless separated by dotted lines, which mean that their ranking is unknown.

(i)	C ₁	C ₂	C ₃	C ₄
c _y	*!			
 c _x		*		

(iii)	C ₁	C ₂	C ₃	C ₄
c _y	*	*!		
 c _x	*		*	*

(v)	C ₁	C ₂	C ₃	C ₄
c _y		* *		* * * !
 c _x		* *		* *

(ii)	C ₁	C ₂	C ₃	C ₄
c _y	*	*!		
 c _x	*			

(iv)	C ₁	C ₂	C ₃	C ₄
c _y	* * !	*		
 c _x	*			

Terminology

- The *winning candidate* is the form designated by the grammar (= constraint hierarchy, H) as the best SR for a given UR, given H.
- *Tableau* or *violation tableau*: an evaluation by H of competing SRs for *one* UR
- c_x *better satisfies* any C than c_y : c_x has fewer violations of C than c_y
- Some C *favors* c_x over c_y : c_x has fewer violations of C than c_y

More on Faithfulness

- F constraints assign *s marks when SRs mismatch corresponding URs in specific ways.
- Three possible mismatches:
 1. SR may be missing a piece of UR; or may have added a new piece to the UR
 2. SR may still have that piece of UR, but in changed form.
 3. SR may have changed *relations* between pieces of the UR that it preserved
- Type 1: e.g. MAX SEG/ MAX TONE (= no deletion of segments; of tones);

One violation for each UR segment/tone that lacks a SR correspondent.

e.g. DEP SEG/ DEP TONE (= no insertion of segments/tones)

One violation for each SR segment/tone that lacks a UR correspondent.
- Type 2: e.g. V STAYS V, aka IDENT $\pm$ SYLLABIC; many other IDENT, one for each F.
- Type 3: e.g. LINEARITY: don't change precedence relations between segments
if $a > b$ in UR, and if a and b are preserved in SR, then $*b > a$

- In other cases, the full constraint hierarchy is known in advance but not the SR of a word. That's the case of a speaker using their grammar to predict the shape of some new word.
- In still other cases, neither the precise form of constraints nor their rankings are given in advance. This is the case of a language learner starting from very limited knowledge to acquire a grammar.

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