Class 1
Rule Ordering in Phonology: Transparent Orders: Rules vs. Constraints

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1 Reminder: rules and constraints

- Phonological processes and (static) phonological generalizations can be expressed using **rules**:

(1) **Rule notations**

a. /X/ → [Y] / A_B "*X becomes Y in the context of a preceding A and a following B*"
b. /AXB/ → [AYB] "*The string AXB becomes the string AYB*"

- They can also be expressed using **constraints**:

(2) **Converting rules to constraints**
/AXB/ → [AYB] ≈ MARKEDNESS:*AXB ≫ FAITHFULNESS:*X→Y (FAITH[X])

- To use the same simple example as last semester, we can represent German final devoicing (3) through either rules (4a) or constraints (4b).

(3) **German final devoicing data** (Brockhaus 1995:4)

a. *bunte* [bʊ**n**t-ə] 'colorful-NOM.FEM.SG.' ∼ *bunt* [bʊn**t**] 'colorful.NOM.MASC.SG.'
b. *Bunde* [bʊn**d**-ə] 'league-DAT.SG.' ∼ *Bund* [bʊn**t**] 'league.NOM.SG.'

(4) **German final devoicing analysis**

a. *Rules*: /−sonorant(,+voice)/ → [(−sonorant,)−voice] / _#
b. *Constraints*: *[−sonorant,+voice]# ≫ IDENT[voice]-IO

- Regardless of formalism or theory, it is empirically clear that phonological processes/generalizations frequently **interact**.

⋆ A good theory will therefore capture all and only the types of process interactions that are attested.

2 Finnish

- Here's some data from Finnish. What's going on?

(5) **Finnish** (data from Campbell 2013:202, Rasin 2016:1; based on Kiparsky 1973b, 1993)

	Essive singular		*Nominative singular*	
a.	onne-na	'as happiness'	onni	'happiness'
b.	sukse-na	'as (a) ski'	suksi	'ski'
c.	vete-næ	'as water'	vesi	'water'
d.	kæte-næ	'as (a) hand'	kæsi	'hand'
e.	tuoli-na	'as (a) chair'	tuoli	'chair'

	Infinitive		*Past*	
f.	halut-a	'to want'	halus-i	'wanted'

2.1 The basic processes

- The contrast between /e/ and /i/ (non-low front vowels) is neutralized to [i] in final position.
  ↪ Final vowel raising (6)
- The contrast between /t/ and /s/ (voiceless coronal obstruents) is neutralized to [s] before [i].
  ↪ Assibilation (7)
- (The suffix vowel alternates between [a] and [æ] based on the backness of the root-initial(?) vowel.)

(6) **Process A: Final vowel raising (FVR)**
  a. /e/ → [i] / _#
  b. *e# ≫ IDENT[high]-IO

(7) **Process B: Assibilation**
  a. /t/ → [s] / _i
  b. *ti ≫ IDENT[strident]

- Derivations contrasting cases where FVR applies with those where it does not are shown in (8):

(8) **FVR**: /onne/ → [onni]

a. *Rule-based derivation*

Underlying Representation (UR)	/onne-na/	/onne/	/tuoli-na/	/tuoli/
Rule A: FVR	—	onn**i**	—	—
Surface Representation (SR)	[onnena]	[onni]	[tuolina]	[tuoli]

b. *Constraint-based derivation*

/onne/		*e#	IDENT[high]
a.	onne	*!	
b. ☞	onni		*

- Derivations contrasting cases where Assibilation applies with those where it does not are shown in (9):

(9) **Assibilation**: /halut-i/ → [halus-i]

a. *Rule-based derivation*

UR	/halut-a/	/halut-i/
Rule B: Assib	—	halusi
SR	[haluta]	[halusi]

b. *Constraint-based derivation*

/halut-i/		*ti	IDENT[strid]
a.	halut-i	*!	
b. ☞	halus-i		*

2.2 Process interaction

- What we're interested in is what happens when these two processes interact:

(10) **Interaction between FVR and Assibilation**

	Essive singular		*Nominative singular*		
a.	vete-næ	'as water'	vesi	'water'	(*veti, *vete, *vese)
b.	kæte-næ	'as (a) hand'	kæsi	'hand'	(*kæti, *kæte, *kæse)

⋆ **How do the rules have to work in order to generate these forms correctly?**

→ If rules apply **sequentially** (as is standardly assumed), FVR must **precede** Assibilation.

- If FVR precedes Assibilation (11), FVR creates a [i], which newly creates the environment for Assibilation to apply.

(11) **Sequential rule-based derivation (correct): FVR precedes Assibilation**

UR	/vete-næ/	/vete/	/onne/	/halut-i/
Rule A: FVR	—	vet**i**	onn**i**	—
Rule B: Assibilation	—	ve**s**i	—	halu**s**i
SR	[vetenæ]	[vesi]	[onni]	[halusi]

⋆ Because Rule A *creates a new environment for Rule B to apply*, Rule A **feeds** Rule B.

- If we reversed the order of the rules (12), we would end up with the wrong result (for Finnish), because FVR applies *too late* to create a context where Assibilation can apply.

(12) **Sequential rule-based derivation (incorrect): Assibilation precedes FVR**

UR	/vete-næ/	/vete/	/onne/	/halut-i/
Rule B: Assibilation	—	—	—	halu**s**i
Rule A: FVR	—	vet**i**	onn**i**	—
SR	[vetenæ]	*[veti]	[onni]	[halusi]

⋆ Under this order, because Rule B *would have created a new environment* for Rule A if it had applied first, Rule B **counter-feeds** Rule A.

→ On the other hand, if rules (can) apply **simultaneously** (Koutsoudas, Sanders, & Noll 1974) and iteratively (13), then these two rules will apply correctly without ordering.
  - On the first pass through the grammar, FVR applies (Assibilation's context is not met).
  - On the second pass through the grammar, Assibilation applies (FVR's context is not met, since it was already removed).

(13) **Simultaneous, iterative rule-based derivation (correct)**

UR	/vete-næ/	/vete/	/onne/	/halut-i/
Assibilation & FVR	—	vet**i** (FVR)	onn**i** (FVR)	halu**s**i (Assib)
Assibilation & FVR	—	ve**s**i (Assib)	—	—
Assibilation & FVR...	—	—	—	—
SR	[vetenæ]	[vesi]	[onni]	[halusi]

- However, this shows that simultaneous rule application *without iterativity* will not work for such a case.
  - This would be equivalent to the counter-feeding derivation, where Assibilation doesn't get another chance to apply after FVR applies.

- Simultaneous, non-iterative application is though possible using constraints.

(14) **Simultaneous derivation using constraints**

/vete/		*e#	*ti	IDENT[high]	IDENT[strid]
a.	vete	*!			
b.	veti		*!	*	
c.	vese	*!			*
d. ☞	vesi			*	*

- Given that the two processes are independently attested, we know that the markedness constraints each outrank their respective faithfulness constraint.
- If both markedness constraints dominate the other process's faithfulness constraint, this ranking will derive simultaneous application of both processes.

⇒ OT is designed to capture feeding orders (and bleeding orders, as we'll see below), but has trouble with (certain types of) counter-feeding (and counter-bleeding) orders.

3 Basic types of rule ordering interactions

- There are **four main types** of rule ordering interactions, coming in two logical pairs:
  - Feeding and counter-feeding (which we've already seen)
  - Bleeding and counter-bleeding

3.1 Feeding and counter-feeding

- The first basic type is a *feeding* interaction:

(15) **Feeding:**
- Rule A *creates* the input or environment for the application of Rule B, and
- Rule A is ordered before Rule B, so

→ Rule B successfully applies to the output of Rule A.

- The flip side of feeding is: If Rule A feeds Rule B, but you reverse the order, you get a *counter-feeding* interaction:

(16) **Counter-feeding:**
- Rule A *creates* the input or environment for the application of Rule B, **but**
- **Rule B is ordered before Rule A**, so

→ Rule B never gets the chance to apply to the output of Rule A.

- These can be schematized as follows:

(17) **Feeding order (Rule A bef. Rule B)**

UR	/WXYZ/
Rule A: X → A / W_Y	*W**A**YZ*
Rule B: Y → B / A_Z	*WA**B**Z*
SR	[WABZ]

(18) **Counter-feeding order (Rule B bef. Rule A)**

UR	/WXYZ/
Rule B: Y → B / A_Z	—
Rule A: X → A / W_Y	*W**A**YZ*
SR	[WAYZ]

3.2 Bleeding and counter-bleeding

- The second basic type if is a *feeding* interaction:

(19) **Bleeding:**
- Rule A *destroys* the input or environment for the application of Rule B, and
- Rule A is ordered before Rule B, so

→ Rule B cannot apply to the output of Rule A (even though it would have applied if Rule A hadn't).

- The flip side of bleeding is: If Rule A bleeds Rule B, but you reverse the order, you get a *counter-feeding* interaction:

(20) **Counter-bleeding:**
- Rule A *destroys* the input or environment for the application of Rule B, **but**
- Rule B is ordered before Rule A, so

→ Rule B successfully applies before Rule A can destroy its input or environment.

- These can be schematized as follows:

(21) **Bleeding order (Rule A bef. Rule B)**

UR	/XYZ/
Rule A: Z → A / _#	*XY**A***
Rule B: Y → B / X_Z	—
SR	[XYA]

(22) **Counter-bleeding order (Rule B bef. Rule A)**

UR	/XYZ/
Rule B: Y → B / X_Z	*X**B**Z*
Rule A: Z → A / _#	*XB**A***
SR	[XBA]

4 Karok

- Consider the following data from Karuk (isolate, California):

(23) **Karuk** (Kenstowicz 1994:97, citing Bright 1957)

	Imperative	*1st singular*	*3rd singular*	*Gloss*
a.	pasip	nipasip	ʔupasip	'shoot'
b.	kifnuk	nikifnuk	ʔukifnuk	'stoop'
c.	siːtva	niʃiːtva	ʔusiːtva	'steal'
d.	suprih	niʃuprih	ʔusuprih	'measure'
e.	ʔaktuv	niʔaktuv	ʔuʔaktuv	'pluck at'
f.	ʔaxyar	nixyar	ʔuxyar	'fill'
g.	ʔiʃkak	niʃkak	ʔuskak	'jump'
h.	ʔuksup	nikʃup	ʔuksup	'point'
i.	ʔikʃah	nikʃah	ʔuksah	'laugh'

- There are three processes going on. What are they?

4.1 Processes

- The first set of roots are consonant-initial and well-behaved. They tell us the UR's for the different affixes:

(24) a. IMP ⇔ /Ø/
b. 1SG ⇔ /ni-/
c. 3SG ⇔ /(ʔ)u-/ (We can't know for sure whether this [ʔ] is underlying...)

- They also clearly show that there is a palatalization process (25), triggered by the /i/ of the 1SG prefix, e.g. [niʃiːtva] and [niʃuprih].

- The trick is to notice that the second set of roots are underlyingly *vowel-initial*.
  - In the imperative, a glottal stop is inserted before this vowel (26), presumably because the language doesn't allow word-initial vowels: e.g. /axyar/ → [ʔaxyar]
    - ∗ Because we need this rule independently, we could derive the [ʔ] of the 3SG prefix by rule instead of putting it in the UR. We might be able to tell the difference if another consonant were to precede it.
  - In the 1SG and 3SG, the root-initial vowel deletes (27), presumably to resolve hiatus: e.g. /ni-axyar/ → [nixyar], /ʔu-axyar/ → [ʔuxyar].

(25) **Palatalization:**
/s/ → [ʃ] / i(C)_
(*i(C)s ≫ IDENT[anterior])

(26) **Prothesis:**
Ø → ʔ / #_V
(*#V ≫ DEP-ʔ)

(27) **Vowel Elision:**
V → Ø / V_
(*VV ≫ MAX-V)

4.2 Process interaction

- Honing in on the vowel-initial roots: what sort of interaction is going on, and which form(s) reveal that?

(28) **Karuk**

	Imperative	*1st singular*	*3rd singular*	*Gloss*
f.	ʔaxyar	nixyar	ʔuxyar	'fill'
g.	ʔiʃkak	niʃkak	ʔuskak	'jump'
h.	ʔuksup	nikʃup	ʔuksup	'point'
i.	ʔikʃah	nikʃah	ʔuksah	'laugh'

- Given what we know about the processes, the root of the forms in (28g) has to be /iskak/, and the root of the forms in (28i) has to be /iksah/.
  - In the imperative, the root-initial vowel is retained, and palatalization is triggered. In the other forms, elision deletes that vowel.
  - In the 1SG, the prefix vowel [i] does trigger palatalization, so the root /s/ surfaces palatalizes to [ʃ].
  - ⋆ **In the 3SG, the prefix vowel [u] does not trigger palatalization, so the root /s/ surfaces faithfully as [s].**

→ Vowel Elision **bleeds** Palatalization, because Palatalization would have applied in these 3SGforms if the vowel hadn't been deleted first.

(29) **Sequential rule-based derivation (correct): Vowel Elision precedes Palatalization**

UR	/iskak/	/ni-iskak/	/ʔu-iskak/
Rule A: Prothesis	ʔiskak	—	—
Rule B: Vowel Elision	—	niskak	ʔuskak
Rule C: Palatalization	ʔiʃkak	niʃkak	—
SR	[ʔiʃkak]	[niʃkak]	[ʔuskak]

⋆ This is a **bleeding** order, because Vowel Elision prevents Palatalization from having the chance to apply.

- We can prove that this ordering is crucial by trying to swap it:

(30) **Sequential rule-based derivation (incorrect): Palatalization precedes Vowel Elision**

UR	/iskak/	/ni-iskak/	/ʔu-iskak/
Rule A: Prothesis	ʔiskak	—	—
Rule C: Palatalization	ʔiʃkak	niʃkak	ʔu-iʃkak
Rule B: Vowel Elision	—	niskak	ʔuʃkak
SR	[ʔiʃkak]	[niʃkak]	*[ʔuʃkak]

- This is a **counter-bleeding** order, because Palatalization managed to apply just in time to avoid getting bled by Vowel Elision.

- OT can get this sort of bleeding interaction just fine:

(31) **Bleeding derivation using constraints**

/ʔu-iskak/			*i(C)s	*VV	IDENT[anterior]	MAX-V
a.		ʔu-iskak	*!			
b.		ʔu-iʃkak		*!	*	
c.	☞	ʔu-skak				*
d.		ʔu-ʃkak			*!	*

- The point of a bleeding interaction, from an OT perspective, is that applying one repair fixes both problems.
  - The optimal way to repair hiatus is vowel deletion.
  - Because vowel deletion in Karuk targets the second vowel, which in this case is the one that is causing the markedness problem, you kill two birds with one stone by doing vowel deletion.
- Once the vowel is deleted, there's reason to incur the extra faithfulness violation (31d) from palatalization.
  → (31d) is harmonically bounded by the (31c) because of this extra violation, so there's no ranking under which (31d) can win.

5 Comparison between rules and constraints for process interaction

- The actual patterns I've shown you (feeding in Finnish, bleeding in Karuk) are **transparent** orders.
  - Essentially: it's *clear* from the surface representation why all the rules that did or didn't apply did or didn't apply.

→ Both ordered rules and simultaneous constraints (OT) can derive these patterns easily.

- The opposite orders (counter-feeding and counter-bleeding, which absolutely exist but I haven't shown you) are **opaque** orders (cf. Kiparsky 1973a et seq.).
  - Essentially: it's *not completely clear* from the surface representation why all the rules that did or didn't apply did or didn't apply.

→ Ordered rules (and, to some extent, simultaneous rule application; see again Koutsoudas, Sanders, & Noll 1974) can derive these patterns easily, but OT can't always do so (it depends a lot on the details).

- For example, ordered rules can derive the counter-bleeding pattern instantiated by swapping Vowel Elision and Palatalization:

(32) **Counter-bleeding Karuk′: Palatalization precedes Vowel Elision** (= (30) above)

UR	/iskak/	/ni-iskak/	/ʔu-iskak/
Rule A: Prothesis	**ʔ**iskak	—	—
Rule C: Palatalization	ʔi**ʃ**kak	ni**ʃ**kak	ʔu-i**ʃ**kak
Rule B: Vowel Elision	—	n<u>i</u>ʃkak	ʔ<u>u</u>ʃkak
SR	[ʔiʃkak]	[niʃkak]	[ʔuʃkak]

- I told you earlier that an OT derivation using just the basic markedness and faithfulness constraints can only derive the transparent, bleeding output *[ʔuskak].
  - There are fixes involving additional technology (Stratal OT, Base-Derivative Correspondence Theory, maybe Harmonic Serialism...), but it won't follow from the core architecture of OT.

- Likewise, OT will generally have trouble with counter-feeding patterns, like the opposite of Finnish:

(33) **Counter-feeding Finnish′: Assibilation precedes FVR** (= (12) above)

UR	/vete-næ/	/vete/	/onne/	/halut-i/
Rule B: Assibilation	—	—	—	halu**s**i
Rule A: FVR	—	vet**i**	onn**i**	—
SR	[vetenæ]	[veti]	[onni]	[halusi]

- Because of the nature of the interaction, we can generate a total bleeding interaction (34) using the same constraints that we used for Finnish earlier, by ranking the faithfulness constraint for Assibilation over the markedness constraint for FVR:

(34) **Bleeding Finnish′ (but no Counter-feeding Finnish′)**

/vete/			*ti	IDENT[strid]	*e#	IDENT[high]
a.	☞	vete			*	
b.	💣	veti	*!			*
c.		vese		*!	*	
d.		vesi		*!		*

- But there's no ranking of these constraints will generate (34b), the counter-feeding interaction.
  - Again, there are additional technologies that can be brought to bear for different kinds of patterns (Distantial Faithfulness, Non-derived environment blocking, etc.), but straight up OT can't get it.

⋆ That is not to say that OT is bad, just that opacity is a critically important phenomena for theory building.

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