Class 5: Rule+constraint theories; more big-picture stuff

To do
- Read Prince & Smolensky excerpt (SQs due Tues., Oct. 12)
- Beginning-OT assignment is posted (Yokuts, Kalinga & Ladakhi); due Fri., Oct. 15

Overview: First we'll try to make the framework for rule/constraint interaction more explicit. Then, we'll turn to some big-picture issues again (reviewing levels of adequacy).

1. Recall blocking and triggering

Here's my attempt lay out the simplest version of what we want constraints to do

In all rule theories, applying Rule i in a derivation begins this way
- Form at current state of derivation, $form_{i-1}$, is saved as CURRENT

In a theory without constraints (SPE-style), it continues this way
- Apply Rule *i* to CURRENT, yielding $form_i$
- Replace CURRENT with $form_i$

Blocking continues this way:
- Apply Rule *i* to CURRENT, yielding $form_i$—save $form_i$ as TENTATIVE
- Does TENTATIVE violate the constraint?
  - If yes, make no change to CURRENT
  - If no, replace CURRENT with TENTATIVE

Triggering continues this way:
- Does CURRENT violate the constraint?
  - If no, make no change to CURRENT
  - If yes, apply Rule *i* to CURRENT, yielding $form_i$—save $form_i$ as TENTATIVE
    - Does TENTATIVE violate the constraint?
      - If no, replace CURRENT with TENTATIVE
      - If yes, make no change to CURRENT

2. Implementing triggering: Sommerstein's (1974)[1] proposal (underlining is mine)

"A P-rule R is positively motivated with respect to a phonotactic constraint C just in case the input to R contains a matrix or matrices violating C AND the set of violations of C found in the output of R is null or is a proper subset of the set of such violations in the input to R." (p. 74)

"A rule, or subcase of a conspiracy, positively motivated by phonotactic constraint C does not apply unless its application will remove or alleviate a violation or violations of C." (p. 75)

Later modified: "a rule applies if its application will remove or alleviate a violation of AT LEAST ONE of its motivating constraints" (p. 87)

[1] Sommerstein, Alan H. (1974). On Phonotactically Motivated Rules. *Journal of Linguistics* 10: 71-94.

3. Latin example (Sommerstein p. 87; slightly re-formatted)

genitive sg.	*nominative sg.*	*UR*
lakt-is	lak	/lakt/
kord-is	kor	/kord/

deletion

$$\begin{bmatrix}-\text{continuant}\\ \langle-\text{voice}\rangle\end{bmatrix} \rightarrow \text{Ø} \,/\, \begin{bmatrix}+\text{consonantal}\\ \left\langle \begin{matrix}-\text{sonorant}\\ -\text{continuant}\end{matrix}\right\rangle\end{bmatrix} \_\_\ \#$$ [2]

positively motivated by constraints that are **surface-true** in the language:[3]

no final voiced in cluster $\quad * \,[+\text{consonantal}]\begin{bmatrix}+\text{consonantal}\\ +\text{voice}\end{bmatrix}\#$ (p. 82)

final obst. restrictions $\quad \text{if} \underbrace{\begin{bmatrix}-\text{sonorant}\\ \langle-\text{continuant}\rangle\end{bmatrix}}_{1}\underbrace{[-\text{sonorant}]}_{2}\ \#\ \text{then 2 is} \begin{bmatrix}+\text{coronal}\\ \langle+\text{continuant}\rangle\end{bmatrix}$ (p. 82)

i.e., [st], [ps], [ks] are OK

- With those constraints, how can we simplify the deletion rule?

A derivation might look like this:

	/lakt/	/kord/	/re:ks/
violates no final voiced in cluster*?*	no	yes	no
violates final obstruent cluster restrictions*?*	yes	no	no
if so, tentatively apply deletion			NA
is the violation alleviated/eliminated?			NA
if so, accept the change (else don't)			NA

we'll have to fill in the rest according to how we formulate the rule.

4. Multiple available repairs

Imagine a hypothetical language, "Matin", that is just like Latin except that it has this rule too:

$[\,] \rightarrow [-\text{voice}]$

- How does our derivation change (assuming we want to get the same result as in Latin)? Do we need to add more information to the grammar?

Imagine a hypothetical language, "Natin", that is just like Latin except that it has this rule too:

$[\,] \rightarrow [+\text{continuant}]$

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[2] Kaeli Ward pointed out last year, this rule schema doesn't exactly do what we want: if a voiceless word-final C fails to be preceded by a stop, it can still delete under the shorter version, which deletes any word-final stop that's after another consonant.

[3] Actually, Sommerstein refers to a different constraint (16 on p. 79), but that seems to be the wrong one for /lakt/.

- How does our derivation change (again, assuming we want the same result)? Do we need to add more information to the grammar?

5. Partial violation, violation alleviation

Under Sommerstein's conception, a constraint doesn't have to be surface-true to be part of the grammar [bold mine] (p. 76):

> The DEGREE OF VIOLATION $V_{M,C}$ to which a matrix M violates a phonotactic constraint C is equal to the **cost** of the minimal structural change necessary to turn M into a matrix satisfying C.
> The application to a matrix M of operation A ALLEVIATES a violation in M of phonotactic constraint C just in case the output M´ of such application is such that $0 < V_{M',C} < V_{M,C}$.

- Can you invent a case where a violation could be alleviated without being eliminated? (It's OK if it's silly—it's hard to think of plausible cases, and Sommerstein himself introduces this idea just to keep the possibility open, not because he has any data that require it.)

6. Implementing blocking: taking inspiration from Sommerstein...

A P-rule R is <u>negatively motivated</u> with respect to a phonotactic constraint C just in case the <u>tentative output of</u> R contains a matrix or matrices violating C AND the set of violations of C found in the input to R is null or is a proper subset of the set of such violations in the tentative output of R.

A rule that is negatively motivated by phonotactic constraint C does not apply if its application will <u>create or worsen a violation</u> or violations of C.

The application to a matrix M of operation A <u>worsens</u> a violation in M of phonotactic constraint C just in case the output M´ of such application is such that $V_{M',C} > V_{M,C}$

7. What a derivation might look like

syncope rule $\quad V \rightarrow \text{Ø} / C\_\_C$

cluster constraint $\quad * \begin{Bmatrix} \# \\ C \end{Bmatrix} C \begin{Bmatrix} \# \\ C \end{Bmatrix}$

	/abito/	/ildoku/	/uda/	/brodu/
tentatively apply syncope	(abto)	(ildku)	NA	
does this create/worsen violation of cluster constr.?	no	yes	NA	
if not, accept the change (otherwise reject)	abto	ildoku	NA	
	[abto]	[ildoku]	[uda]	

8. Blocking vs. triggering: Myers 1991's [4] persistent rules

Zulu: prenasalized affricates, but no prenasalized fricatives. We might propose a constraint:[5]

$$*\begin{bmatrix}\text{+continuant}\\ \text{+nasal}\end{bmatrix}$$

Here is a prefix that creates prenasalized consonants (p. 329):

singular	*plural*	
uː-bambo	izi-ᵐbambo	'rib'
uː-pʰapʰe	izi-ᵐpapʰe	'feather'
ama-tʰatʰu	ezi-ⁿtatʰu	'three'
uː-kʰuni	izi-ᵑkuni	'firewood'

- Assume the underlying form of the prefix is /izin/. Formulate a prenasalization rule.

Here's what happens when the prefix attaches to a fricative-initial stem:

singular	*plural*	
eli-ʃa	e-ⁿt͡ʃa	'new'
uː-fudu	izi-ᵐp͡fudu	'tortoise'
uː-sizi	izi-ⁿt͡sizi	'sorrow'
uː-zwa	izi-ⁿd͡zwa	'abyss'
uː-zime	izi-ⁿd͡zime	'walking staff'
uː-ɮubu	izi-ⁿd͡ɮubu	'groundnut'
uː-ʃikisi	izi-ⁿt͡ʃikisi	'quarrelsome person'

- What would happen if prenasalization were subject to blocking by the constraint above?

Myers proposes instead a "**persistent rule**"—it tries to apply at every point in the derivation, so that any time its structural description is created, it immediately gets changed.

$$\begin{bmatrix}\text{+nasal}\\ \text{+continuant}\end{bmatrix} \rightarrow \begin{bmatrix}\text{+delayed release}\\ \text{–continuant}\end{bmatrix}$$ i.e., nasal fricative → affricate

[4] Myers, Scott (1991). Persistent rules. *Linguistic Inquiry* 22: 315-344.
[5] Myers actually uses autosegmental representations.

- Let's spell out what the derivation would look like.

- Can we recast this as a simpler rule that is triggered by the constraint?

Next time: OT—a constraints-only theory

Reflecting on big-picture issues
How do humans learn, store, and use linguistic sound patterns? Chomsky lays out a useful framework for investigating this question for language in general (see Chomsky 1965[6] pp. 25-27—but what it is below is an amalgam of various works, slightly simplified and colored by my own views)...

9. Preliminaries

Let a **grammar** consist of (at least)[7]

- a function that labels any utterance as **grammatical** or **ungrammatical**. We can call such labelings **grammaticality judgments.**
- a function that assigns truth conditions to any utterance

The grammar might be implemented as a lexicon and a list of rules, or a set of constraints, or something else.
Let a **linguistic theory** be a function that, given a (finite) set of utterances (the **learning data**), produces a grammar.[8]

These functions should be accompanied by algorithms for calculating them.

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[6] Chomsky, Noam (1965). *Aspects of the theory of syntax*. Cambridge: MIT Press.
[7] We probably want the grammar to do much more. It could, given an utterance, return a gradient "goodness score" rather than a simple binary judgment. Given one utterance and some instruction, it could return some other utterance (e.g., PLURAL(*cat*) = *cats*). And of course there's a lot more to meaning than truth conditions.
Chomsky also requires a grammar to assign a structural description to an utterance, but I wonder if this is begging the question: the structural description can be used to explain more-observable properties of a sentence, such as its truth-conditions—and thus we might want to *hypothesize* that a grammar assigns structural descriptions—but we don't know *a priori* that a structural description is necessary.
[8] Chomsky's definition of a linguistic theory is broader: a theory need only define the set of possible grammars, independent of learning data. This allows Chomsky to define the term **descriptively adequate theory**, which is a theory that includes, as possible grammars, a descriptively adequate grammar for every language—but does not necessarily return that grammar given learning data for that language.

Let's use a concrete example, English noun plurals again, but this time not just the regulars:

cat	kʰæt	kʰæt**s**
sack	sæk	sæk**s**
dog	dɑg	dɑg**z**
grub	gɹʌb	gɹʌb**z**
dish	dɪʃ	dɪʃ**ɨz**
fudge	fʌd͡ʒ	fʌd͡ʒ**ɨz**
pea	pʰi	pʰi**z**
cow	kʰaʊ	kʰaʊ**z**
man	mæn	m**ɛ**n
foot	fʊt	f**i**t
leaf	lif	li**vz**
reef	ɹif	ɹif**s**
...		

10. Observational adequacy

- A grammar that accepts all the forms that a typical speaker would have been exposed to and assigns the right truth conditions to them, is an **observationally adequate grammar**, regardless of what it says about other forms
- Note that there are infinitely many observationally adequate grammars for any (finite) set of learning data (why?).
- Examples of observationally adequate grammars for English noun plurals

I. (just list every word you know)

kʰæt	kʰæt**s**	dɪʃ	dɪʃ**ɨz**	mæn	m**ɛ**n	
sæk	sæk**s**	fʌd͡ʒ	fʌd͡ʒ**ɨz**	fʊt	f**i**t	
dɑg	dɑg**z**	pʰi	pʰi**z**	lif	li**vz**	
gɹʌb	gɹʌb**z**	kʰaʊ	kʰaʊ**z**	ɹif	ɹif**s**	...

This grammar's judgment function accepts utterances containing the above items in positions where a plural is required (*I like cats*); its truth-condition-assigning function assigns the appropriate truth-conditions to utterances containing the items in the right column (*I like cats* is true iff I like members of the set CAT—it has nothing to do with whether I like members of DOG).

II. ***Add –s to everything****, except for these exceptions:*

dɑg	dɑg**z**	fʌd͡ʒ	fʌd͡ʒ**ɨz**	mæn	m**ɛ**n	
gɹʌb	gɹʌb**z**	pʰi	pʰi**z**	fʊt	f**i**t	
dɪʃ	dɪʃ**ɨz**	kʰaʊ	kʰaʊ**z**	lif	li**vz**	...

III. ***Add –z to everything****, except for these exceptions:*

k^hæt	k^hæt**s**
sæk	sæk**s**
dɪʃ	dɪʃ**ɨz**
fʌd͡ʒ	fʌd͡ʒ**ɨz**
mæn	m**ɛ**n
fʊt	f**i**t
lif	li**vz**
ɹif	ɹif**s**
...	...

*IV. Add –ə****z*** *after "sibilant" sounds, –s after non-sibilant [–voice] sounds, and –z otherwise, except for these exceptions:*

mæn	m**ɛ**n
fʊt	f**i**t
lif	li**vz**
...	...

*IV. Change final /f/ to [v], and then add –ə****z*** *after "sibilant" sounds, –s after non-sibilant [–voice] sounds, and –z otherwise, except for these exceptions:*

mæn	m**ɛ**n
fʊt	f**i**t
ɹif	ɹif**s**
...	...

11. Descriptive adequacy

- A grammar that not only is observationally adequate, but also gives the same treatment to novel utterances that a real speaker of the target language gives is a **descriptively adequate grammar**.
  - Strictly speaking, a descriptively adequate grammar captures the generalizations that real learners extract from the learning data—I think it makes the most conceptual sense to operationalize this in terms of novel utterances, but maybe you can think of other tests (either behavioral or neuro).

- In a famous early study of children, Berko (1958)[9] also tested English-speaking adults as a control (all highly educated, in her sample), and found that they consistently give the following plurals when presented with invented words (pp. 155-158):

wʌg	wʌg**z**	lʌn	lʌn**z**
gʌt͡ʃ	gʌt͡ʃ**ɨz**	nɪz	nɪz**ɨz**
kæʒ	kæʒ**ɨz**	kɹɑ	kɹɑ**z**
toɹ	toɹ**z**	tæs	tæs**ɨz**

o Which of the grammars above could be descriptively adequate, given these data?

o The adults disagreed about this word—what might we conclude?

hif hif**s** ~ hi**vz**

12. Descriptive adequacy is hard!

- Achieving descriptive adequacy is often spoken of as though it were easy or could happen through inspection of basic data, but under Chomsky's definition it is actually a huge challenge.
- Words or larger units that the speaker already knows are uninformative! (They don't tell us anything about what generalizations the speaker has learned—she may have simply memorized these words/units.)
- Constructing novel phonological situations to put speakers in is difficult. Contrast this with syntax, where it's easy to construct sentences that—presumably—the speaker has not encountered before (though we might worry about the sentence's subparts' being memorized chunks).

13. Explanatory adequacy

A theory that, when given a typical set of learning data, returns a grammar that is descriptively adequate, is an **explanatorily adequate theory**.

Obviously, developing an explanatorily adequate theory is an even huger challenge!
For some sample of languages, we have to...

- characterize the learning data
- characterize the generalizations that speakers have learned (whether present in the data or not)
- see if our theory maps those learning data to those generalizations

And even then we're not really done. For instance, we'd like not just a function that maps data to generalizations/experimental behavior, but also an algorithm to implement the function that unfolds over time in a way that mirrors humans' linguistic development (e.g., which generalizations are acquired first?).

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[9] Berko, Jean (1958). The child's learning of English morphology. *Word* 14: 150-177.