Complex Neutralization Patterns

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CRISSP

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Outline

Review

- $\emptyset$ is a morpheme with no phonological content
- ϵ is a null symbol

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- $\emptyset$ is a morpheme with no phonological content
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	form	gloss
a.	to	a dog
b.	tolgi	the dog
c.	to	a hat
d.	togi	the hat

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a.	to	a dog
b.	tolgi	the dog
c.	to	a hat
d.	togi	the hat

- $l \rightarrow \epsilon / \_\_ \%$

	form	gloss
a.	toj	a dog
b.	toju	the dog
c.	to	a hat
d.	toju	the hat

	form	gloss
a.	toj	a dog
b.	toju	the dog
c.	to	a hat
d.	toju	the hat

- $\epsilon \rightarrow$ j / o ___u

Outline

No evidence for a rule

	form	gloss	UR
a.	luš	a dog	/luš/
b.	luši	the dog	/luš-i/
c.	lus	a hat	/lus/
d.	lusi	the hat	/lus-i/

A boring Segment Mapping Diagram

s   š   Underlying segs (present in lexicon, selected by MORPHOLOGY)

↓   ↓

s   š   Surface segs that show effects (if any) of the PHONOLOGY

- In this example, there are no effects of the phonology.
- Each arrow corresponds to an identity function:
  - For each string r containing a segment x, map x to x

- Rule: Neutralization of s and š: s → š / ___i

	form	gloss	UR
a.	luš	a dog	/luš/
b.	luši	the dog	/luš-i/
c.	lus	a hat	/lus/
d.	luši	the hat	/lus-i/

Relations between UR and SR of segments

Segment mapping diagram (SMD):

$$\begin{tikzcd} s \arrow[d] \arrow[dr] & \check{s} \arrow[d] \\ s & \check{s} \end{tikzcd}$$

Underlying segs (present in lexicon, selected by Morpholog

Surface segs that show effects of the Phonology

- Map the string *si* to *ši*

Relations between UR and SR of segments

Segment mapping diagram (SMD):

$$\begin{tikzcd} s \arrow[d] \arrow[dr, "/\_i"] & š \arrow[d] \\ s & š \end{tikzcd}$$

Underlying segs (present in lexicon, selected by MORPHOLOG

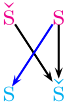
Surface segs that show effects of the PHONOLOGY

- Map the string *si* to *ši*

Order on rows is not important

$$\begin{tikzcd} \check{s} \arrow[d] & s \arrow[d] \arrow[dl] \\ \check{s} & s \end{tikzcd}$$

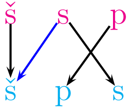
Perverse layout



The same information as a set of ordered pairs

$$\{< s, s >, < s, \check{s} >, < \check{s}, \check{s} >\}$$

No need to line up segments



- The point of presenting the diagram is to help you see that an input *š* is as irrelevant to the rule in question as an input *p*.
- The neutralization of *s* and *š* confuses *us*, but it has no status from the perspective of the phonology.
    - (Wason, fallacy, inverse)


3
8
Blue
Red


16
25
SODA

Wason's (1966) selection task and the relevance of content:

- Four cards: **A B 4 7**
- Given: each card has a letter on one side and a number on the other side.
- Which cards *must* be turned over to verify the following hypothesis? *If a card has an* **A** *on one side, then it has a* **4** *on the other side.*
- If a person x is drinking alcohol, then x must be over 18
- P_1 is drinking beer; P_2 is drinking Perrier; P_3 is 16; P_4 is 25

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SMD for deletion

$$\begin{tikzcd}[column sep=small] l \arrow[d] \arrow[dr] & \epsilon \arrow[d] \\ l & \epsilon \end{tikzcd}$$

or

$$\begin{tikzcd}[column sep=small] l \arrow[d] \arrow[dr] & \\ l & \epsilon \end{tikzcd}$$

SMD for insertion

$$\begin{tikzcd} j \arrow[d] & \epsilon \arrow[dl] \arrow[d] \\ j & \epsilon \end{tikzcd} \qquad \text{or} \qquad \begin{tikzcd} j \arrow[d] & \epsilon \arrow[dl] \\ j & \end{tikzcd}$$

Provide an analysis of the following, with a SMD:

	form	gloss
a.	waka	a dog
b.	ziwaka	the dog
c.	waka	a pig
d.	ziaka	the pig

Outline

	form	gloss
a.	luš	a dog
b.	luši	the dog
c.	luş	a pig
d.	luši	the pig

At this point you should be able to analyze such data in terms of rules and a set of underlying forms and to provide a SMD, as follows.

Analysis of Language (26)

Lexicon:

luš	dog
luş	pig
-i	the

- Neutralization of ş and š: ş → š / ___i

SMD for Language (26)

$$\begin{tikzcd} \check{S} \arrow[d] & \text{\c{S}} \arrow[d] \arrow[dl] \\ \check{S} & \text{\c{S}} \end{tikzcd}$$

Now consider a language that is the union of Language 1 and Language 2. This Language 3 contains all the forms that occur in at least one of the other two languages.

WARNING!!!: What do we mean by "language?"

CORPUS vs. GRAMMAR

Let it slide for now, but don't tell Noam we did this.

Language 3 = Language 1 ∪ Language 2

Language 3 = Language 1 ∪ Language 2

	form	gloss
a.	luš	a dog
b.	luši	the dog
c.	lus	a hat
d.	luši	the hat
e.	luş	a pig
f.	luši	the pig

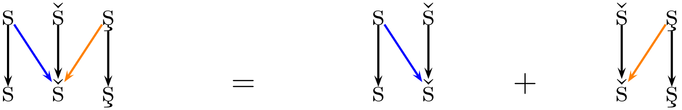
Analysis of Language 3 with relations between UR and SR of segments

Lexicon: /luš/ ‘dog’, /lus/ ‘hat’, /luş/ ‘pig’, /-i/ ‘the’

Phonological rules:

- Neutralization of s and š: s → š / __i
- Neutralization of ş and š: ş → š / __i

SMD



The point of this example is that multiple neutralization is *nothing special.*

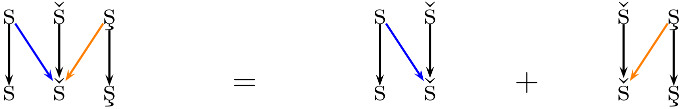
Analysis of Language 3 with relations between UR and SR of segments

Lexicon: /luš/ ‘dog’, /lus/ ‘hat’, /luş/ ‘pig’, /-i/ ‘the’

Phonological rules:

- Neutralization of s and š: s → š / __i
- Neutralization of ş and š: ş → š / __i

SMD



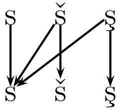
The point of this example is that multiple neutralization is *nothing special.*

In Language 3, the output of the converging neutralization rules was [š]. In Language 4, we lead you to an analysis with a different set of rules that converge to an output of [s].

	form	gloss
a.	lus	a dog
b.	luši	the dog
c.	lus	a hat
d.	lusi	the hat
e.	lus	a pig
f.	luşi	the pig

Relations between UR and SR of segments in Language 4

- š → s / ___ %
- ş → s / ___ %



- The two previous languages have been presented as containing two rules each.
- However, when we break down segments into features, will see that it may be possible to collapse two or more rules affecting different segments into a single rule.
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- This important issue is logically separate from our point about multiple convergent neutralizations.

Ask a Korean speaker how to say

‘face’

‘day’

‘sickle’

‘piece’

‘grain’

Ask a Korean speaker how to say

‘face’	[nat˺]
‘day’	
‘sickle’	
‘piece’	
‘grain’	

Ask a Korean speaker how to say

'face'
'day' [nat˺]
'sickle'
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- ‘sickle’
- ‘piece’ [nat˺]
- ‘grain’

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‘face’

‘day’

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‘piece’

‘grain’ [nat˺]

Ask a Korean speaker how to say

‘face’	[nat̚]
‘day’	[nat̚]
‘sickle’	[nat̚]
‘piece’	[nat̚]
‘grain’	[nat̚]

Ask a Korean speaker use these nouns as objects

'face'

'day'

'sickle'

'piece'

'grain'

The ending [-ɨl] marks the form of a noun used as the object, but what happened to all the final [t˺] consonants? Why do they now show up in five different forms? Posit an underlying form for each root and draw a segment mapping diagram.

Ask a Korean speaker use these nouns as objects

‘face’	[nač^hɨl]
‘day’	
‘sickle’	
‘piece’	
‘grain’	

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‘face’	
‘day’	[naǰɨl]
‘sickle’	
‘piece’	
‘grain’	

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‘face’

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‘sickle’ [nasɨl]

‘piece’

‘grain’

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‘grain’

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'piece'

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Ask a Korean speaker use these nouns as objects

'face'	[načʰɨl]
'day'	[naǰɨl]
'sickle'	[nasɨl]
'piece'	[natʰɨl]
'grain'	[nadɨl]

The ending [-ɨl] marks the form of a noun used as the object, but what happened to all the final [t˺] consonants? Why do they now show up in five different forms? Posit an underlying form for each root and draw a segment mapping diagram.

Outline

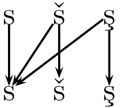
Convergent in different contexts

	form	gloss
a.	lus	a dog
b.	luši	the dog
c.	luša	dogs
d.	lus	a hat
e.	lusi	the hat
f.	lusa	hats
e.	luş	a pig
f.	luşi	the pig
g.	lusa	pigs

You can figure out the lexicon for this language—here are the rules and SMD.

Relations between UR and SR of segments in Language 5

- š → s / ___ %
- ş → s / ___ a



	form	gloss
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f.	lusa	hats
e.	luş	a pig
f.	luşi	the pig
g.	lusa	pigs

Samoan data

In a multiple neutralization pattern, one of the 'underlying segments' can be ϵ.

simple	perfective	gloss
1. tau	tauia	'reach a destination'
2. tau	taulia	'cost'
3. taui	tauia	'repay'

Samoan verb roots

Assume that the perfective suffix is /-ia/. We can posit the following underlying forms for the verb roots:

simple	gloss
1. /tau/	'reach a destination'
2. /taul/	'cost'
3. /taui/	'repay'

Samoan underlying forms

The underlying form for each of the six words is then the following—the simple forms have no suffixes; the perfective forms have the suffix /-ia/.

	simple	perfective	gloss
1.	/tau/	/tau-ia/	‘reach a destination’
2.	/taul/	/taul-ia/	‘cost’
3.	/taui/	/taui-ia/	‘repay’

In the surface form [tauia] from underlying /taui-ia/, it is not apparent which /i/ has been lost, but we can tell from other forms not given here. Just take our word form it that the /i/ of the suffix is the one that is deleted. We can then posit the following rules:

Samoan rules

- Rule A. $l \rightarrow \epsilon$ / ___% (Delete *l* at the end of the word.)
- Rule B. $i \rightarrow \epsilon$ / i ___ (Delete *i* after an *i*.)

Draw the SMD

Samoan rules

- Rule A. l $\rightarrow \epsilon$ / __%   (Delete *l* at the end of the word.)
- Rule B. i $\rightarrow \epsilon$ / i __   (Delete *i* after an *i*.)

Draw the SMD

Samoan SMD

This analysis corresponds to the following SMD.

$$\begin{tikzcd} \mathrm{i} \arrow[d] \arrow[dr] & \epsilon \arrow[d] & \mathrm{l} \arrow[d] \arrow[dl] \\ \mathrm{i} & \epsilon & \mathrm{l} \end{tikzcd}$$

Both l and i are deleted, but in different contexts: the former at the end of a word, the latter after another i. This case of convergent neutralization refers to completely different contexts, and the neutralizations happen to converge to ϵ. This may seem a bit exotic, but there is nothing here that we haven't already seen, when we take the pieces apart.

The two context-sensitive deletion rules lead to neutralization with ϵ by two underlying segments, /i/ and /l/. The result is that the root /taul-/ ends up losing its /l/ in the simple form, and thus is homophonous with the simple form of /tau/; and the root /taui-/ loses its /i/ in the perfective form (before the /i/ of the suffix) and ends up homophonous with the perfective form of /tau/. The data itself looks complicated, but it just reflects a combination of simple rule applications.

- What form does a Samoan need to learn?
  - Simple? Perfective? Something else?
- Should we expect such data to exist?
- What should be the null hypothesis?

Outline

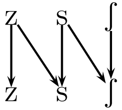
Neutralizations may be non-converging

- z$\rightarrow$ s / p ___
- s $\rightarrow$ $\int$ / p___

$$\begin{tikzcd}
\mathrm{z} \arrow[d] \arrow[dr] & \mathrm{s} \arrow[d] \arrow[dr] & \int \arrow[d] \\
\mathrm{z} & \mathrm{s} & \int
\end{tikzcd}$$

Contexts may differ

- z→ s / p ___
- s → ∫ / ___%



- z→ s / p ___
- s → ʃ / n ___

$$\begin{tikzcd} z \arrow[d] \arrow[dr] & s \arrow[d] \arrow[dr] & ʃ \arrow[d] \\ z & s & ʃ \end{tikzcd}$$

Chainshifts

a → ɛ → e → i

Njebi (Gabon)

Sg	Pl
sal	sɛli
sɛl	seli
sel	sili
sil	sili

- There is nothing special going on—if you separate the SMDs you might as well have a $\rightarrow$ b and c$\rightarrow$ d.
- ...well, you need rule ordering.

Outline

Thus far we have seen examples of neutralization in which two (or more) underlying segments share one of their realizations. However, other patterns are possible.

Don't panic!

	form	gloss
a.	rat	a dog
b.	radba	the dog
c.	ratpi	as a dog
c.	rad	a hat
d.	radba	the hat
e.	ratpi	as a hat

	form	gloss
a.	rat	a dog
b.	radba	the dog
c.	rad	a hat
d.	radba	the hat

Provide an analysis. You should end up with the following SMD:

$$\begin{tikzcd} t \arrow[d] \arrow[dr] & d \arrow[d] \\ t & d \end{tikzcd}$$

More data from the same language

	form	gloss
a.	rat	a dog
b.	ratpi	as a dog
c.	rad	a hat
d.	ratpi	as a hat

First analyze this data set on its own—you should end up with this SMD:

$$\begin{tikzcd} t \arrow[d] & d \arrow[dl] \arrow[d] \\ t & d \end{tikzcd}$$

- What happens with our MTP & RAA reasoning? Which forms are relevant

Relations between UR and SR of segments:

$$\begin{tikzcd}
t \arrow[d] \arrow[dr] & d \arrow[d] \arrow[dl] \\
t & d
\end{tikzcd}$$

What rules do we need to generate this pattern?

- t → d / __b
- d → t / __p

We will see later how these two rules can be collapsed into one.

Hungarian reciprocal voicing

	nom.sg.	iness.sg	dat.sg.	abl.sg.	
a.	kalap	kala[b]-ban	kalap-nak	kalap-tól	‘hat’
	rés	ré[z]-ben	rés-nek	rés-től	‘slit’
	zsák	zsá[g]-ban	zsák-nak	zsak-tól	‘bag’
b.	rab	rab-ban	rab-nak	ra[p]-tól	‘captive’
	víz	víz-ben	víz-nek	ví[s]-től	‘water’
	meleg	meleg-ben	meleg-nek	mele[k]-től	‘warmth’
c.	szem	szem-ben	szem-nek	szem-től	‘eye’
	őr	őr-ben	őr-nek	őr-től	‘guard’

Outline

Solve this:

sg.	pl.	gloss
pak	pakla	cat
pag	pagla	mat
pag	pakla	rat

Non-surfacing URs

sg.	pl.	gloss
pak	pakla	cat
pag	pagla	mat
pag	pakla	rat

Models that won't work for such a language

Which assumption gets us into trouble? How does this bear on another assumption?

A. Lexical form of 'rat' is /pak/ and rule is k → g / __%
(This would mess up *pak*, 'cat')

B. Lexical form of 'rat' is /pag/ and rule is g → k / __l
(This would mess up *pagla*, 'mats')

Models that won't work for such a language

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B. Lexical form of 'rat' is /pag/ and rule is g → k / ___l (This would mess up *pagla*, 'mats')

Possible analysis of language in (71)

sg.	pl.	Root UR
pak	pakla	/pak/
pag	pagla	/pag/
pag	pakla	/paC/

Rules:

- C → k / ___l
- C → g / ___%

$$\begin{tikzcd} k \arrow[d] & C \arrow[dl] \arrow[dr] & g \arrow[d] \\ k & & g \end{tikzcd}$$

Ternary voicing in Turkish

		nom.sg.	acc.sg.	nom.pl.	1sg.poss.	
a.	voiceless:	sana**t**	sana**t-**	sana**t**-lar	sana**t-** m	'art'
b.	voiced:	ety**d**	ety**d**-y	ety**d**-ler	ety**d**-ym	'etude'
c.	alternating:	kana**t**	kana**d-**	kana**t**-lar	kana**d-** m	'wing'

Alternation with ϵ

sg.	pl.
pak	pakla
pa	pala
pa	pakla

Possible analysis

sg.	pl.	Root UR
pak	pakla	/pak/
pa	pala	/pa/
pa	pakla	/paC/

Rules:

- $\mathrm{C} \rightarrow \mathrm{k}$ / ___l
- $\mathrm{C} \rightarrow \epsilon$ / ___%

$$
\begin{tikzcd}
\mathrm{k} \arrow[d] & \mathrm{C} \arrow[dl] \arrow[dr] & \epsilon \arrow[d] \\
\mathrm{k} & & \epsilon
\end{tikzcd}
$$

It's the same old same old...

- appreciate just how mind-blowing this actually is
- UR of the root can be a form that never surfaces
- this may sound shocking, but it is a natural result of the model, and entirely expected
- think back to intonation

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Palauan ‘cover’

a. Suffix [-áll], stress on suffix: dəŋəbáll
b. Suffix [-l], stress on second vowel of root: dəŋóbl
c. Prefix [mə-], stress on first vowel of the root: mədáŋəb

When the suffix is stressed and neither root vowel is stressed in (a), both root vowels show up as [ə]. In (b), stress falls on the second root vowel and it shows up as a non-ə vowel, [o]. In (c), there is a prefix, but the stress falls on the first root vowel, and it shows up as a non-ə vowel, [a]. Here is another set of forms for the verb meaning 'pull out':

a. Suffix [-áll], stress on suffix: təʔəbáll
b. Suffix [-l], stress on second vowel of root: təʔíbl
c. Prefix [mə-], stress on first vowel of the root: mətéʔəb

- A rule for determining where stress falls (which we have not explained)
- A rule that makes each unstressed vowel be pronounced [ə]
- A unique, constant stored form for each verb

- ‘cover’ daŋob
- ‘pull out’ teʔib

Outline

What is the relationship between neutralization and homophony?

Combined neutralization

Two neutralizations in a form lead to homophony:

form	gloss
vɪʁa	with an ox
vɪθon	with oxen
sɛʁa	for an ox
sɛθon	for oxen
vɛθa	with a sheep
vɛθon	with sheep (pl.)
sɛθa	for a sheep
sɛθon	for sheep (pl.)

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sɛθon	for sheep (pl.)

v-	'with'
s-	'for'
-a	SING
-on	PLURAL
ɪʁ	'ox'
ɛθ	'sheep'

- Rule A. ʁ → θ/__o
- Rule B. ɪ → ɛ/ s __

Derivations

Underlying Rep	v-ɪʁ-a	v-ɪʁ-on	v-εθ-a	v-εθ-on
Effect of Rule A. ʁ → θ/____o		vɪθon		
Effect of Rule B. ɪ → ε/ s ____				
Surface Rep	vɪʁa with an ox	vɪθon with oxen	vεθa with a sheep	vεθon with sheep (pl.)

Underlying Rep	s-ɪʁ-a	s-ɪʁ-on	s-εθ-a	s-εθ-on
Effect of Rule A. ʁ → θ/____o		sɪθon		
Effect of Rule B. ɪ → ε/ s ____	sεʁa	sεθon		
Surface Rep	sεʁa for an ox	sεθon for oxen	sεθa for a sheep	sεθon for sheep (pl.)

Neutralization due to two rules affecting a single input.

Independent SMDs in combined neutralization pattern

$$\begin{tikzcd} ʁ \arrow[d] \arrow[dr] & θ \arrow[d] \\ ʁ & θ \end{tikzcd} \qquad \begin{tikzcd} ɛ \arrow[d] & ɪ \arrow[dl] \arrow[d] \\ ɛ & ɪ \end{tikzcd}$$

Note that the meaning ‘ox’ is realized in four different ways in this simple data set: [ɪʁ, ɪθ, ɛʁ, ɛθ]. However, this complex surface set is accounted for by just two rules. In ‘with an ox’ neither rule has an effect; in ‘with oxen’ Rule A has an effect; in ‘for an ox’ Rule B applies; and in ‘for oxen’ both rules have an effect.

Deriving surface alternants of /ɪʁ/ 'ox' and relevant rules:

Lexical form: /ɪʁ/	ɪʁ	ɪθ	ɛʁ	ɛθ
Rule A applies:	✘	✔	✘	✔
Rule B applies:	✘	✘	✔	✔

It is important to note that the form [sεθon] is ambiguous, it corresponds to two forms that are homophonous, ‘for oxen’ and ‘for sheep’, *not* because of a neutralization rule, but because of the combined effect of two rules.

Combined Neutralization Across Paradigms

Neutralization in different forms lead to homophony:

form	gloss
vɪʁa	with an ox
vɪʁon	with oxen
sɛʁa	for an ox
sɛʁon	for oxen
vɛʁa	with a sheep
vɛθon	with sheep (pl.)
sɛʁa	for a sheep
sɛθon	for sheep (pl.)

Combined Neutralization Across Paradigms

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vɛθon	with sheep (pl.)
sɛʁa	for a sheep
sɛθon	for sheep (pl.)

v-	‘with’
s-	‘for’
-a	SING
-on	PLURAL
ɪʁ	‘ox’
ɛθ	‘sheep’

- Rule A.θ → ʁ/___a
- Rule B. ɪ → ɛ/ s ___

Derivations

Underlying Rep	v-ɪʁ-a	v-ɪʁ-on	v-ɛθ-a	v-ɛθ-on
Effect of Rule A. θ → ʁ/____a			vɛʁa	
Effect of Rule B. ɪ → ɛ/ s ____				
Surface Rep	vɪʁa with an ox	vɪʁon with oxen	vɛʁa with a sheep	vɛθon with sheep (pl.)

Underlying Rep	s-ɪʁ-a	s-ɪʁ-on	s-ɛθ-a	s-ɛθ-on
Effect of Rule A. θ → ʁ/____a			sɛʁa	
Effect of Rule B. ɪ → ɛ/ s ____	sɛʁa	sɛʁon		
Surface Rep	sɛʁa for an ox	sɛʁon for oxen	sɛʁa for a sheep	sɛθon for sheep (pl.)

Neutralization due to different rules affecting two different inputs, causing them to end up the same

In both of the examples, combined neutralization just refers to the situation in which sets of segments related by neutralization occur in paradigms some of whose members end up being homophonous due to the neutralizations.

Outline

To think about:

- Do we expect to find all these patterns?
- Is this a complex model?
- Where do all these patterns come from?
- The grammar does not care about maintaining contrast, avoiding neutralization, etc.

All from this:

$$\alpha \rightarrow \beta \;/\; \gamma \;\_\_\delta$$

The richness achieved by combining simple primitives is typical of scientific modeling. According to Chomsky, it is the "natural approach" (Chomsky 2000:122):

> *...to abstract from the welter of descriptive complexity certain general principles governing computation that would allow the rules of a particular language to be given in very simple forms*

Substance-Free Logical Phonology

Charles Reiss*

Concordia University, Montréal

CRISSP, March 2025

1 Introduction

Substance-Free Logical Phonology (henceforth LP) is an austere, formally rigorous theory of phonological computation drawing on:

- the application of ordered rules,
- expressed as simple logical operations over natural classes,
- the postulate that phonological computation is "substance-free", and
- underlying representations employing a form of archiphonemic underspecification.

LP is thus a theory of possible phonological processes and grammars; it also has consequences for our theories of morphophonology and phonological exceptionality.

1.1 What we won't cover

We will **not** discuss:

- phonotactic generalizations (which we conceptualize as ontologically distinct from phonology proper),
- "non-local", long-distance phonological processes (though see Dabbous et al. 2021 for our approach to locality and non-locality),
- phonological—prosodic or tonal—structure above the segment (though we believe that LP can easily be extended to support this), or
- formal results in expressivity or learnability (though we suspect positive results of this sort are very much within reach).

*This is a revised version of a tutorial developed with Rim Dabbous and Kyle Gorman, presented at LSA 2025.

1.2 Why phonology should be logical

- Phonological rules from the *Sound Pattern of English* (SPE; Chomsky and Halle 1968) era—and much subsequent descriptive work—employ numerous abbreviatory devices such as:
  - "Greek letter" variables to express non-identity with feature coefficients,
  - exchange rules,
  - parentheses to indicate optional expansions,
  - curly braces for disjunctions, etc.
- Logical rigor should allow us to discern which of these are mere metalanguage conventions (cf. McCawley 1974) and which expand the space of possible grammars.

1.3 Variable subsumption

α-notation wreaks havoc with natural classes

(1) $[-\textsc{Sonorant}] \sqcup \{\alpha\textsc{Voice}\}$ / ___ $[-\textsc{Sonorant}, \alpha\textsc{Voice}]$

However, the environment is defined by the partial description [−Sonorant, αVoice], and there is no segment that is a superset of the set {−Sonorant, αVoice}, because no segment literally contains the specification αVoice (see Bale et al. (submitted)).

1.4 Talking about nothing

- What could be more innocuous? McCarthy (2008): "Obviously, a Placeless coda can be targeted for assimilation, but so can a Placeless onset."
- The question here (e.g., Lees 1961b:12–14, Lightner 1971:236, Hayes 1986, Archangeli 1988, Reiss 2003) is how one should refer to underspecified/unmarked members of a class without referring to the whole class; the literature fails to provide an acceptable solution.
- Lees (1961a)

> Thus, we must assume that **any rule which applies to a column of features like /B/ also at the same time applies to every other type of column which contains that same combination of features, such as /p/ and /b/**. This is tantamount to imposing the constraint on phonological features that they never be required to identify unspecified, or zero, features. To the best of our present knowledge, there seems to be no other reasonable way to prevent the awkward consequences mentioned above.
>
> To return to Turkish this decision means that the **grammar is incapable of distinguishing native vowel-harmonic morphemes from borrowed non-vowel-harmonic morphemes simply be the presence of the archiphoneme /E/ in the former versus /e/ or /a/ in the latter**.

(2) Linkage notation (from Archangeli 1988): Z is a ‘melody unit or anchor:

a. Z unlinked to F

b. $\begin{array}{c}\mathrm{Z}\\ | \\ \mathrm{F}\end{array}$ linked to F

c. Z ambiguously linked or unlinked to F

Kiparsky (1985) proposes the following representations:

(3) Fricatives:

$$\begin{array}{ccc}
\text{a. /s/} & \text{b. /f/} & \text{c. all fricatives} \\
 & [+\textsc{Labial}] & \\
\not| & | & \\
\begin{bmatrix}+\textsc{Continuant}\\+\textsc{Obstruent}\end{bmatrix} & \begin{bmatrix}+\textsc{Continuant}\\+\textsc{Obstruent}\end{bmatrix} & \begin{bmatrix}+\textsc{Continuant}\\+\textsc{Obstruent}\end{bmatrix} \\
| & | & | \\
\mathrm{C} & \mathrm{C} & \mathrm{C}
\end{array}$$

- Anderson (1982) suggests that the following rule should be interpreted as “delete schwa”:

  (4) $\varnothing \rightarrow \varnothing$

- But could it not just as well mean “insert schwa” or even “do nothing”?
- Kiparsky (1985) proposes the following representations:

  (5) Fricatives:

$$\begin{array}{ccc}
\text{a. /s/} & \text{b. /f/} & \text{c. all fricatives} \\
 & [+\textsc{Labial}] & \\
\not| & | & \\
\begin{bmatrix}+\textsc{Continuant}\\+\textsc{Obstruent}\end{bmatrix} & \begin{bmatrix}+\textsc{Continuant}\\+\textsc{Obstruent}\end{bmatrix} & \begin{bmatrix}+\textsc{Continuant}\\+\textsc{Obstruent}\end{bmatrix} \\
| & | & | \\
\mathrm{C} & \mathrm{C} & \mathrm{C}
\end{array}$$

- The question here (e.g., Lees 1961b:12–14, Lightner 1971:236, Hayes 1986, Archangeli 1988, Reiss 2003) is how one should refer to underspecified/unmarked members of a class without referring to the whole class; the literature fails to provide an acceptable solution.

- As the examples become phenomenologically more complex—and more challenging for analysts—little enrichment to our theory is needed. Rather, apparent complexity emerges from the combinatorics of our set-theoretic system.

- This reflects Chomsky's (1982:3) characterization of scientific progress.

> As concepts and principles become simpler, argument and inference tend to become more complex—a consequence that is naturally very much to be welcomed.

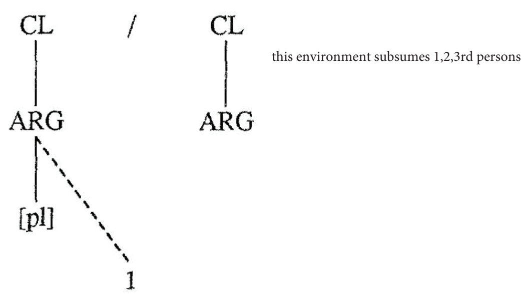
1.5 A tidbit for the non-phonologists

- As Bonet (1995:fn 28) notes in a study on clitic selection, this issue also occurs in morphology: "The formulation in [her 25, see 6] is defective because, as it is stated, the insertion rule should operate in the context of any [ARG] clitic (then the rule would apply in the context of a second person clitic or a first person clitic, for instance, which is not the case)."

(6) Bonet Rule: "insert 1st person on clitic that only has ARG and nothing else"

Once the structure in (24a) is assumed for the impersonal clitic, the change from *si* to *ci* is fairly easy to account for. The rule responsible for the change, a two-step process, inserts the feature [1] to the structure in (24a) and links it to the impersonal clitic when this clitic is combined with the bare [ARG] clitic. This is shown in (25):[28]

(25)



1.6 Why phonology should be substance-free

- Consider the following set of informally-specified rules.

  (7) Simple rule I:

  - e → ẽ / __ n
  - Search and copy: "vowel looks at the segment to its immediate right, and if it finds +NASAL it copies it"

(8) Simple rule II:

- e → i / __ n
- Search but **do not** copy: "vowel searches to its immediate right, and if it finds +NASAL it becomes +HIGH"

(9) Simple rule III:

- e → X / __ n
- Search and change: "vowel searches to its immediate right, and if it finds +NASAL something about it changes."

- There is no need to reify—or even define—notions like assimilation or dissimilation.
- Environments need not provide the features to the target; the rules are computationally arbitrary in this sense.

(10) Substance-Freeness of Structural Changes (Dabbous et al. 2021):

The features added to segments by the application of a rule need not be found in the rule environment.

1.7 Context

LP ties into other important theoretical currents:

- The *diachronic filter*—à la J. Ohala (2003), M. Hale (2003), and Ju. Blevins (2004)—and properties of the LAD explain observed ("Greenbergian") asymmetries/tendencies.
- *Cognitive Phonetics*: a theory of features at the phonology-phonetics interface (Volenec and Reiss 2018, 2019, 2025).
- (Small-*m*) minimalism: we make do without markedness, feature geometry, etc.
- Language as a natural object:

> ...to abstract from the welter of descriptive complexity certain general principles governing computation that would allow the rules of a particular language to be given in very simple forms. (Chomsky 2000:122)

1.8 Outline

- Defining features, segments, and natural classes.
- Decomposing the traditional → operator into:
  - subtraction (\) for deleting features,
  - unification (⊔) for inserting features, and
  - full-segment insertion and deletion via ↦ and ϵ.
- Applying these tools to propose narrow phonological analyses of "exceptions" and other morpheme-conditioned processes, generalizing classic work by Sharon Inkelas and colleagues.

2 Features, segments and natural classes

2.1 Features

- We assume UG provides $W = \{+, -\}$ and universal, innate, finite feature set $\mathcal{F}$ (Chomsky and Halle 1965, Reiss and Volenec 2022a).
- A valued feature is an element of $W \times \mathcal{F} = \{+, -\} \times \{\mathrm{F}_1, \ldots, \mathrm{F}_n\}$; e.g., $+\mathrm{F}_1$ or $-\mathrm{F}_2$.
- There is *no language-specific phonetics*: transduction of features is the same in Swahili, Japanese, etc., *contra* other so-called *substance-free approaches* (cf. Reiss and Volenec 2022b).

2.2 Segments

- A feature specification is a set of zero or more valued features.
- Two valued features are *opposing* if they have the same feature but a different coefficients; e.g., +F and −F. A feature specification is *consistent* if it does not contain opposing valued features; e.g., if ς is consistent, then $+\mathrm{F} \in \varsigma \implies -\mathrm{F} \notin \varsigma$, etc.
- Segments are (consistent) feature specifications, linked to an X-slot (shown when relevant).
- Feature specifications for segments need not be *complete*: underspecification is permitted.

(11) Segments as sets of features:

$$/\mathrm{i}/ = \left\{\begin{matrix} +\textsc{Syllabic} \\ -\textsc{Back} \\ -\textsc{Round} \\ +\textsc{High} \\ -\textsc{Low} \\ +\mathrm{ATR} \end{matrix}\right\} \qquad /\mathrm{e}/ = \left\{\begin{matrix} +\textsc{Syllabic} \\ -\textsc{Back} \\ -\textsc{Round} \\ -\textsc{High} \\ -\textsc{Low} \\ +\mathrm{ATR} \end{matrix}\right\} \qquad /\mathrm{I}/ = \left\{\begin{matrix} +\textsc{Syllabic} \\ -\textsc{Back} \\ -\textsc{Round} \\ -\textsc{Low} \\ +\mathrm{ATR} \end{matrix}\right\}$$

2.3 Natural classes

- Natural classes are *sets of sets of valued features*:

(12) $\left[+\textsc{High}\right] = \left\{x : x \supseteq \left\{+\textsc{High}\right\}\right\} = \{\text{i, y, ɨ, ʉ, ɯ, u, Y}, \ldots\}$

(13) $\left\{+\textsc{High}\right\}$ = /Y/

- Note the difference in brackets.

(14) Targets:

a. $\begin{bmatrix} +\textsc{High} \\ -\textsc{Back} \end{bmatrix}$ b. $\begin{bmatrix} +\textsc{High} \end{bmatrix}$ c. $\begin{bmatrix} +\textsc{High} \\ -\textsc{Back} \\ +\textsc{Rd} \end{bmatrix}$

(15) Tall, dark and handsome principle (TDH)—logic, not phonology:

There is an inverse relationship between the number of features used in a partial description to intensionally define a natural class, and the number of elements in the extension of the class

- In (14), (b) is bigger than (a) (or the same)

(16) Smallest natural class:

Given a language λ and a set of segments S' that is a subset of S (the set of all segments in λ), the smallest natural class containing every member of S' is $N = \{n : n \in S \text{ and } n \supseteq \bigcap S'\}$.

- A natural class can consist of a single member: $\bigcap\{\text{i}\}$ = {i}. (Recall that each segment is a set, so {i} is a set of sets.)

(17) No natural class, no rule:

Rules are defined w.r.t. natural classes. Assume a language with i,e,a,o,u. If a rule targets i,o then it must (intensionally) target i,e,o,u. We get a theory of rules—this is rare.

(18) **Pop quiz 1:** Is there single rule of Lamba palatalization?:

a. s → ʃ / ___ i (e.g., [masa, maʃika] ‘to plaster’)
b. k → tʃ / ___ i (e.g., [fuka, futʃila] ‘to creep’)
c. t → t / ___ i (e.g., [pata, patila] ‘to creep’)

(19) The natural class containing /i, e, I/—note I notation:

$$\begin{bmatrix} +\textsc{Syllabic} \\ -\textsc{Back} \\ -\textsc{Round} \\ -\textsc{Low} \\ +\text{ATR} \end{bmatrix} = \{\text{i, e, I}\} = [\text{I}]$$

- We can use [I] even if the language has just {i, e,}.

(20) Singleton natural class:

$$\begin{bmatrix} +\textsc{Syllabic} \\ -\textsc{Back} \\ -\textsc{Round} \\ +\textsc{High} \\ -\textsc{Low} \\ +\text{ATR} \end{bmatrix} = \{\text{i}\} = [\text{i}]$$

(21) Natural class versus segment:

singleton class $\{\text{i}\}$: segment /i/:

$$\begin{bmatrix} +\textsc{Syllabic} \\ -\textsc{Back} \\ -\textsc{Round} \\ +\textsc{High} \\ -\textsc{Low} \\ +\text{ATR} \end{bmatrix} = \left\{ \begin{Bmatrix} +\textsc{Syllabic} \\ -\textsc{Back} \\ -\textsc{Round} \\ +\textsc{High} \\ -\textsc{Low} \\ +\text{ATR} \end{Bmatrix} \right\} \neq \begin{Bmatrix} +\textsc{Syllabic} \\ -\textsc{Back} \\ -\textsc{Round} \\ +\textsc{High} \\ -\textsc{Low} \\ +\text{ATR} \end{Bmatrix}$$

(22) **Pop quiz 2**: Using square brackets, specify the singleton natural class {I}.

- Bale et al. (2020) note that this formalism can refer to the natural class of all segments without resorting to a feature SEGMENT or the class [+SEGMENT].
- Rather this class can be referred to using empty brackets [ ] because it is a theorem of set theory is that every set—and here, every segment—is a superset of the empty set.
- More formally, the empty square brackets are interpreted as follows.

(23) $[\ ] = \{x : x \supseteq \{\ \}\}$

(24) Terminological note:

yes: The vowel /i/ is (specified) +HIGH.

no: The vowel /i/ is (specified) [+High].

- Note then that the traditional notation is not type-consistent:
  - a rule's target and environment are natural classes,
  - but the change is a feature specification.

(25) Extensional formulation:

o, e	→	u, i	/ __	m, n, ŋ
(Target)		(Change)		(Environment)

(26) Traditional formulation:

[−Low]	→	[+High]	/ __	[+Nasal]
(Target)		(Change)		(Environment)

(27) Revised LP formulation:

[−Low]	→	{+High}	/ __	[+Nasal]
(Target)		(Change)		(Environment)

3 Deconstructing →

- The → symbol has several different uses including:
  - changing features,
  - inserting features,
  - deleting features,
  - inserting segments, and
  - deleting segments.
- LP deconstructs → into a system of three operators.
- Deconstruction precludes the need for a (diacritic) distinction between feature-filling and feature-changing rules.

3.1 Subtraction

- *Subtraction* (or difference) is denoted by \ (`\setminus` in LaTeX)

(28) $x \in X \setminus Y \text{iff} x \in X \text{and} x \notin Y$.

(29) $\{a, b, c\} \setminus \{a, b\} = \{c\}$

(30) $\{a, b, c\} \setminus \{b, d\} = \{a, c\}$

(31) $\{a, b, c\} \setminus \{d\} = \{a, b, c\}$ (vacuous subtraction)

(32) $\begin{Bmatrix} +\textsc{High} \\ -\textsc{Round} \\ -\textsc{Back} \end{Bmatrix} \setminus \begin{Bmatrix} +\textsc{High} \\ +\textsc{Round} \end{Bmatrix} = \begin{Bmatrix} -\textsc{Round} \\ -\textsc{Back} \end{Bmatrix}$

- To formulate subtraction rules, we assume:
  - the target is a natural class, appearing on the left-hand side of the subtraction,
  - the change is a feature specification, appearing on the right-hand side,
  - an optional environment is specified using natural classes.

(33) $\begin{bmatrix} -\textsc{Back} \end{bmatrix} \setminus \begin{Bmatrix} -\textsc{High} \end{Bmatrix} \; / \_\_ \begin{bmatrix} +\textsc{Nasal} \end{bmatrix}$

(34) Terminological note:

a. In LP, rules are total functions whose domain and range are phonological structures (strings, etc.) (see Bale and Reiss 2018).

b. Each rule "applies to" every string at a given point in the derivation so that its output serves as the input to the next rule (or yields the surface representation).

c. **We never say that a rule "does not apply".**

d. Rather, when input and output are identical we say it *applies vacuously*.

3.2 Unification

- First consider *union*, denoted by ∪.

(35) $\{a, b, c\} \cup \{a, b, d\} = \{a, b, c, d\}$

- But union of valued features can give rise to inconsistency.

(36) $\left\{\begin{matrix}+\textsc{High}\\ \underline{+\text{Round}}\\ -\textsc{Back}\end{matrix}\right\} \cup \left\{\begin{matrix}+\textsc{High}\\ \underline{-\textsc{Round}}\end{matrix}\right\} = \left\{\begin{matrix}+\textsc{High}\\ \underline{+\textsc{Round}}\\ \underline{-\textsc{Round}}\\ -\textsc{Back}\end{matrix}\right\}$

- We instead use a variant called *unification*, denoted by $\sqcup$ (`\sqcup` in LaTeX).

(37) Unification (to be revised):

If A and B are feature specifications, and the union $A \cup B$ is consistent, then $A \sqcup B = A \cup B$; otherwise it is undefined.

(38) Feature insertion: $\left\{\begin{matrix}+\textsc{High}\\ -\textsc{Round}\end{matrix}\right\} \sqcup \left\{-\textsc{Back}\right\} = \left\{\begin{matrix}+\textsc{High}\\ -\textsc{Round}\\ -\textsc{Back}\end{matrix}\right\}$

(39) Vacuous application: $\left\{\begin{matrix}+\textsc{High}\\ -\textsc{Round}\\ -\textsc{Back}\end{matrix}\right\} \sqcup \left\{-\textsc{Back}\right\} = \left\{\begin{matrix}+\textsc{High}\\ -\textsc{Round}\\ -\textsc{Back}\end{matrix}\right\}$

(40) Unification failure: $\left\{\begin{matrix}+\textsc{High}\\ \underline{-\textsc{Round}}\\ -\textsc{Back}\end{matrix}\right\} \sqcup \left\{\begin{matrix}+\textsc{High}\\ \underline{+\textsc{Round}}\end{matrix}\right\} \rightsquigarrow$ **undefined**

- To preserve the LP notion of rules as total functions, we reinterpret unification failure as vacuous application.

(41) Unification (revised):

If A and B are feature specifications, and their union $A \cup B$ is consistent, then $A \sqcup B = A \cup B$; otherwise, $A \sqcup B = A$.

- In other words, there are two types of vacuous application of unification rules:
  - vacuous unification and
  - unification failure.
- We formulate unification rules similarly to subtraction rules.

(42) $\left[-\textsc{Back}\right] \sqcup \left\{+\textsc{High}\right\} \ / \ \_\_ \ \left[+\textsc{Nasal}\right]$

- For set theoretic reasons, we know that the second argument of a unification rule must be a singleton set. For subtraction, the second argument is not (in general) a singleton set (Bale et al. 2020). This follows from TDH.

3.3 Examples

3.3.1 Russian

Following the suggestions of Poser (1982), Inkelas and Cho (1993), and Siptár and Törkenczy (2000) we model feature-changing processes as subtraction followed by unification.

- As is well-known, Russian exhibits final devoicing.

(43) Russian final devoicing:

	nom.sg.	gen.sg.	
a.	$\widehat{ts}v^{j}et$	$\widehat{ts}v^{j}eta$	‘color’
b.	prut	pruda	‘pond’

- The LP intuition is that devoicing should be modeled as two-step process: d $\rightsquigarrow$ D $\rightsquigarrow$ t.

(44)

	/t/	/d/	/D/
Voice	–	+	
Sonorant	–	–	–

(45) Part 1 (deletion): $\left[-\textsc{Sonorant}\right] \setminus \left\{+\textsc{Voice}\right\} \;/\; \_\_\ \%$

- Rule (45) maps any word-final segment-set that is a superset of {–Sonorant} to that same segment-set minus {+Voice}.

(46) Part 2 (insertion): $\left[-\textsc{Sonorant}\right] \sqcup \left\{-\textsc{Voice}\right\}$

(47) Yield of (46):

a.	$/t/ \sqcup \{-\textsc{Voice}\} \rightsquigarrow /t/$	(vacuous unification)
b.	$/d/ \sqcup \{-\textsc{Voice}\} \rightsquigarrow /d/$	(unification failure)
c.	$/D/ \sqcup \{-\textsc{Voice}\} \rightsquigarrow /t/$	(feature filling)

- Thanks to this two-step process and our definition of unification, it is not necessary to distinguish between feature-filling and feature-changing rules. We create the *illusion* that we have targeted the *absence* of a voicing value, but we have not. This has been a longstanding problem since at least Lees (1961b).

(48) Russian segment mapping diagram:

$$
\begin{tikzcd}
\text{UR:} & t \arrow[d] & & d \arrow[dl] \arrow[d] \\
\text{Rule (45):} & t \arrow[d] & D \arrow[dl] & d \arrow[d] \\
\text{Rule (46):} & t \arrow[d] & & d \arrow[d] \\
\text{SR:} & t & & d
\end{tikzcd}
$$

3.3.2 Hungarian (Reiss 2021a)

- Hungarian exhibits a more complex process of reciprocal voice neutralization.

(49) Hungarian reciprocal voicing (Siptár and Törkenczy 2000:§4.1.1):

	nom.sg.	iness.sg	dat.sg.	abl.sg.	
a.	kalap	kala[b]-ban	kalap-nak	kalap-tól	‘hat’
	rés	ré[z]-ben	rés-nek	rés-től	‘slit’
	zsák	zsá[g]-ban	zsák-nak	zsak-tól	‘bag’
b.	rab	rab-ban	rab-nak	ra[p]-tól	‘captive’
	víz	víz-ben	víz-nek	ví[s]-től	‘water’
	meleg	meleg-ben	meleg-nek	mele[k]-től	‘warmth’
c.	szem	szem-ben	szem-nek	szem-től	‘eye’
	őr	őr-ben	őr-nek	őr-től	‘guard’

- In this language obstruents take on the voicing of the following obstruent, which might be written as follows in SPE notation.

(50) Reciprocal voice neutralization (traditional notation, to be revised):

$$\begin{bmatrix}-\textsc{Sonorant}\end{bmatrix} \rightarrow \{\alpha\textsc{Voice}\} \;/\; \_\_ \begin{bmatrix}-\textsc{Sonorant}\\ \alpha\textsc{Voice}\end{bmatrix}$$

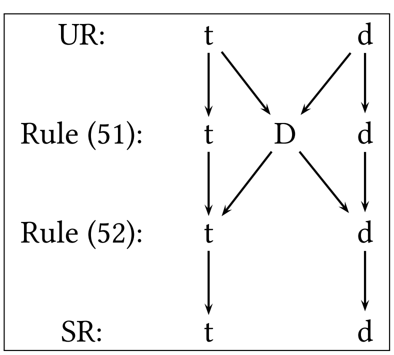
- We now proceed to decompose this into a two-step process.

(51) Part 1 (deletion): $\begin{bmatrix}-\textsc{Sonorant}\end{bmatrix} \setminus \{\alpha\textsc{Voice}\} \;/\; \_\_ \begin{bmatrix}-\textsc{Sonorant}\\ -\alpha\textsc{Voice}\end{bmatrix}$

(52) Part 2 (insertion): $\begin{bmatrix}-\textsc{Sonorant}\end{bmatrix} \sqcup \{\alpha\textsc{Voice}\} \;/\; \_\_ \begin{bmatrix}-\textsc{Sonorant}\\ \alpha\textsc{Voice}\end{bmatrix}$

(53) Critical ordering: (51) $\ll$ (52)

(54) Hungarian segment mapping diagram:



- Note that we were able to use the same two operations for both Russian and Hungarian even though reciprocal voicing “looks” more complex than final devoicing.

3.3.3 Turkish (Bale et al. 2014)

This logic also generalizes to cases involving "ternary" (three-way) contrasts.

- There are three kinds of plosive-final roots in Turkish.

(55) Ternary voicing (Inkelas 1995):

		nom.sg.	acc.sg.	nom.pl.	1sg.poss.	
a.	voiceless:	sana**t**	sana**t**-ɨ	sana**t**-lar	sana**t**-ɨm	'art'
b.	voiced:	ety**d**	ety**d**-y	ety**d**-ler	ety**d**-ym	'etude'
c.	alternating:	kana**t**	kana**d**-ɨ	kana**t**-lar	kana**d**-ɨm	'wing'

- Inkelas proposes final plosives in roots like (55), are underspecified for Voice.

(56)

	/t/	/d/	/D/
Continuant	–	–	–
Voice	–	+	

- She then proposes that the rules which fill in voice specifications are strictly feature-filling.
- LP does not make this distinction, and so it affects /D/ without affecting /t, d/ via vacuity.

(57) Onset voicing: $\left[-\text{Continuant}\right] \sqcup \left\{+\text{Voice}\right\} \;/\; [_\sigma \,\_\_$

(58) Yield of (57):

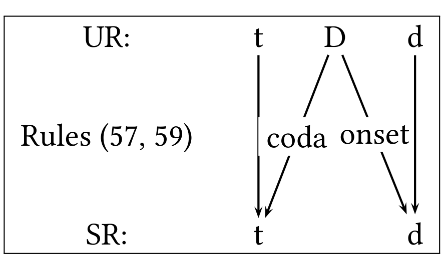
a. /t/ $\sqcup$ {+Voice} $\rightsquigarrow$ /t/ (unification failure)
b. /d/ $\sqcup$ {+Voice} $\rightsquigarrow$ /d/ (vacuous unification)
c. /D/ $\sqcup$ {+Voice} $\rightsquigarrow$ /d/ (feature filling)

- Parallel reasoning applies to Coda devoicing

(59) Coda devoicing: $\left[-\text{Continuant}\right] \sqcup \left\{-\text{Voice}\right\} \;/\; \_\_\,]_\sigma$

- Again, only application to /D/ is non-vacuous. Onset /D/ $\rightsquigarrow$ [d], but /t/ is inalterable.

(60) Turkish segment mapping diagram (non-crucial rule ordering ignored here):



3.4 Summary thus far

- Inkelas et al. (1997) argue against treating ternary alternations using cophonologies.
  - Suppose that one of the three patterns in (55)—it's not clear which ought to be—is treated as having a separate cophonology.
  - Then, one could just as well do away with underlying plosive VOICE altogether, and have three separate cophonologies; they take this to be a *reductio ad absurdum*.
- This analysis supports our assumptions of underspecification and binarity, and provides evidence against privativity.
  - Were VOICE privative—as it has often been argued (see citations in Inkelas and Cho 1993:544, fn. 3 and Lombardi 1995)—we could not target /t/ to the exclusion of /d/.
  - And were it privative, underspecification could not help us to express the contrast between /t/ and /D/.
- The Turkish voicing pattern—which might have analyzed using lexical exceptionality or cophonology—can be generated with the same tools as the clearly-phonological patterns in Russian and Hungarian. In fact, if you accept Russian and Hungarian, you have no way to *not accept* Turkish!
- This use of underspecification have been criticized as "opportunististic" (Steriade 1995).
  - But the stipulation that underlying segments are fully specified would be an unmotivated stipulation.
  - And if feature-changing is a two-step deletion-and-insertion process, we must allow partially specified segments in intermediate representations too.
  - We also reject Nevins's (2010:12) "interface requirement", the stipulation that segments be fully specified the surface:
    * Keating (1988) provides phonetic evidence for surface underspecification.
    * Benz and Volenec (2023) use LP subtraction rules to model debuccalization: "Arbore debuccalizes glottalized obstruents in codas: /beːkᴾ.taw/ and /dʒédᴾ.lo/ surface as [beːʔ.táw] and [déʔ.lo] (Hayward 1984)". Subtraction w/o unification = *derived surface underspecification*
- Indeed it is not clear what principle would exclude our analysis of Turkish.
- Progress does not only come from new good ideas, but also rejecting old bad ideas!

3.5 QUIZ

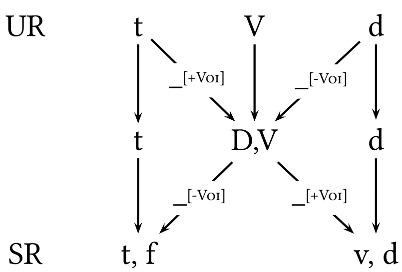
- Feature-filling allophony
- Feature-changing allophony
- Several kinds of final devoicing

3.6 A slightly complicated case: Hungarian *v* 1

(61) *v* is a **target** of assimilation, but not a **trigger**: posit /V/ unspecified for VOICE:

- Target: *hívsz* /Vs/ $\rightsquigarrow$ [fs] 'you call', *óvtam* /Vt/ $\rightsquigarrow$ [ft] 'I protected'; *révbe* 'to port', *bóvli* 'junk', *sav* 'acid'
- Non-trigger: *kvarc* /kV/ $\not\rightsquigarrow$ [gv] 'quartz', *pitvar* /tV/ $\not\rightsquigarrow$ [dv] 'porch'; *medve* 'bear', *olvas* 'read', *kova* 'flint', *vér* 'blood'

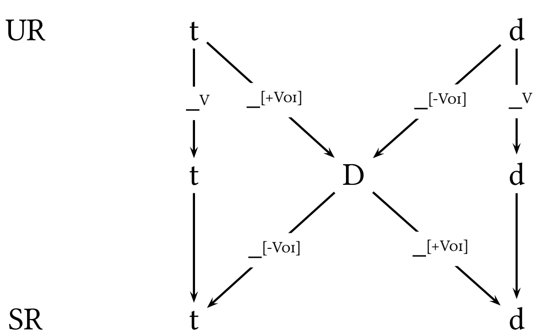
(62) SMD for *v* as *target* (output agrees with following obstruent, e.g., *óvtam*, w/ [ft]):



Rule (51): V has 'nothing to lose' by subtraction

Rule (52): V gets a value by unification, like (derived) D

(63) SMD for *v* as a non-*trigger*:



Rule 51: No subtraction before V, b/c there's no mismatch

Rule 52: No feature-filling before V: /t, d/ keep input values

(64) Remaining V undergoes non-vacuous unification with {+VOICE}—see how general the rule can be stated:

$\left[\ -\textsc{Sonorant}\ \right] \sqcup \{+\textsc{Voiced}\}$

(65) Abstracting from everything but VOICE we have this:

$$
\begin{tikzcd}[row sep=small]
\text{UR} & \phi \arrow[d, "-\alpha\text{sub}"'] \arrow[dr] & \Delta \arrow[d] & \psi \arrow[dl] \arrow[d] \\
 & \phi \arrow[d, "\alpha\text{unif}"'] & \Delta \arrow[dl] \arrow[d] \arrow[dr] & \psi \arrow[d] \\
 & \phi \arrow[d, "\text{def.unif.}"'] & \Delta \arrow[dr] & \psi \arrow[d] \\
\text{SR} & \phi & & \psi
\end{tikzcd}
$$

Similar reasoning can handle Hungarian *h*, which is not a target for voicing assimilation, but is a trigger (Reiss 2021b)

(66) Finally—if we have time—we will see that Hungarian has two *v*'s (Reiss 2025b) and two *h*'s. We can handle it all phonologically.

3.7 Insertion and deletion of segments

- We require some additional tools to implement the insertion and deletion of full segments.
- Let us assume that segments are not merely sets of features, but also that these sets are linked to X-slots.

(67) X-slot representation of /i/:

$$
\begin{matrix} \text{X} \\ | \\ \left\{ \begin{matrix} +\textsc{Syllabic} \\ -\textsc{Back} \\ -\textsc{Round} \\ +\textsc{High} \\ -\textsc{Low} \\ +\text{ATR} \end{matrix} \right\} \end{matrix}
$$

- We then introduce a new operator, $\mapsto$ (`\mapsto` in LaTeX), for computations over timing slots, and use ϵ to symbolize the null segment. We can then define rules for inserting and deleting segments.

(68) Word-final nasal deletion:

$$
\begin{matrix} \text{X} \\ | \\ \left[+\textsc{Nasal}\right] \end{matrix} \quad \mapsto \quad \epsilon \quad / \, \underline{\quad} \; \%
$$

- The target of this rule is the set of all X-slots associated with a set of features which are a superset of {+Nasal}.
- Segments which are targeted for deletion are commonly assumed to be featurally less specified (e.g., Scholten 1987:56, van Oostendorp 2003:435f., Flemming 2009, Silverman 2011).
- For example, consider two possible representations for a schwa-like vowel.

(69) Strong vs. weak schwa:

a. "strong" b. "weak"

$$\begin{array}{c} \text{X} \\ | \\ \left\{\begin{array}{c} +\textsc{Syllabic} \\ -\textsc{Back} \\ -\textsc{Round} \\ -\textsc{High} \\ -\textsc{Low} \\ -\text{ATR} \end{array}\right\} \end{array} \qquad \begin{array}{c} \text{X} \\ | \\ \left\{+\textsc{Syllabic}\right\} \end{array}$$

- The following rule is an attempt to delete only the weak schwa.

(70) Schwa deletion (to be revised):

$$\begin{array}{c} \text{X} \\ | \\ \left[+\textsc{Syllabic}\right] \end{array} \mapsto \epsilon$$

- This rule does not just delete (69b), but rather deletes all +Syllabic segments, including strong schwas and any other vowels.
- However, the model can specifically target richly-specified vowels, as in the following example targeting "strong" schwas.

(71) Schwa deletion (revised):

$$\begin{array}{c} \text{X} \\ | \\ \left[\begin{array}{c} +\textsc{Syllabic} \\ -\textsc{Back} \\ -\textsc{Round} \\ -\textsc{High} \\ -\textsc{Low} \\ -\text{ATR} \end{array}\right] \end{array} \mapsto \epsilon$$

- "Weak" schwa can't be deleted, but it is trivial to insert one.

  (72) Weak schwa insertion:

$$\epsilon \quad \mapsto \quad \begin{array}{c} \mathrm{X} \\ | \\ \{+\textsc{Syllabic}\} \end{array}$$

- **Brackets matter!** (70) targets *all* vowels. Weak schwa deletion is impossible in LP. But insertion of this segment alone is possible (72). Compare the brackets in (70) and (72).
- The traditional idea that segment deletion is accomplished via a gradual loss of features simply cannot be stated in LP: it conflates "nothing" with the empty set. Rather, deletion must target richly-specified segments.
- As it turns out, many apparent cases of weak schwa deletion can be reanalyzed as insertion; see Reiss 2025a for discussion.

4 Underspecification and prespecification

LP, combined with a judicious use of underspecification and prespecification, can model a number of phenomena traditionally classified as *morphophonology*, i.e., involving phonological rules making reference to morphemic/lexical identity.

- Our goal is to show that at least some patterns previously attributed to morphophonology can be expressed using the restrictive LP model of the *narrow phonology*.
- We make the common—but usually implicit—assumption that a narrow phonological analysis is preferable, *ceteris paribus*, to morphophonological alternatives.
- We assume that the child is *epistemically bounded* (in the sense of Fodor 1980:33f.) to prioritize narrow phonological solutions, and resorts to morphophonology (or suppletion) only when they encounter an alternation exceeding the power of the narrow phonology.

4.1 Background

- Sharon Inkelas and colleagues (Inkelas and Cho 1993, Inkelas 1995, Inkelas and Orgun 1995, Inkelas et al. 1997) argue for a form of archiphonemic underspecification from which they derive two conclusions:
  - inalterability is prespecification, and
  - mutability is underspecification.
- We will later add the following slogans, direct corollaries of the LP model:[1]

[1] Inkelas and colleagues do not use the term "mutability", *catalysis*, or *quiescence*; these are our terms.

  - prespecification is catalysis and
  - underspecification is quiescence.

4.2 Inalterability and mutability

- Inkelas and Cho (1993) propose to use prespecification to exempt certain morphemes from phonological processes.
- Inkelas and Cho propose that various forms of prespecified structure—including feature specifications—prevents targets from undergoing feature-filling processes.
- We translate this intuition into LP by using prespecification to create 'negative exceptions'—like a [d] that appears to exceptionally avoid coda devoicing.

4.2.1 Baztan (Gorman and Reiss 2024)

- Hualde (1991) discusses a process called Low Vowel Assimilation (henceforth, LVA) in several dialects of Basque. LVA is attributed to "a rule that raises a low vowel to /e/ after a high vowel, with or without any intervening consonants" (op. cit.:23).

(73) Low Vowel Assimilation (loc. cit.):

/mutil-a/	[multil**e**]	'the boy'
/mendi-a/	[mendi**e**]	'the mountain'
/egun-a/	[eɣun**e**]	'the day'

- We focus on Hualde's account of the Baztan dialect (§2.2), in which LVA affects vowels within words and across certain word boundaries.

(74) Auxiliary verbs with raised vowel after high vowel (op. cit.:29–30.):

a.	torri d**e**	'he has come'	cf. gan d**a**	'he has gone'
b.	gain d**e**	'he will go'	cf. lorriko d**a**	'he will come'
c.	torri g**e**ra	'we have come'	cf. gan g**a**ra	'we have gone'
d.	torri z**e**ra	'you have come'	cf. gan z**a**ra	'you have gone'
e.	in z**e**zu	'do it'	cf. jan z**a**zu	'eat it'

- Hualde claims morphemes in which /a/ are unaffected by LVA belong to different morphological strata from those where it does, but it seems difficult to maintain this position.

(75) Exceptions to LVA (op. cit.:26–30):

  - "Not all derivational suffixes present the same behaviour with respect to Low Vowel Assimilation."

- "Verbal suffixes generally undergo assimilation."
- "We need to examine now the application of the rule in conjugated verbal forms. Here, the situation is not uniform… [I]n quite a few conjugated forms the rule fails to apply."
- "The forms that present the context for Low Vowel Assimilation, but, nevertheless, do not undergo the rule, have just one more irregularity that must be lexically marked."
- "Certain auxiliary verbs also undergo assimilation… Other forms of the auxiliary, on the other hand, never undergo assimilation, including the other persons of the intransitive present indicative not mentioned above…"
- "We must conclude that only a few auxiliary forms can behave like clitics and thus undergo Low Vowel Assimilation."

(76) Some auxiliaries that do not undergo LVA:

1sg. *naiz* (e.g., *torri naiz* 'I have come'), 2sg. informal *aiz*, 2pl. form *zate*

- It is hard to imagine any account which would place (76) in different morphological strata than the auxilaries in (74).
- We instead propose that some morphemes contain underspecified /A/ which is *mutable* via a unification rule (e.g., the singular definite /-A/, the auxiliary /dA/), whereas others (e.g., the auxiliary /naiš/) contain a prespecified /a/ which is *inalterable* with respect to this rule.

(77) Baztan vowel specification (partial):

	/a/	/e/	/A/	/o/
High	–	–	–	–
Low	+	–		–
Back	+	–		+
Round	–	–	–	+

(78) Low Vowel Assimilation: $\begin{bmatrix}-\text{High}\\-\text{Round}\end{bmatrix} \sqcup \{-\text{Low}\} \;/\; [+\text{High}]\; C_0 \_\_$

(79) Yield of (78):

a. /a/ $\sqcup$ {–Low} $\rightsquigarrow$ /a/ (unification failure)
b. /e/ $\sqcup$ {–Low} $\rightsquigarrow$ /e/ (vacuous unification)
c. /A/ $\sqcup$ {–Low} $\rightsquigarrow$ /e/ (feature filling)
d. /o/ $\sqcup$ {–Low} $\rightsquigarrow$ /o/ (vacuous unification)

- It only *seems* like (78) targets the underspecified segment to the exclusion of others.
- It is necessary to ensure that the "raised" vowel surfaces as –Back, but there are several ways to implement this.

4.2.2 Kashaya

- Buckley (1994) gives the following phonological rules of Kashaya, stated informally.

(80) $\mathrm{i} \rightarrow \mathrm{a} \,/\, \mathrm{m}\ \_\_$

(81) $\mathrm{i} \rightarrow \mathrm{u} \,/\, \mathrm{d}\ \_\_$

(82) $\mathrm{V} \rightarrow \mathrm{a} \,/\, \mathrm{q}\ \_\_$

(83) $\mathrm{V} \rightarrow \mathrm{o} \,/\, \mathrm{q}^{\mathrm{w}}\ \_\_$

- While (80–81) appear to be quite regular, 3 of the 21 *i*-initial suffixes—inchoative *-ibic* and reflexives *-iyic'* and *-ic'*)—do not undergo the expected alternations. For example, [cahno·**dí**ʔ] 'talk to oneself' seems to meet the conditions for (81) but the *i* does not back.
- Similarly, the same three suffixes are apparent exceptions to the otherwise-regular (82–83).
- Buckley proposes that Kashaya has two *i*'s: mutable /I/ and inalterable /i/.[2]

(84) Kashaya vowel specification (op. cit.:24):

	/I/	/i/	/e/	/a/	/o/	/u/
Syllabic	+	+	+	+	+	+
High		+	−	−	−	+
Low		−	−	+	+	+
Back		−	−	+	−	−

- Assuming this specification, we can translate (80–81) into a sequence of unification rules.

(85) $$\begin{bmatrix}+\textsc{Syllabic}\end{bmatrix} \sqcup \left\{\begin{matrix}-\textsc{High}\\ +\textsc{Low}\\ +\textsc{Back}\end{matrix}\right\} \Big/ \begin{bmatrix}+\textsc{Labial}\\ +\textsc{Nasal}\\ -\textsc{Continuant}\\ \ldots\end{bmatrix} \_\_$$

(86) $$\begin{bmatrix}+\textsc{Syllabic}\end{bmatrix} \sqcup \left\{\begin{matrix}+\textsc{High}\\ -\textsc{Low}\\ +\textsc{Back}\end{matrix}\right\} \Big/ \begin{bmatrix}+\textsc{Coronal}\\ +\textsc{Alveolar}\\ +\textsc{Voice}\\ \ldots\end{bmatrix} \_\_$$

(87) $$\begin{bmatrix}+\textsc{Syllabic}\end{bmatrix} \sqcup \left\{\begin{matrix}+\textsc{High}\\ -\textsc{Low}\\ -\textsc{Back}\end{matrix}\right\}$$

(88) Critical ordering: (85–86) $\ll$ (87)

[2] We modify Buckley's notation for consistency; he uses /i/ for mutable *i* and /î/ for inalterable *i*.

4.2.3 Spanish (Gorman and Reiss 2024)

- Many Spanish verbs of the third (*-i-*) conjugation have a so-called "raising" alternation between the *e* and *i*, as in *pedí* 'I asked' vs. *pido* 'I ask' or *gemí* 'I wailed' vs. *gimo* 'I wail'; other third conjugation verbs (e.g., like *vivir* 'to live', *sumergir* 'to submerge').

- One could imagine analyzing raising verbs as involving suppletion between *e* and *i* stem allomorphs (e.g., /ped-, pid-/), but Embick (2012:33) notes such an analysis would have to make reference to a complex, disjunctive set of morphosyntactic contexts.[3]

  (89) Morphosyntactic contexts for *ped-*/*pid-* (after Embick 2012:33):

  a. *ped-*: 1pl./2pl. present indicatives, 1sg./1pl./2sg./2pl. preterites, all imperfectives, all futures, all conditionals

  b. *pid-*: 1sg./2sg./3sg./3pl. present indicatives, all present subjunctives, all imperfect subjunctives, 3sg./pl. preterites

- There is no obvious way to treat the difference between (89a) and (89b) in terms of natural classes of morphosyntactic features, so the grammar would necessarily contain:

  – a list with both stem allomorphs,
  – a list of which morphosyntactic contexts select the *i* vs. *e* allomorph.

  He concludes "[a]n analysis that makes reference to morphosyntactic features thus looks very unpromising".

- Embick (2012) instead assumes the alternating vowel is /i/ and proposes the following morphophonological rule to generate /e/ allomorphs (cf. Harris 1969:110f.).

  (90) Lowering (to be revised): $\mathrm{i} \rightarrow \mathrm{e}$ / ___ $\mathrm{C_0 i}$ (condition: certain roots)

- Embick's proposal is certainly an improvement over a suppletion analysis, because it eliminates the need for the second list expressing the generalizations in (89), but LP allows us to go a step further and replace (90) with a narrow phonological rule.

- Suppose instead that the alternating vowel in underlyingly underspecified for High; let us write this vowel as /I/.

  (91) Spanish vowel specification:

	/I/	/i/	/e/	/a/	/o/	/u/
High		+	−	−	−	+
Low	−	−	−	+	−	−
Back	−	−	−	+	+	+

[3] Embick also notes that a stem suppletion account for this Spanish case would run counter to his theory of locality conditions on stem suppletion (Embick 2010).

- Then in lieu of (90), we can give a purely phonological rule for lowering.

(92) Lowering: $\begin{bmatrix}-\textsc{Back}\\-\textsc{Low}\end{bmatrix} \sqcup \left\{-\textsc{High}\right\}$ / __ C_0 $\begin{bmatrix}-\textsc{Back}\\+\textsc{High}\end{bmatrix}$

This rule maps underspecified /I/ to [e] when there is an /i/ in the next syllable, applying vacuously to /i, e/.

(93) $\begin{bmatrix}-\textsc{Low}\end{bmatrix} \sqcup \left\{+\textsc{High}\right\}$

(94) Critical ordering: (92) ≪ (93)

4.3 A note on markedness

- Inkelas and Cho (S5.3.2) note that some of their analyses require prespecification—or early insertion—of unmarked features, which is inconsistent with the tenets of *radical underspecification* (Kiparsky 1982 et. seq.).
- This is not a problem for LP: it is substance-free and it has no formal notion of markedness.

4.4 Quiescence and catalysis

Inkelas and Cho (55, fn. 26) claim that underspecification cannot handle cases in which "exceptionality takes the form of failure to trigger, rather than failure to undergo, a rule"; they write that cases "remain a problem for us until they can be resolved in a representational fashion".

- LP can handle such cases with ease:
  - Prespecification makes triggers *catalytic*.
  - Underspecification makes "exceptional" non-triggers *quiescent*.
- This is not a novel intuition but it follows directly from the principles of LP.

4.4.1 Barrow Inupiaq

- Barrow Inupiaq has three surface vowels: [i, a, u]. As discussed by Archangeli and Pulleyblank (1994:§2.2.2), Buckley (1994), and Dresher (2009:§7.2.1), among others:
  - "strong" *i*'s are catalytic and trigger palatalization of a following coronal,
  - but "weak" *i*'s (< Eskimo-Aleut **ə*) are quiescent and do not.

(95) Palatalization (Kaplan 1981:§3.22):

a.	iki	'wound'	iki-**ʎ**u	'and a wound'	iki-**ɲ**ik	'wounds'
b.	ini	'place'	ini-**l**u	'and a place'	ini-**n**ik	'places'

- We propose that weak *i* as in ***ini*** is underspecified relative to strong *i* as in *ik**i***, and derive palatalization via a two-step subtraction-and-unification process.

(96)

	strong *i*	weak *i*	a	u
High	+	+	−	+
Back	−		+	+

(97)

	plain coronals	palatal coronals
Anterior	+	−
Coronal	+	+

(98) $\left[+\textsc{Coronal}\right] \setminus \left\{+\textsc{Anterior}\right\} \;/\; \begin{bmatrix}+\textsc{High}\\ -\textsc{Back}\end{bmatrix}$ —

(99) $\left[+\textsc{Coronal}\right] \sqcup \left\{-\textsc{Anterior}\right\}$

(100) $\left[+\textsc{High}\right] \sqcup \left\{-\textsc{Back}\right\}$

(101) Critical ordering: (98) ≪ (99–100)

4.4.2 Czech (baby version—see forthcoming paper in *Phonology*)

- Anderson and Browne (1973, henceforth A&B) give an analysis of Czech palatalization which is very similar to our analysis of Barrow Inupiaq.

- The surface front vowels in the “literary” register of Czech are [i, iː, ɛ, ɛː].[4] However, specific instances of these may or may not trigger palatalization of the preceding consonant.

(102) Partial paradigm for *sestřin* ‘sister’s’ (A&B:453):

a.	sestřini	[sɛstr̝i**ɲ**i]	masc.anim. nom.pl.
b.	sestřiny	[sɛstr̝i**n**i]	fem. nom.pl.
c.	sestřinych	[sɛstr̝i**n**ix]	gen.pl.

- Here the “strong” (palatalizing) front vowels are written *i*, *í*, and *ě*, and “weak” front vowels are written *y*, *ý*, *e*, and *é*; the latter are the reflexes of central vowels in Old Czech.

- A&B propose that weak *y* and *ý* are underlyingly /ɨ(:)/ and strong *i* and *í* are /i(:)/. We instead propose that weak front vowels are simplify underspecified with respect to the front vowels and the feature Back.

[4] We have taken the liberty of adapting A&B’s semi-orthographic transcriptions into IPA.

4.5 Taxonomy

- The following summarizes possible interactions between under-/prespecified segments.
  - Let the phonemic inventory be /x, y, X, Y/.
  - Suppose that /x/ is prespecified +x and /X/ is underspecified with respect to /x/ and this feature but otherwise identical, so that $x \setminus X = \{+\textsc{x}\}$.
  - Similarly, suppose that /y/ is prespecified +y and /Y/ is underspecified with respect to /y/ and this feature but otherwise identical, so that $y \setminus Y = \{+\textsc{y}\}$.
  - Then consider a rule which targets +x when followed by trigger +Y.

(103) Interaction taxonomy:

a.	x / __ Y:	inalterability	×	quiescence	⇝ no effect
b.	x / __ y:	inalterability	×	catalysis	⇝ no effect
c.	X / __ Y:	mutability	×	quiescence	⇝ no effect
d.	X / __ y:	mutability	×	catalysis	⇝ potential effect

- We'll see examples of (103d) in the next section.

4.6 Interactions between mutability and catalysis

Our taxonomy predicts that for a unification rule to apply, the target must be mutable and the trigger (if there is one) catalytic meaning that either target or triggers can prevent non-vacuous application (cf. Kisseberth 1970 on lexical exceptionality).

4.6.1 Blackfoot

- Frantz (2017: ch. 6) describes a breaking process in Blackfoot:

  > The *s* following the future prefix in [*kit-áak-***s***-ipii* 'you will enter'] requires some discussion. The initial vowel of stem *ipii* 'enter,' unlike the initial vowel of *itsiniki* 'tell a story,' always causes a preceding *k* to be replaced by the affricate *ks.* We will speak of this phenomenon as breaking of *k*, and of the *i* which is involved as a breaking *i.* For any morpheme which begins with *i* we need to know whether that i is a breaking *i* or not; if it is a breaking *i*, then if it immediately follows a morpheme ending in *k* we know that the *k* will be replaced by *ks.* (82–83)

- Frantz's informal analysis of "breaking", catalytic *i* and non-breaking, quiescent *i* is quite similar to the situation in Barrow Inupiaq and Czech.[5]

[5]Note that Frantz uses capital *I* to denote the catalytic breaking *i*, whereas we use that symbol for the underspecified, quiescent vowel. He does not distinguish the two *k*'s; presumably he takes the 2nd person prefix, which is impervious to breaking, to be a lexical exception.

(104) Quiescent /I/ ⊆ catalytic /i/:

	/i/	/I/
Syllabic	+	+
High	+	

- He also proposes, similarly, that there is a "rule that indicates that the difference between these two vowels is neutralized at the level of pronunciation" (89–90).
- But there is one wrinkle: the second person prefix *k-* is "always impervious to breaking" (93). Breaking also seems to require a distinction between inalterable and mutable targets.

(105) Mutable /K/ ⊆ inalterable /k/:

	/k/	/k͡s/	/K/
Velar	+	+	−
DelRel	−	+	

(106) $\left[\text{K}\right] \sqcup \left\{+\text{DelRel}\right\} \;/\; \_\_ \left[\text{i}\right]$

(107) $\left[\text{K}\right] \sqcup \left\{-\text{DelRel}\right\}$

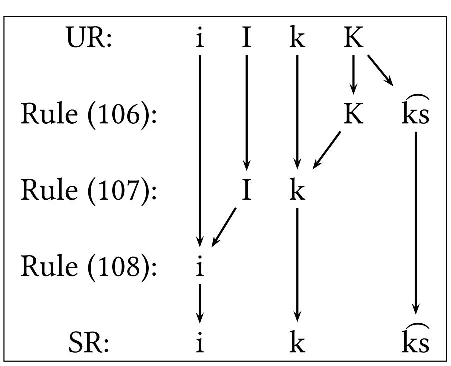
(108) $\left[\text{I}\right] \sqcup \left\{+\text{High}\right\}$

(109) Critical ordering: (106) ≪ (107–108)

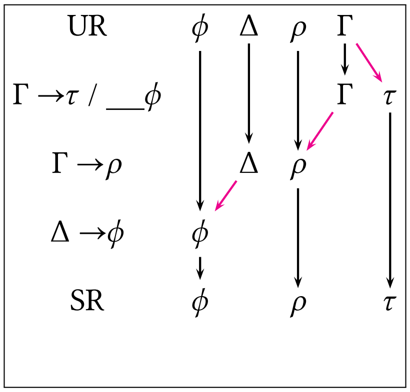
(110) Blackfoot derivations:

UR	ki	kI	Ki	KI
Rule (106):			k͡si	
Rule (107):			kI	
Rule (108):		ki		ki
SR	ki	ki	k͡si	ki

(111) Blackfoot segment mapping diagram:



- We can derive the Blackfoot pattern with just three unification rules.



4.6.2 Arbizu Basque

(112) Catalysis and Mutability in the same slot: V_2 in V_1V_2:

- Arbizu Basque has two vowels that can occur as [e] at the beginning of various suffixes
- Hualde represents one of them, in the genitive indefinite, as V, a vowel unspecified for any other specific vowel features. V takes all the features from a preceding vowel.
  - /aśto-Vn/ ⇝ [aśtoon] 'of donkeys', /mendi-Vn/ ⇝ [mendiin] 'of mountains' (genitive indefinite)
- Other suffixes like the genitive plural begin with what Hualde represents as /e/. This vowel is a catalyst for a raising process $o \rightarrow u$:
  - /aśto-en/ ⇝ [aśtuen] 'of the donkeys'
- /V/ is underspecified and Mutable (target of "full copy")
- /e/ is 'pre'-specified and Catalytic (triggers gliding of preceding vowel)

4.6.3 English

- The *SPE* (*passim*) analysis of English velar softening (e.g., *electri*[k]/*electri*[s]*ity*) could easily be made parallel to our analysis of Blackfoot using:
  - underspecified targets contrasting with prespecified inalterable segments, in place of *SPE*'s ±Latinate lexical diacritic, and
- We can discuss whether we *want* phonology to **generate** *electricity*

4.7 Other patterns

4.8 Non-derived environment blocking

Finnish raises /e/ to [i] word-finally as in (113).

(113) Finnish data:

1. *vetenä* ‘water-ESSIVE.SG vs. *vesi* ‘water-NOM.SG from /vete/
2. *taksina* ‘taxi-ESSIVE.SG vs. *taksi* ‘taxi-NOM.SG from /taksi/

The root for ‘water’ has a final [e∼i] alternation, but the root for ‘taxi’ has non-alternating [i]. **Within a morpheme**, in *vesi*, the underlying /t/ surfaces as [s] before the [i] that results from the raising rule. **Across a morpheme boundary** underlying /i/ vowels, not from /e/, also trigger this assibilation as in *halusi* (114).

(114) More Finnish:

halut-a ‘want-INFINITIVE’ vs. halus-i (/halut-i/) ‘want-PAST’

In contrast, there are underlying *ti* sequences that are **part of stored morphemes** in which the assibilation does not occur (115).

(115) Assibilation blocked in lexical *ti*:

(i) *tila* ‘room-NOM.SG’ and (ii) *äiti* ‘mother-NOM.SG.’

Because the environments where the change does occur **don’t form a natural class**, some scholars propose a general phonological rule that is blocked from applying in **non-derived** environments (Kiparsky 1993), whence the term Nonderived Environment Blocking (NDEB). Inkelas (2000) demonstrated that NDEB is unnecessary by positing an underlying distinction between a segment /t/ (underlyingly fully specified or ‘prespecified’) and a segment /T/ (underlying underspecified for CONTINUANT). If the assibilation is the result of feature-filling effects, then underlying /T/ can be affected, without affecting underlying /t/.

We extend Inkelas’ approach in two ways. First, we follow up on a suggestion (Inkelas and Cho 1993, fn. 26) to explore the prespecified/underspecified distinction for potential rule triggers, not just to targets. We do this by providing an alternative account of Finnish (without /T/ vs. /t/) that appeals to a contrast between a fully specified /i/ as opposed to a vowel /I/, underspecified for HIGH, which fails to trigger assibilation of *t* to *s*. Because /i/ is more specific than /I/, it is possible to formulate a rule that is triggered by /i/, but not /I/, and we provide an analysis that derives all the relevant forms using only rules based on set subtraction and unification, as in the Logical Phonology literature (e.g., Reiss 2021b).

4.8.1 More Hungarian

- There are roughly 60 Hungarian noun stems which are apparent exceptions to harmony in that they have a front vowel but select back-harmonic suffix allomorphs.

(116) Neutral and antiharmonic stems (Siptár and Törkenczy 2000:§3.2.2):

	nom.sg.	dat.sg.	abl.sg.	
a.	víz	víz-n**e**k	víz-t**ő**l	'water'
	rét	rét-n**e**k	rét-t**ő**l	'meadow'
b.	híd	híd-n**a**k	híd-t**ó**l	'bridge'
	héj	héj-n**a**k	héj-t**ó**l	'crust'

- Siptár and Törkenczy (henceforth S&T) refer to the (116a) pattern as "neutral" and the (116b) pattern as "antiharmonic". Most antiharmonic stems are in *i* or *í* [iː]; a few are in *é* [eː].

- S&T treat the front-harmonic suffix allomorphs as defaults because multisyllabic stems containing a back vowel followed by a front vowel select back-harmonic suffix allomorphs, suggesting that the front stem vowels in (116a) are neutral with respect to harmony.

(117) Back-neutral stems (loc. cit.):

nom.sg.	dat.sg.	abl.sg.	
kávé	kávé-n**a**k	kávé-t**ó**l	'coffee'
papír	papír-n**a**k	papír-t**ó**l	'paper'

- While antiharmonic stems are usually understood as lexical exceptions to harmony, LP can reanalyze them phonologically.

- We assume that the neutral vowels are underspecified with respect to Back and antiharmonic vowels are prespecified +Back.

(118) Hungarian vowel specification (partial):

	neutral *i*	antiharmonic *i*	*u*	*ü* [y]
High	+	+	+	+
Low	–	–	–	–
Back		+	+	–
Round	–	–	+	+

- Then, the following rules, applying after harmony, generate the surface forms of the stems.

(119) $\left[-\text{Round}\right] \setminus \left\{+\text{Back}\right\}$

(120) $\left[\ \right] \sqcup \left\{-\textsc{Back}\right\}$

(121) Critical ordering: (119) ≪ (120)

- Rule (119) gives neutral and antiharmonic front vowels the same underspecified representation (applying vacuously to the latter), and (120) ensures that both surface as −Back.[6]

(122) Hungarian derivations (height features omitted):

	neutral *i*	antiharmonic *i*	*u*	*ü* [y]
UR	−Round	+Back, −Round	+Back, +Round	−Back, +Round
Rule (119):		−Round		
Rule (120):	−Back, −Round	−Back, −Round		
SR	−Back, −Round	−Back, −Round	+Back, +Round	−Back, +Round

4.8.2 More Turkish

- Clements and Sezer (1982:§3.1) given an analysis of disharmonic Turkish roots which is extremely similar to our analysis of Hungarian antiharmonic roots.

4.9 Limitations

There are still a problems in morphophonology which are not yet amenable to analysis with LP and pre-/underspecification.

- LP currently lacks an adequate theory of reduplication, metathesis and the like.

- Consider German umlaut, incompletely summarized below:

(123) Some umlaut patterns:

a. noun plurals:
Nuss 'nut' — N**ü**sse [nʏsə] 'nuts' — (cf. B**u**sse 'buses')

b. diminutive nouns:
Haus 'house' — H**äu**schen [hɔʏ̯sçən] 'little house' — (cf. **Au**t**o**chen 'little car')

c. 2nd/3rd singular present indicative verbs:
ich fange 'I catch' — du f**ä**ngst [fɛːŋst] 'you catch' — (cf. du b**a**ngst 'you fear')

d. comparative/superlative adjectives:
groß 'big' — gr**ö**ßerer [gʁøːsɐʁɐ] 'bigger' — (cf. bl**o**ßerer 'more bare')

[6] Without the −Round condition in (119), these rule sequence would erroneously front the back round vowels *u*, *ú* [uː], *o*, and *ó* [oː], and would also "front"—in the style of the grand old Duke of York—the already-front round vowels *ü* [y], *ű* [yː], *ö* [ø], and *ő* [øː].

- It seems likely that pre- and underspecification could be used to specify which stems undergo umlaut and which do not (cf. Lieber 1987:100f.).
- LP rules could also account for both umlauted and un-umlauted forms of the stem.
- But it is not clear that LP can account for the the (apparently morphosyntactic) contexts in which trigger umlaut—if it is in fact a unitary phenomenon.

- So-called "morphomic" patterns (Aronoff 1994)—if they in fact exist (cf. Luís and Bermúdez-Otero 2016)—also involve suppletive stem allomorphy conditioned by both lexical and morphosyntactic conditions, but not necessarily by phonological triggers amenable to LP.

5 Back to Hungarian: The other *v* and *h*

- Key points on poster
  - Circle notation
  - Compound unification and the SSR
  - The forms that are deleted or assimilated MUST be highly specified

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