Phonology II: derivations, rules, phonotactics

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LING 20001

17 October 2011

Outline

Generative phonology

The American structuralist approach to phonology was based on the idea that the right phonemic analysis of a language's sounds could be — and must be — built *up* from the sounds and from the knowledge of when two words are in contrast.
This approach kept the phonemic representation relatively close to the surface phonetic form.
Because of that, there was a significant *morphophonemic* component to the grammar.
Generative phonology challenged the idea that there was a difference between these two components, the *morphophonological* and the *phonological*. It said there was just one thing, and it called it *phonology*.

Palauan

Noun	my N	our N	
ʔáb	ʔəbúk	ʔəbəmám	ashes
mád	mədák	mədəmám	eyes
kér	kərík	kərəmám	question
ʔúr	ʔərík	ʔərəmám	laughter
ʔár	ʔərák	ʔərəmám	price
búʔ	bəʔík	bəʔəmám	spouse
dúʔ	dəʔák	dəʔəmám	skill
bád	bədúk	bədúməm	rock

Palauan

Noun	my N	our N	
ʔáb	ʔəbú-k	ʔəbə-mám	ʔáb,ʔəbú, ʔəbə
mád	mədá-k	mədə-mám	mád, mədá, mədə
kér	kərí-k	kərə-mám	kér, kərí,kərə
ʔúr	ʔərí-k	ʔərə-mám	ʔúr, ʔərí, ʔərə
ʔár	ʔərá-k	ʔərə-mám	ʔár, ʔərá, ʔərə
búʔ	bəʔí-k	bəʔə-mám	búʔ, bəʔí, bəʔə
dúʔ	dəʔá-k	dəʔə-mám	dúʔ, dəʔá, dəʔə
bád	bədú-k	bədú-məm	bád, bədú, bədú
	-k	-mám	

Tonkawa: a classical case of morphophonology

Based on work by Harry Hoijer

verb	gloss	verb	gloss
picnoʔ	he cuts it	picnanoʔ	he is cutting it
wepcenoʔ	he cuts them	wepcenanoʔ	he is cutting them
kepcenoʔ	he cuts me	kepcenanoʔ	he is cutting me
picen	steer		
netloʔ	he licks it	netlenoʔ	he is licking it
wentaloʔ	he licks them	wentalenoʔ	he is licking them
kentaloʔ	he licks me	kentalenoʔ	he is licking me
notxoʔ	he hoes it	notxonoʔ	he is hoeing it
wentoxoʔ	he hoes them	wentoxonoʔ	he is hoeing them
kentoxoʔ	he hoes me	kentoxonoʔ	he is hoeing me
notox	hoe		

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we-ntal-oʔ	he licks them	we-ntale-n-oʔ	he is licking them
ke-ntal-oʔ	he licks me	ke-ntale-n-oʔ	he is licking me
notx-oʔ	he hoes it	notxon-oʔ	he is hoeing it
we-ntox-oʔ	he hoes them	we-ntoxo-n-oʔ	he is hoeing them
ke-ntox-oʔ	he hoes me	ke-ntoxo-n-oʔ	he is hoeing me
notox	hoe		

Tonkawa: a classical case of morphophonology

	cut		lick	
	simple	prog.	simple	prog.
he V it	picno?	picnano?	netlo?	netleno?
he V them	wepceno?	wepcenano?	wentalo?	wentaleno?
he V me	kepceno?	kepcenano?	kentalo?	kentaleno?
nominal	picen			

	hoe		make a fire	
	simple	prog.	simple	prog.
he V it	notxo?	notxono?	naxco?	naxceno?
he V them	wentoxo?	wentoxono?	wenxaco?	wenxaceno?
he V me	kentoxo?	kentoxono?	kenxaco?	kenxaceno?
nominal	notox			

Generative phonology

- The first and most fundamental premise of generative phonology is the rejection of the structuralist method of building phonemic representations out of surface contrasts.

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- The first and most fundamental premise of generative phonology is the rejection of the structuralist method of building phonemic representations out of surface contrasts.
- The underlying phonological representation in the generative view contains all the information necessary to generate (with a set of phonological rules) the related forms falling within both derivational and inflectional morphology.

Outline

Phonological derivations

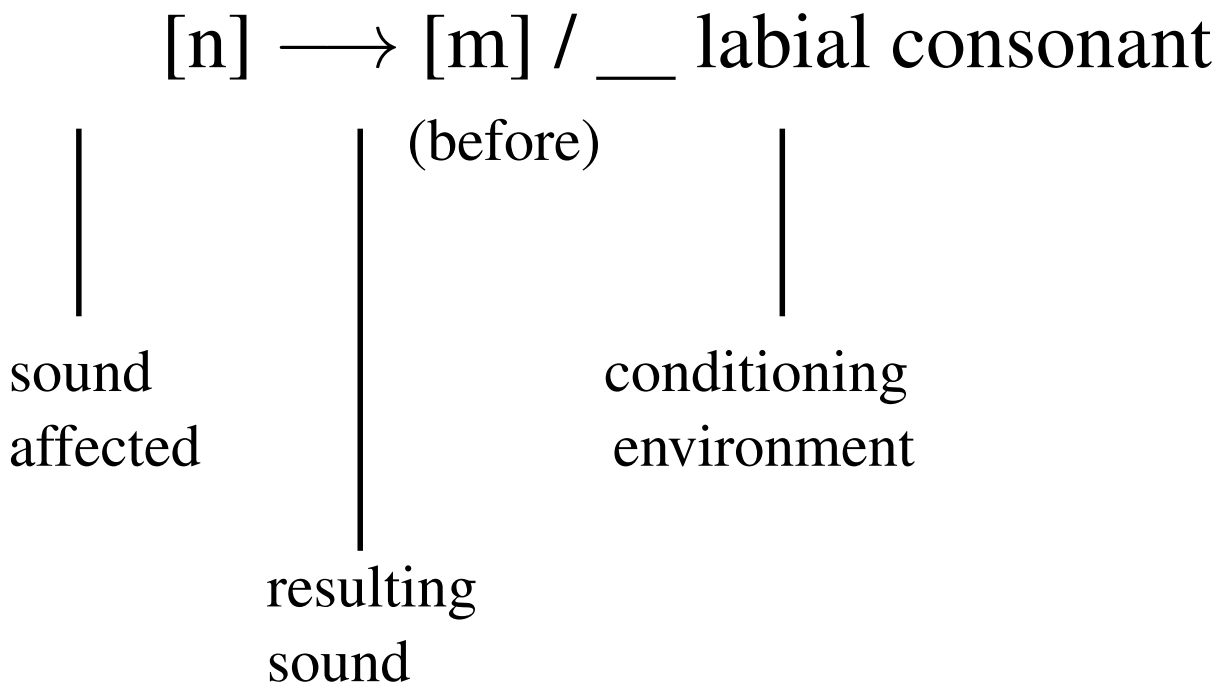
- In generative phonology, phonological rules operate on URs to generate SRs

Phonological derivations

- In generative phonology, phonological rules operate on URs to generate SRs
- This operation is called a **derivation**, because we **derive** SRs from URs

URs:	phonological knowledge
rules:	allophonic processes
SRs:	phonetic implementation

Phonological rule format



"[n] becomes [m] before a labial consonant"

Doing phonology the generative way

The basic steps in doing phonology problems are:

1. Look for minimal pairs (phonemes).

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3. State the environment where each allophone occurs.
4. Determine the underlying representation.
5. Write the rule that derives the surface forms.

Doing phonology: Korean

- Consider the distribution of [ɾ] and [l] in the following examples from Korean:

[talda]	'sweet'	[kɔːɾi]	'distance'
[ɔːlmana]	'how much'	[noɾɛ]	'song'
[sɔlhwa]	'legend'	[puɾida]	'to use'
[pulgogi]	'barbecued meat'	[saɾam]	'person'
[tal]	'moon'	[iɾɯm]	'name'
[sul]	'water'	[kɯːɾida]	'to draw'

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[tal]	‘moon’	[iɾɯm]	‘name’
[sul]	‘water’	[kɯːɾida]	‘to draw’

- Are [ɾ] and [l] allophones of one or two phonemes?

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Step 1: look for minimal pairs.

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- No minimal pairs...
- Probably two allophones of a single phoneme

Doing phonology: Korean

Step 2: Organize the forms by alternant.

[l]			[ɾ]		
ta	l	da	kɔː	ɾ	i
ɔː	l	mana	no	ɾ	ɛ
sɔ	l	hwa	pu	ɾ	ida
pu	l	gogi	sa	ɾ	am
ta	l	#	i	ɾ	ɯm
su	l	#	kɯː	ɾ	ida

- [ɾ] and [l] are in complementary distribution

Doing phonology: Korean

Step 3: find the conditioning environment.

[talda]	‘sweet’	[kɔːɾi]	‘distance’
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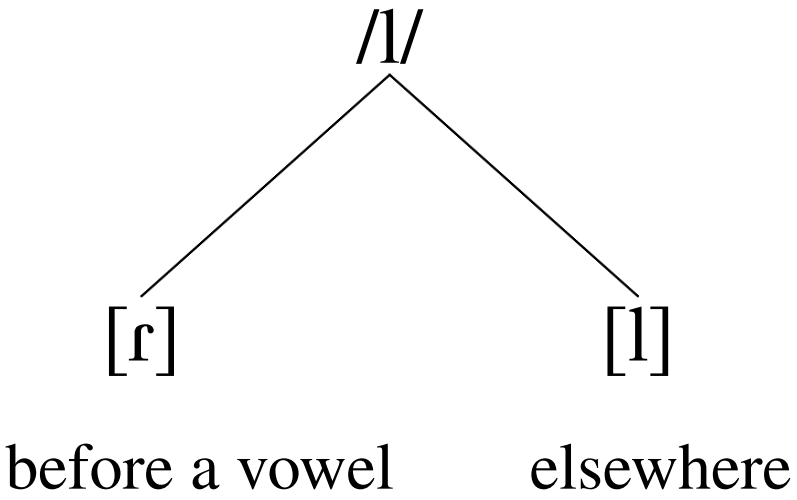
- [ɾ] only occurs **before a vowel**
- [l] occurs **everywhere else**

Doing phonology: Korean

Step 4: determine the underlying representation.



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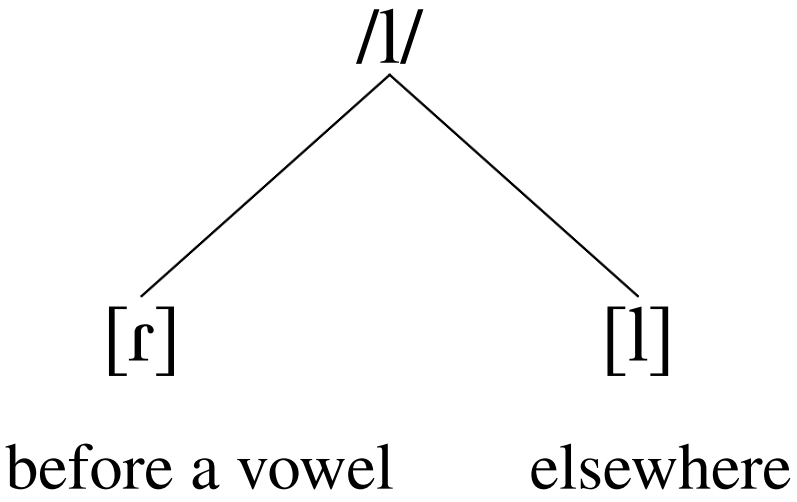

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Doing phonology: Korean

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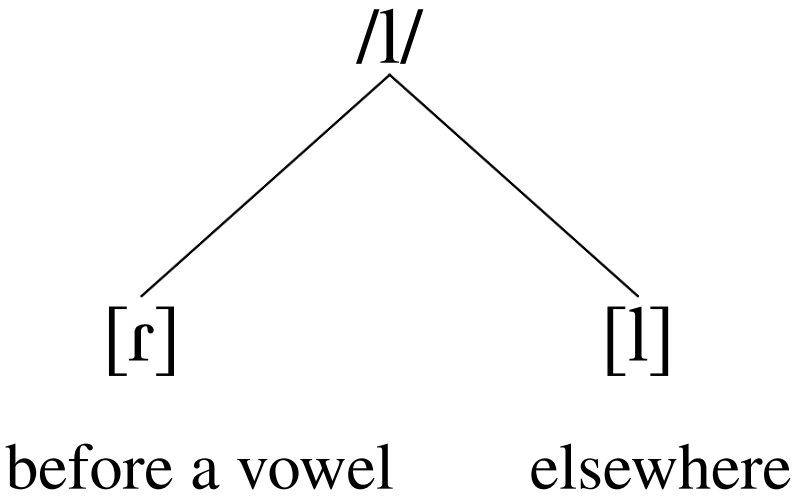

- Usually, we select one allophone as basic
- In most cases, this is the **elsewhere variant** (why?)

Doing phonology: Korean

Step 5: write the rule, and check that it applies.

$$/l/ \rightarrow [ɾ] \; / \; \_\_ \; V$$

UR	/#sul#/	/#salam#/
/l/ → [ɾ] / ___ V	-	saram
SR	[sul]	[saram]

UR	/#pulgogi#/	/#pulida#/
/l/ → [ɾ] / ___ V	-	purida
SR	[pulgogi]	[purida]

Outline

Some useful notation

UR	Underlying representation
SR	Surface representation
#	Word boundary
σ	Syllable ($\_\_\_]_\sigma$ = coda, $_\sigma[\_\_\_$ = onset)
A $\rightarrow$ B	A becomes B...
C ___ D	...in the environment of C and D
C	Consonant
V	Vowel

Alternations

- We've seen that phonemes can be realized in different ways depending on context – position in a word, other sounds they are next to, etc.

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- We've seen that phonemes can be realized in different ways depending on context – position in a word, other sounds they are next to, etc.
- This can change the shape of words (or parts of words, called **morphemes**, which we'll get to later this week) in various (predictable) ways.

Alternations in English

[ɪn]	[ɪm]	[ɪŋ]
inappropriate	*impossible*	*incoherent*
intolerant	*imbalance*	*inglorious*
indecent		

- This is an example of **assimilation**
- Can target manner as well as place:

[s]	[z]	[əz]
rocks	*tabs*	*kisses*
sonorants	*derivations*	*churches*
obstruents	*eyes*	*judges*
births	*cars*	*wishes*

Two rules of English

[p^{h}e͡jːn]	*pain*	[spe͡jːn]	*Spain*
[t^{h}æk]	*tack*	[stæk]	*stack*
[k^{h}æt]	*cat*	[skæt]	*scat*

$$\begin{bmatrix} -\text{spr glottis} \\ -\text{continuant} \\ -\text{voice} \end{bmatrix} \longrightarrow [+\text{spr glottis}] \,/\, \#\_\_$$

- In prose:

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$$\begin{bmatrix} -\text{spr glottis} \\ -\text{continuant} \\ -\text{voice} \end{bmatrix} \longrightarrow [+\text{spr glottis}] \; / \#\_\_$$

- In prose:
- “Voiceless stops are aspirated in initial position”

Two rules of English

[pʰːæd]	*pad*	[pʰæt]	*pat*
[tʰiːð]	*teeth* (v.)	[tʰiθ]	*teeth* (n.)
[slæːb]	*slab*	[slæp]	*slap*

$$V \longrightarrow [+\text{long}] / \_\_ \begin{bmatrix} +\text{cons} \\ +\text{voice} \end{bmatrix}$$

- In prose:

Two rules of English

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$$V \longrightarrow [+\text{long}] \,/\, \_\_ \begin{bmatrix} +\text{cons} \\ +\text{voice} \end{bmatrix}$$

- In prose:
- “Vowels lengthen when followed by a voiced consonant”

Rule application and ordering

UR	/#slæp#/	/#pat#/	/#pad#/
Aspiration	–	p^hæt	p^hæd
V-length	–	–	p^hæːd
SR	[slæp]	[p^hæt]	[p^hæːd]

- Here, more than one rule can apply in the derivation

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- How do rules interact with one another?

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- Here, more than one rule can apply in the derivation
- How do rules interact with one another?
- Does the **order** in which the rules are applied matter?

Rule ordering: Kpelle

UR	*SR*	gloss
/N-polu/	[mbolu]	‘my back’
/N-tia/	[ndia]	‘my taboo’
/N-fela/	[mvela]	‘my waged’
/N-kɔɔ/	[ŋgɔɔ]	‘my foot’

Kpelle is a Mande language spoken in Guinea and Liberia.

/N/ is a [+nasal] segment, unspecified for place

Rule ordering: Kpelle

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/N-polu/	[mbolu]	‘my back’
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/N-kɔɔ/	[ŋgɔɔ]	‘my foot’

voicing assimilation: $C \rightarrow [+\text{voice}] / [+\text{nasal}]\ \_\_\_$

place assimilation: $[+\text{nasal}] \rightarrow [\alpha\text{place}] / \_\_\_\ [\alpha\text{place}]$

Rule ordering: Kpelle

Sometimes, rules can apply in any order:

UR	/#N-polu#/	/#N-kɔɔ#/
place assimilation	mpolu	ŋkɔɔ
voicing assimilation	mbolu	ŋgɔɔ
SR	[mbolu]	[ŋgɔɔ]
UR	/#N-polu#/	/#N-kɔɔ#/
voicing assimilation	Nbolu	Ngɔɔ
place assimilation	mbolu	ŋgɔɔ
SR	[mbolu]	[ŋgɔɔ]

Rule ordering: Kpelle

...but what if there were a third rule?

UR	*SR*	gloss
/N-polu/	[mbolu]	‘my back’
/N-tia/	[ndia]	‘my taboo’
/N-fela/	[mvela]	‘my waged’
/N-kɔɔ/	**[ŋɔɔ]**	‘my foot’

voicing assimilation:	$[-\text{voice}] \rightarrow [+\text{voice}] \,/\, [+\text{voice}]\ \_\_\_$
place assimilation:	$[+\text{cons}] \rightarrow [\alpha\text{place}] \,/\, \_\_\_\ [\alpha\text{place}]$
g-deletion:	$\text{g} \rightarrow \varnothing \,/\, [+\text{nasal}]\ \_\_\_$

Rule ordering: Kpelle

UR	/#N-polu#/	/#N-kɔɔ#/
place assimilation	mpolu	ŋkɔɔ
g-deletion	–	–
voicing assimilation	mbolu	ŋgɔɔ
SR	[mbolu]	[ŋgɔɔ] ŋɔɔ

Rule ordering: Kpelle

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g-deletion	–	–
place assimilation	mpolu	ŋkɔɔ
voicing assimilation	mbolu	ŋgɔɔ
SR	[mbolu]	[ŋgɔɔ] ŋɔɔ

Great success!

UR	/#N-polu#/	/#N-kɔɔ#/
place assimilation	mpolu	ŋkɔɔ
voicing assimilation	mbolu	ŋgɔɔ
g-deletion	–	ŋɔɔ
SR	[mbolu]	ŋɔɔ Hurrah!

Rule ordering: Kpelle

UR	/#N-polu#/	/#N-kɔɔ#/
voicing assimilation	mbolu	Ngɔɔ
g-deletion	–	Nɔɔ
place assimilation	mpolu	Nɔɔ
SR	[mbolu]	?[nɔɔ] ŋɔɔ

Rule ordering: Polish

sg	*pl*	gloss	*sg*	*pl*	gloss
klup	klubɨ	‘club’	ʒwup	ʒwobɨ	‘crib’
trup	trupɨ	‘corpse’	dom	domɨ	‘house’
snop	snopɨ	‘sheaf’	koʃ	koʃe	‘basket’
trut	trudɨ	‘labor’	wuk	wugɨ	‘lye’
nos	nosɨ	‘nose’	ruk	rogɨ	‘horn’
vus	vozɨ	‘cart’	wuk	wukɨ	‘bow’
lut	lodɨ	‘ice’	ul	ule	‘beehive’
nuʃ	noʒe	‘knife’	kot	kotɨ	‘cat’
grus	gruzɨ	‘rubble’	ʃum	ʃumɨ	‘noise’
ʒur	ʒurɨ	‘soup’	dzvon	dzvonɨ	‘bell’

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- Final obstruents are **always** voiceless in the singular

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- Final obstruents are **always** voiceless in the singular
- Same obstruents **sometimes** voiceless in the plural

Which rule is better?

sg	*pl*	gloss	*sg*	*pl*	gloss
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trup	trupɨ	‘corpse’	dom	domɨ	‘house’
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vos	vozɨ	‘cart’	wuk	wukɨ	‘bow’
lut	lodɨ	‘ice’	ul	ule	‘beehive’
nuʃ	noʒe	‘knife’	kot	kotɨ	‘cat’
grus	gruzɨ	‘rubble’	ʃum	ʃumɨ	‘noise’
ʒur	ʒurɨ	‘soup’	dzvon	dzvonɨ	‘bell’

- $[-\text{sonorant}] \rightarrow [+\text{voice}]$ / V ___ V
- $[-\text{sonorant}] \rightarrow [-\text{voice}]$ / ___ #

Which rule is better?

$$[-\text{sonorant}] \rightarrow [+\text{voice}] \text{ / V \_\_ V}$$

(Targets [−voice] obstruents)

UR	/#klup + ɨ#/	/#truP+ ɨ#/
voicing	klubɨ	trupɨ
SR	[klubɨ]	[trupɨ]
UR	/#wuk + ɨ#/	/#wuK + ɨ#/
voicing	wugɨ	wukɨ
SR	[wugɨ]	[wukɨ]

All obstruents are underlyingly voiceless, but only some undergo intervocalic voicing

Which rule is better?

$$[-\text{sonorant}] \rightarrow [-\text{voice}] \; / \; \_\_ \; \#$$

(Targets [+voice] obstruents)

UR	/#klub#/	/#trup#/
devoicing	klup	–
SR	[klup]	[trup]
UR	/#wug#/	/#wuk#/
devoicing	wuk	–
SR	[wuk]	[wuk]

Obstruents are underlyingly specified for voicing

Which rule is better?

$$[-\text{sonorant}] \rightarrow [-\text{voice}] \; / \; \_\_ \; \#$$

sg	*pl*	gloss	*sg*	*pl*	gloss
klup	klubɨ	‘club’	ʒwup	ʒwobɨ	‘crib’
trup	trupɨ	‘corpse’	dom	domɨ	‘house’
snop	snopɨ	‘sheaf’	koʃ	koʃe	‘basket’
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....for two reasons:

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1. The existence of non-alternating stems: why have two types of underlyingly voiceless segment?

Which rule is better?

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2. The non-existence of [+voice] obstruents stem-finally: why should this be an accident?

But wait a second

Something else is going on here...

sg	*pl*	gloss	*sg*	*pl*	gloss
klup	klubɨ	‘club’	ʒwup	ʒwobɨ	‘crib’
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Another problem

/u/ → [o] / plural forms?

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But then why *ʒur, ʒurɨ* ‘soup’, *ul, ule* ‘beehive’?

Another problem

/o/ → [u] / singular forms?

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But then why *snop, snopɨ* ‘sheaf’, *kot, kotɨ* ‘cat’?

Vowel raising comes first...

$$\begin{bmatrix} -\text{cons} \\ +\text{back} \\ -\text{high} \end{bmatrix} \longrightarrow [+\text{high}] \,/\_\_ \begin{bmatrix} +\text{voice} \\ -\text{nasal} \end{bmatrix} \#$$

UR	/#ʒwob#/	/#snop#/
***o*-raising**	**ʒwub**	**–**
devoicing		
SR	[ʒwup]	[snop]
UR	/#ʒwob+ɨ#/	/#snop+ɨ#/
***o*-raising**	**ʒwubɨ**	**–**
devoicing		
SR	[ʒwubɨ]	[snopɨ]

...followed by final devoicing

$$[-\text{sonorant}] \rightarrow [-\text{voice}] \; / \; \_\_ \; \#$$

UR	/#ʒwob#/	/#snop#/
o-raising	ʒwub	–
devoicing	**ʒwup**	–
SR	[ʒwup]	[snop]
UR	/#ʒwob+ɨ#/	/#snop+ɨ#/
o-raising	ʒwubɨ	–
devoicing	–	–
SR	[ʒwubɨ]	[snopɨ]

Ordered otherwise, vowel raising wouldn't occur:

The two rules are crucially ordered in Polish: the reverse order would yield the wrong singular forms.

UR	/#ʒwob#/	/#snop#/
devoicing	ʒwop	–
raising	–	–
SR	*[ʒwop]	[snop]
UR	/#voz#/	/#koʃ#/
devoicing	vos	–
raising	–	–
SR	*[vos]	[koʃ]

Outline

Syllables

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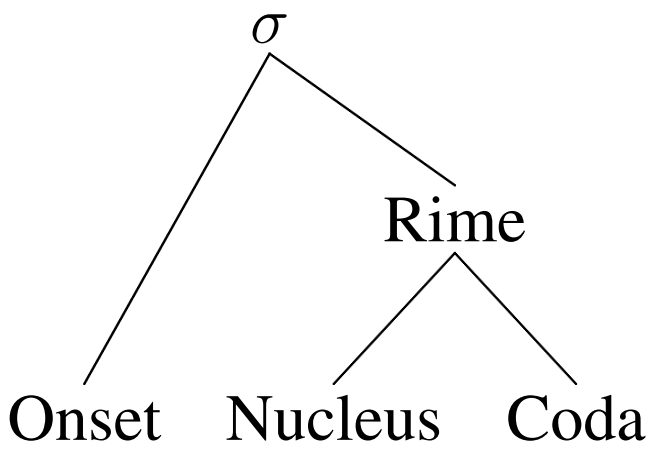
- Since segments are made up of features, the processes have made reference to feature matrices
- Phonological processes can also make reference to **syllable structure**

Syllable structure

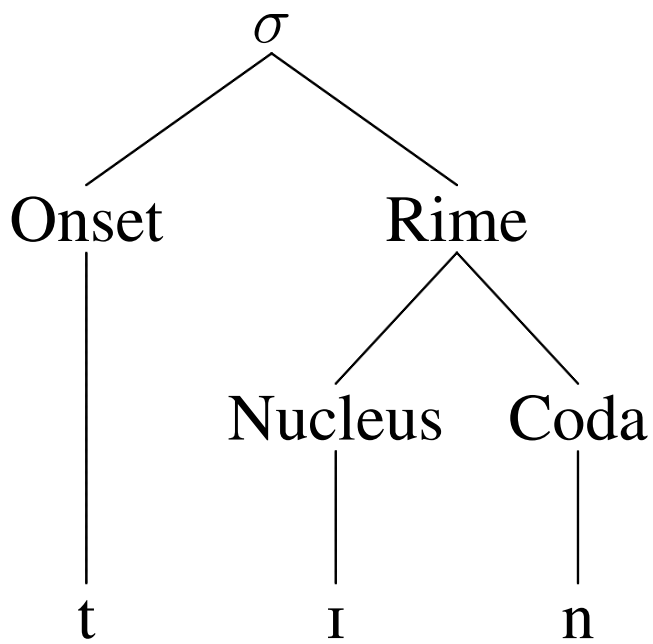
Syllables consist of an **onset**, a **nucleus** and a **coda**.



The nucleus and coda form the **rime** (or *rhyme*).

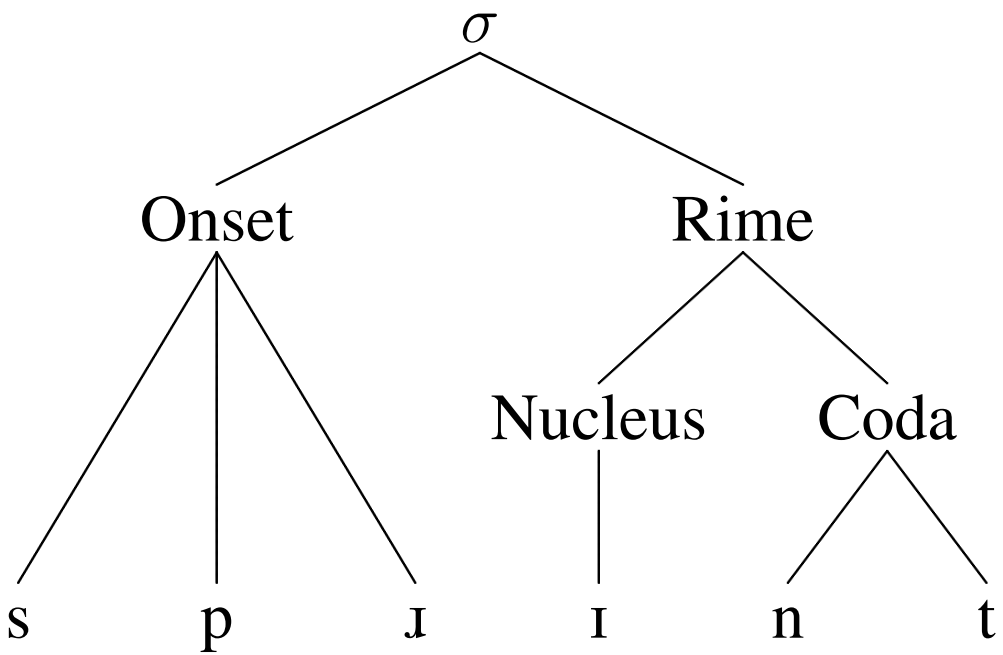
Syllable structure

Onsets and codas may contain a single segment...



Syllable structure

...or multiple segments:



Why syllables?

- Recall one of the fundamental things we know when we know a language: the set of not just actual but also **possible** words

flabble	prznk	spronk	mbil
squirthy	prlauiop	stroimpt	treh
keladulance	trozzit	ztreet	flampidator

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- This set of restrictions are called **phonotactics**
- The restrictions on segment sequences in onsets may not be the same as in codas.

Language games: Pig Latin

- More evidence for syllables: language games

pit	it-pay	*me*	e-may
see	ee-say	*I*	i-way
spit	it-spay	*stink*	ink-stay
stretch	etch-stray	*sixth*	ixth-say

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- What is happening here?
- The game doesn't target the initial *consonant*...
- ...but rather the entire *onset*.

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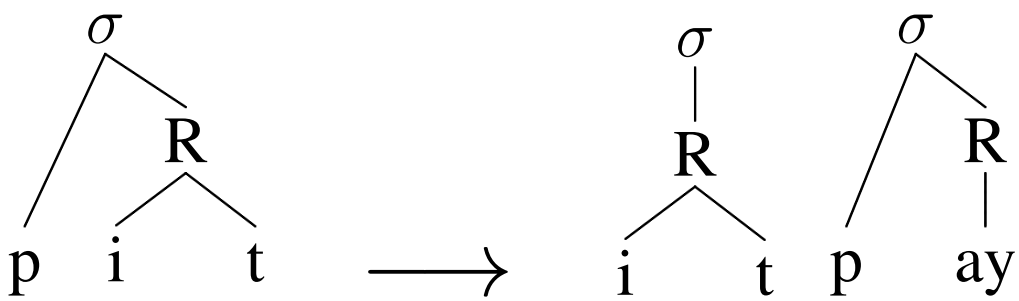

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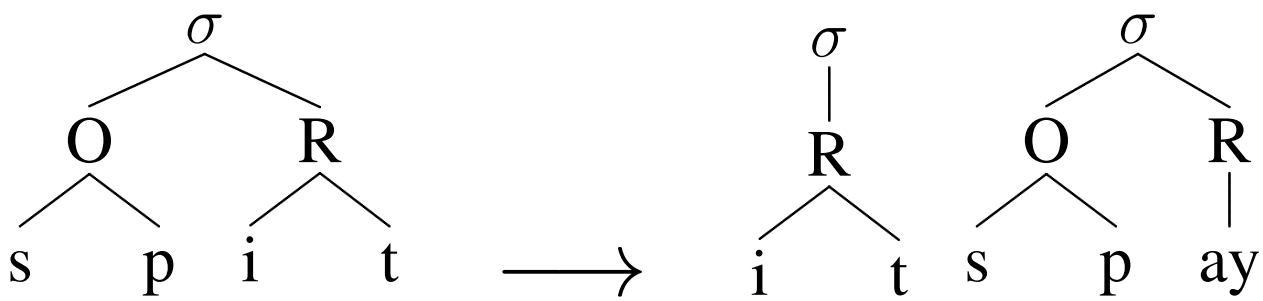

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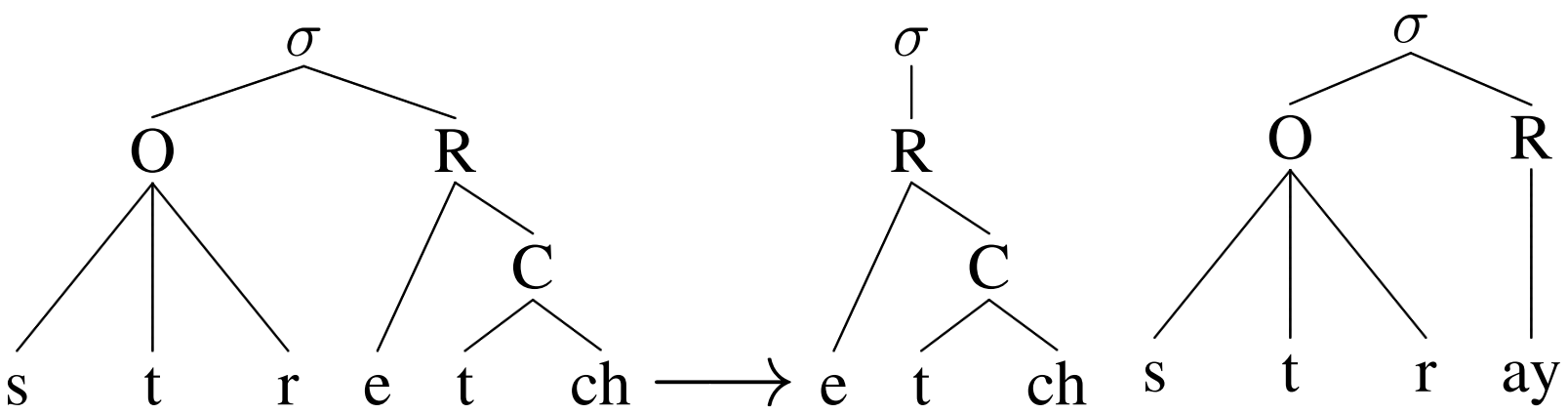

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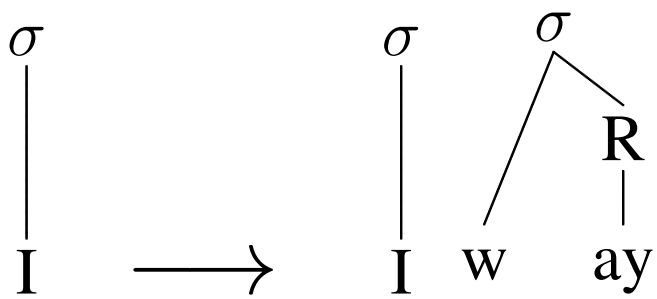

Syllabification

- Language-specific restrictions on how segments are organized (**parsed**) into syllables represent another aspect of subconscious linguistic knowledge.

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print
improvise
explain

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applaud	[ə.plɔd]
telegraph	[tɛ.lə.gɹæf]
print	[pɹɪnt]
improvise	[ɪm.pɹə.vaɪz]
explain	[ɛk.splen]

Syllabification

- Generally speaking, segments can't just combine willy-nilly in the various positions

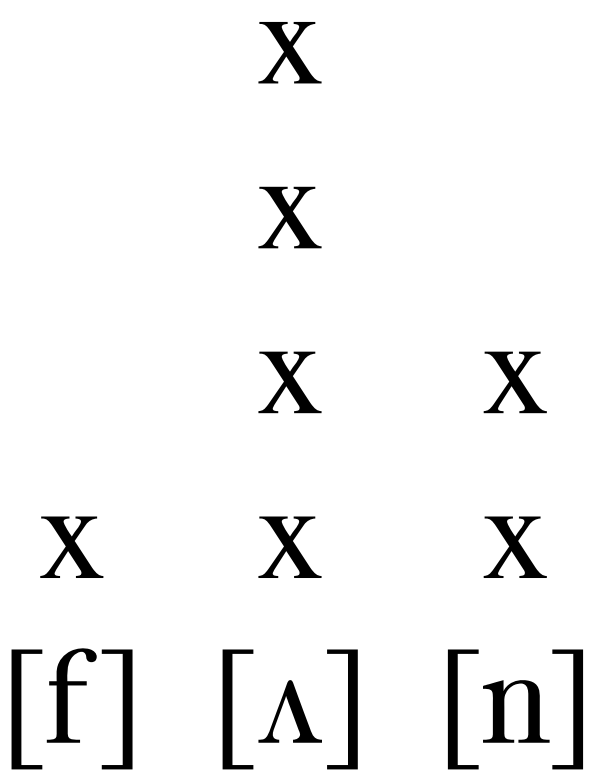
Syllabification

- Generally speaking, segments can't just combine willy-nilly in the various positions
- Languages tend to arrange segments within syllables in such a way so that the **least sonorous** sounds are at the margins, and the **most sonorous** (often, but not always, a vowel) are in the middle (nucleus).

The sonority hierarchy

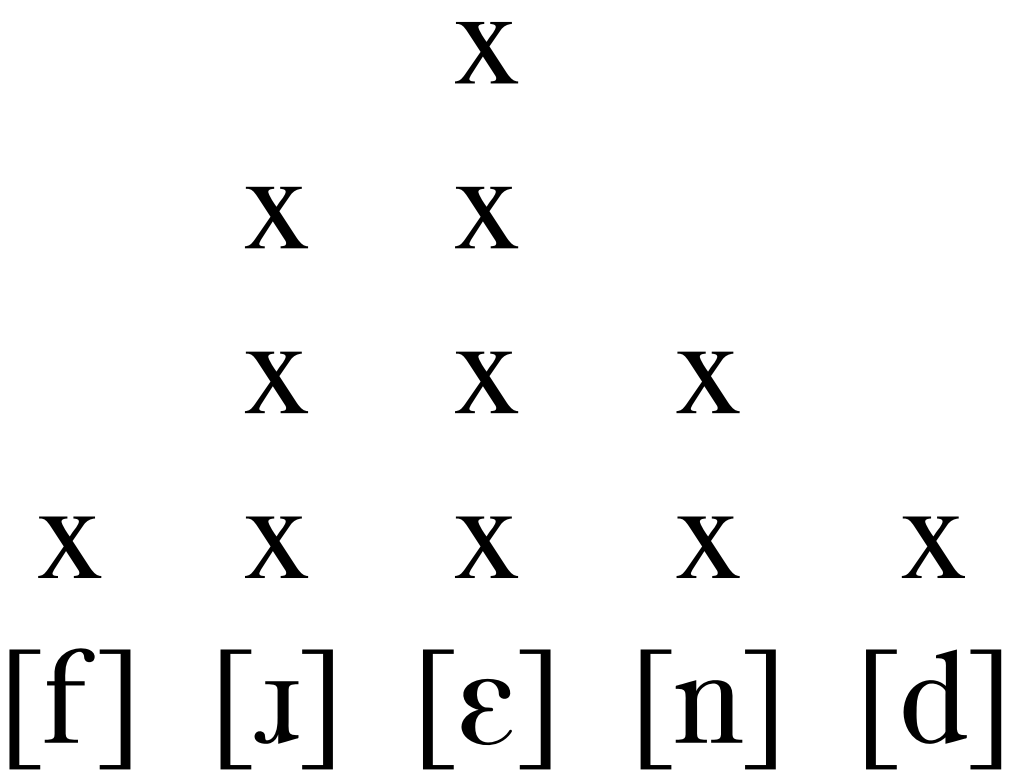
x						
x		x				
x		x		x		
x		x		x		x
vowels	>	liquids	>	nasals	>	obstruents

The sonority hierarchy



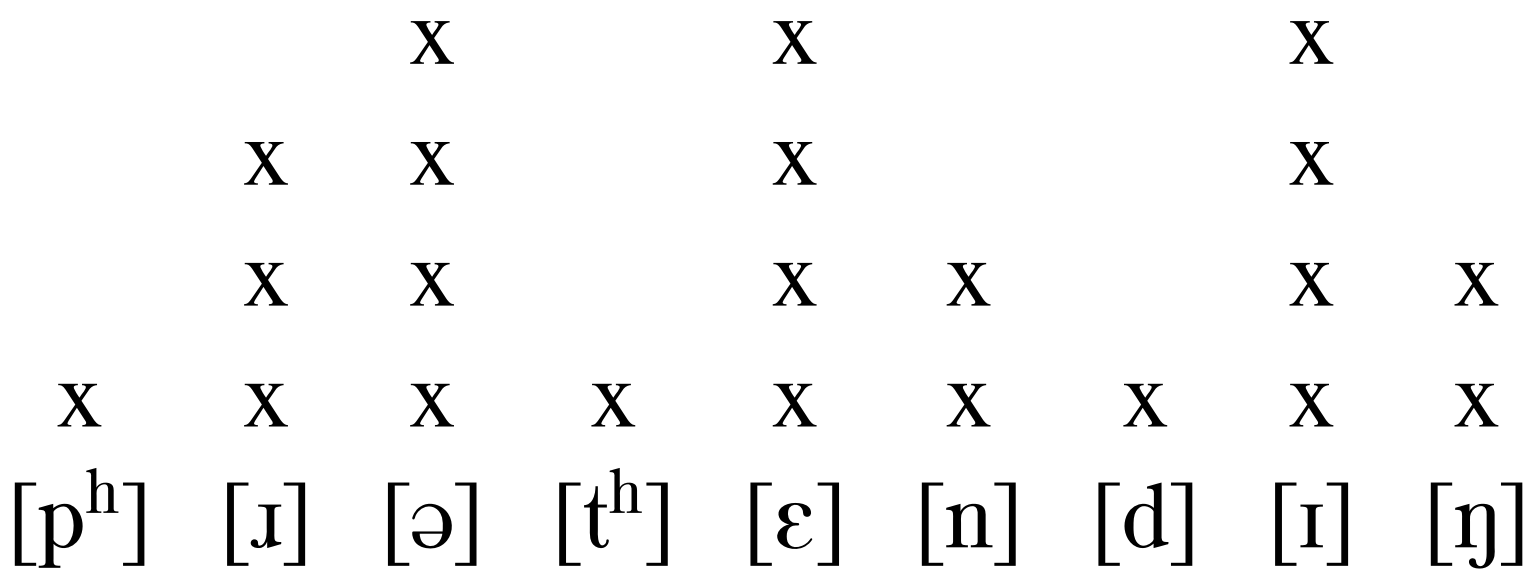
‘fun’

The sonority hierarchy



‘friend’

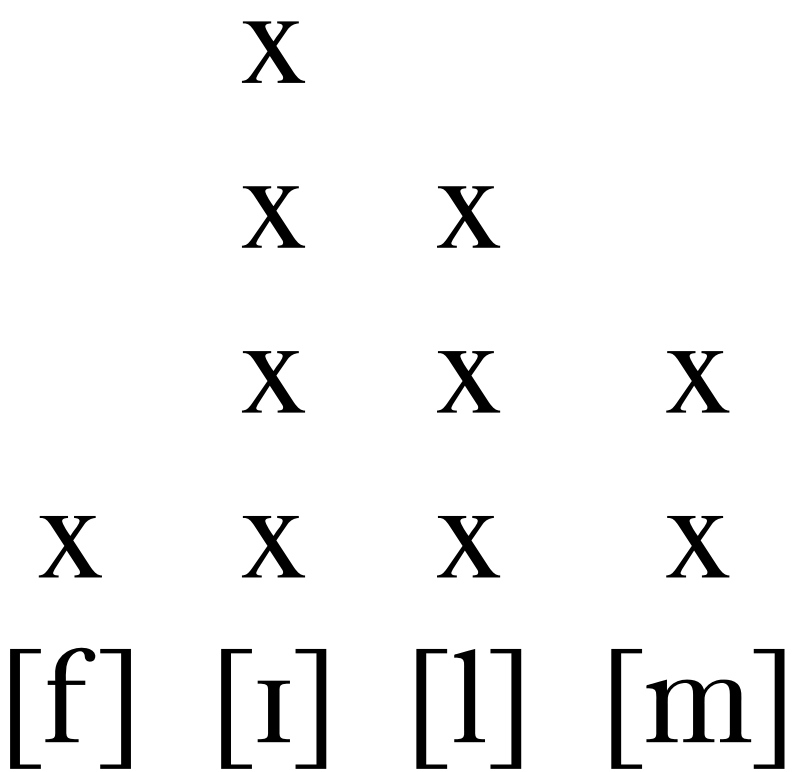
The sonority hierarchy



‘pretending’

The sonority hierarchy

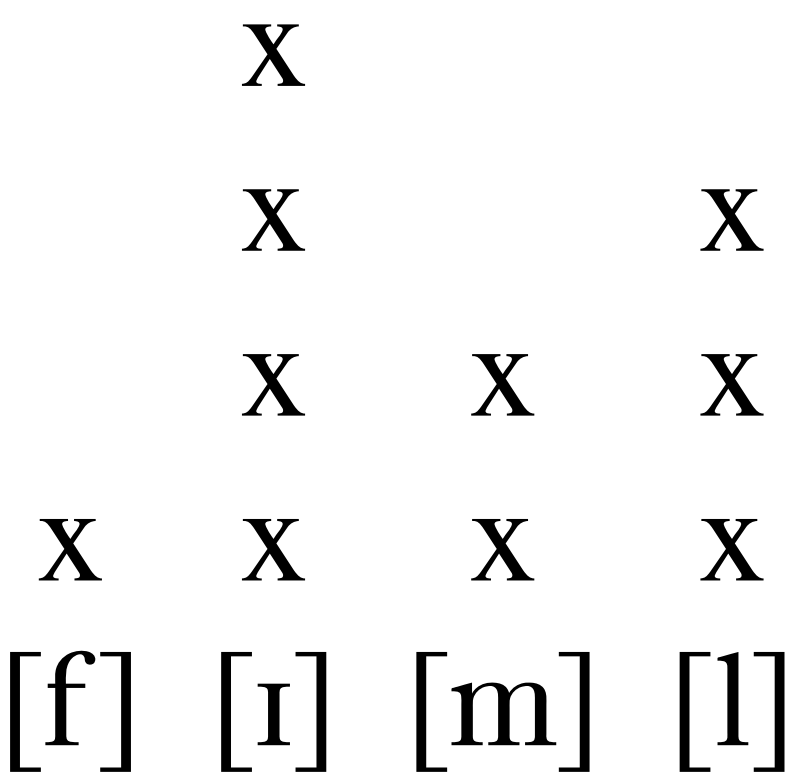
This explains why words like *film* are one syllable...



'film'

The sonority hierarchy

but hypothetical *fiml* would be two:



(cf. *pummel, drivel*)

Sonority: nuclei

- In a form like *pummel*, the consonant serves as the sonority peak in the second syllable

Sonority: nuclei

- In a form like *pummel*, the consonant serves as the sonority peak in the second syllable
- English allows nasals and liquids to serve as syllabic nuclei, at least in unstressed syllables:

[pɹɪzm]	*prism*	[hɪdn̩]	*hidden*
[bɑɾm̩]	*bottom*	[bʌdn̩]	*button*
[bɑɾl̩]	*bottle*	[haj͡ɹ̩]	*higher*
[lɪɾl̩]	*little*	[bʌɾɹ̩]	*butter*

Sonority: onsets

- Sonority considerations also govern what consonants can serve as an onset cluster

Sonority: onsets

- Sonority considerations also govern what consonants can serve as an onset cluster
- In general, sonority has to go up two steps (i.e. obstruent > liquid):

actual words			
[bɹɪk]	*brick*	[fli]	*flea*
[kɹæb]	*crab*	[glɪb]	*glib*
(im)possible words			
[bɹæp]	*[bnæp]	[klig]	*[knig]
[kɹæθ]	*[kdæθ]	[glɪk]	*[lgɪk]

What about [s]?

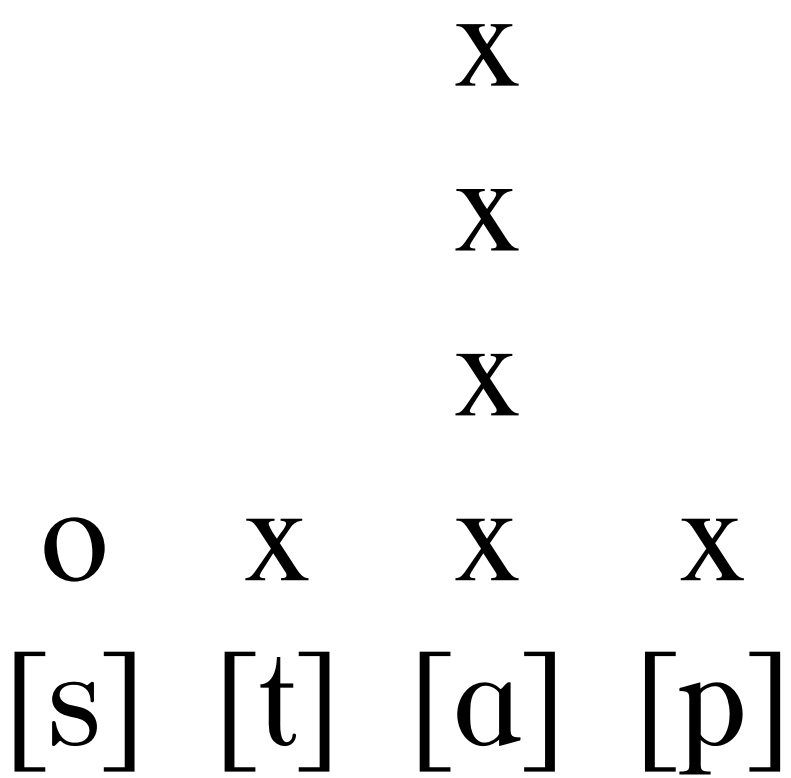
English onsets may actually contain up to *three* consonants:

[pl]	please	[tl]	–	[kl]	clean
[pɹ]	proud	[tɹ]	trade	[kɹ]	crowd
[pw]	–[1]	[tw]	twin	[kw]	quick
[pj]	pure	[tj]	tune (UK)	[kj]	cute
[spl]	splash	[stl]	–	[skl]	sclerotic
[spɹ]	spring	[stɹ]	-string	[skɹ]	scream
[spw]	–	[stw]	–	[skw]	squeak
[spj]	spew	[stj]	stew (UK)	[skj]	skewer

[1] *Puerto Rico*?

What about [s]?

[s] ‘doesn’t count’ in English for onset sonority purposes:



‘stop’

What about [s]?

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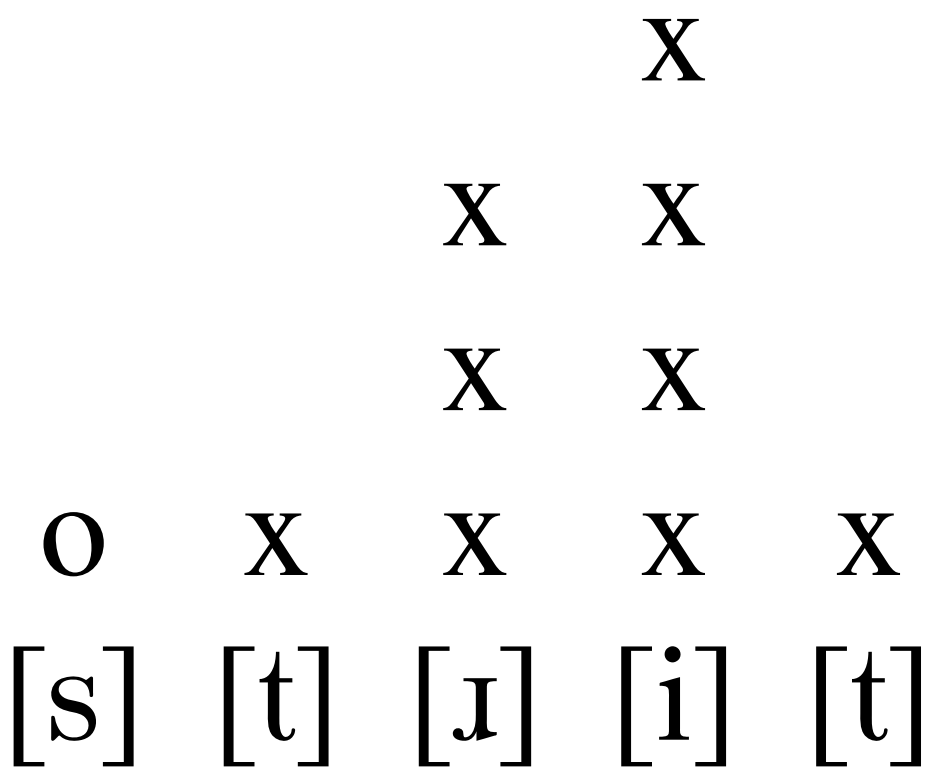

‘street’

Cross-linguistic tendencies in syllable structure

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Cross-linguistic tendencies in syllable structure

- Languages generally like consonants in the onset
- We say that they **prefer** consonants in this position
- Similarly, many languages **dispref**er coda consonants, such as Polynesian languages:

Tongan (Austronesian, Malayo-Polynesian)

- Tongan prohibits coda consonants altogether:

[ta.ŋa.ta]	‘man’
[ta.ma.si.ʔi]	‘child’
[fa.ka.he.ke.he.ke.ʔi]	‘persuade’

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- However, it requires onsets.
- Tongan permits just a single syllable type: CV

Japanese

- Japanese allows only CV, V, CVN, and CVC syllables, but restricts CVC to word-internal positions.

CV, V		*CVN, CVC*	
[ki]	‘tree’	[tom.bo]	‘dragonfly’
[ko.ko.ro.]	‘heart’	[neŋ.kin]	‘pension’
[ma.do]	‘window’	[kit.te]	‘stamp’
[i.to]	‘string’	[hak.ka]	‘peppermint’

Japanese

- We can see more evidence for this in loanwords:

word	*English*	*Japanese*
‘pin’	[pɪn]	[pin]
‘Chicago’	[ʃɪ.ka.go]	[ʃi.ka.go]
‘million’	[mɪ.li.jən]	[mi.ri.on]
‘free’	[fɹi]	[fɯ.riː]
‘peak’	[pik]	[piː.kɯ]
‘baseball’	[be͡js.bɔl]	[ba.sɯ.ba.rɯ]

Czech

- Czech allows up to **four** onset Cs, and three in codas:

VC	[on]	‘he’	CV	[to]	‘that’
CVC	[sin]	‘son’	CVC	[dej]	‘give (imp.)’
CCVC	[jdu]	‘I go’	CCVCC	[trest]	‘punishment’
CCCVC	[strom]	‘tree’	CVVCCC	[za:pst]	‘to freeze’
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- Liquids can serve as syllabic nuclei:

strč	prst	skrz	krk
stick (imp.)	finger	through	neck

English

V	*I*	[a͡j]
CV	*me*	[mi͡j]
CCV	tree	[tɹi͡j]
CCCV	spray	[spɹe͡j]
VC	*eat*	[i͡jt]
VCC	*oats*	[o͡wts]
VCCC	*eighths*	[e͡jtθs]
CVC	*bit*	[bɪt]
CCVC	*spit*	[spɪt]
CCCVC	*split*	[splɪt]
CCCVCC	*splits*	[splɪts]
CCCVCCC	*splints*	[splɪnts]
CCCVCCCC	*strengths*	[stɹɛŋkθs]

Cross-linguistic tendencies in syllable structure

language	V	CV	CVC	VC	CCV	CCVC	CVCC	VCC	CCVCC	CVCCC
Hua		*								
Cayuvava	*	*								
Cairene Arabic		*	*							
Mazateco	*	*			*					
Mokilese	*	*	*	*						
Sedang		*	*		*	*				
Klamath		*	*				*			*
Spanish	*	*	*	*	*	*				
Finnish	*	*	*	*		*	*	*		
Totonac		*	*		*	*	*		*	*
English	*	*	*	*	*	*	*	*	*	*

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- Tendencies are just that: tendencies
- Occasionally, you find a language that seems to flaunt sonority...
- ...and allows consonants basically **anywhere**.

Nuxálk (Bella Coola) (Salish)

ɬq	‘wet’
t’χt	‘stone’
sχs	‘seal fat’
χscc’	‘I’m now fat’
ɬχ^{w}tɬcx^{w}	‘You spat on me’

Tashlhiyt Berber (Afro-Asiatic, Berber)

ks		‘feed on’
kks		‘take off’
kkstt		‘take it off (fem.)’
tkkststt		‘you took it off (fem.)’
tɕtft		‘it dried’
fqqs		‘irritate’
ftsχt		‘you cancelled’
sfqqst		‘irritate him’
tftχtstt		‘you dried it (fem.)’
tsskɕftstt		‘you dried it (fem.)’

(Carrier phrase *innajas* . . . *jat twalt* ‘he told him . . . once’)

Syllabic phonology

- So...what else are syllables good for?

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- So...what else are syllables good for?
- Phonological processes often target syllables
- This lets our rules reference them, w00t!

Sensitivity to syllable structure: English aspiration

[pʰæn]	pan	[spæn]	span
[pʰejn]	pain	[spejn]	Spain
[pʰowk]	poke	[spowk]	spoke
[tʰown]	tone	[stown]	stone
[kʰɪn]	kin	[skɪn]	skin
[ˌpʰɹ̩ˈspajɹ]	perspire	[splæt]	splat
[ˌtʰəˈmerow]	tomato		
[ˌəˈkʰoɹd]	accord	[ˌækˈsɛpt]	accept
[ˌəˈpʰɔn]	upon	[ˌʌpˈsɛt]	upset
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Environment	*aspirated*	*unaspirated*
syllable-initially	yes	no
elsewhere	no	yes

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$$\begin{bmatrix} -\text{spr glottis} \\ -\text{continuant} \\ -\text{voice} \end{bmatrix} \longrightarrow [+\text{spr glottis}] \,/\, \sigma[\_\_\_$$

"Voiceless stops are aspirated in **syllable-initial** position"

Sensitivity to syllable structure: Brazilian Portuguese

[max]	*mar*	'ocean'
[falax]	*falar*	'to speak'
[marɪz]	*mares*	'oceans'
[falara]	*falará*	's/he will speak'

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- /r/ has two allophones, [x] and [r]
- How can we describe their distribution?

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- If we know something about syllable structure...
- "/r/ is realized as [x] in coda position"

Sensitivity to syllable structure: Korean

root	*root + vowel initial suffix*	*root + consonant initial suffix*
/palp/ ‘tread on’	palp + a ‘treading on’	pap + t’a ‘to tread on’
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- ...and it can only syllabify when a vowel-initial suffix is added...
- ...because Korean doesn’t allow multiple Cs in the coda.

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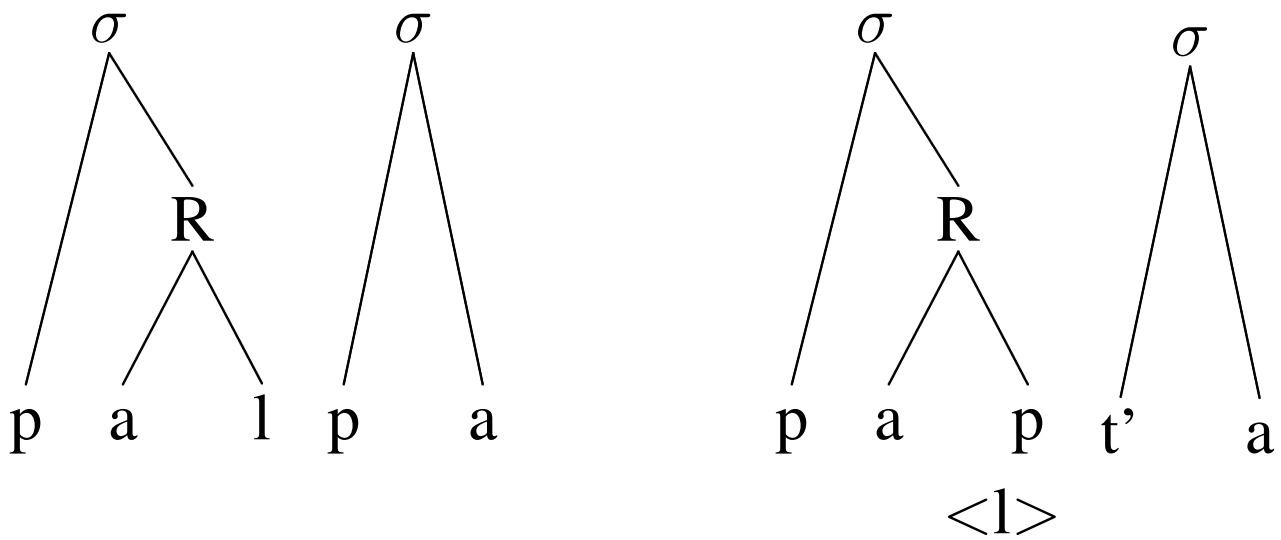

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- Segments are represented as a collections of features (**feature bundles**)
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- Rules can also be crucially **ordered** with respect to one another

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- Phonological representations contain more than segments...they can also include information about higher level structure such as **syllables**
- Phonological rules can make reference to this higher-order structure as well