−	−	−	−	−	−	−	−	+	−	−	−	0	0	0	−	−	0	0
−	−	−	−	−	+	−	−	+	−	−	−	0	0	0	−	−	0	0
+	−	−	−	−	−	−	−	+	−	−	−	0	0	0	−	−	0	0
+	−	−	−	−	+	−	−	+	−	−	−	0	0	0	−	−	0	0
0	−	−	−	+	+	−	−	+	−	−	−	0	0	0	−	−	0	0

UCI Teaching Demo

Phonology and Phonological Features

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LSCI 3: Introduction to Linguistics
26 February 2025

After this lesson, you should be able to:

- Recall the important dimensions of phonological contrast between speech sounds
- Describe the relationship between phonemes in terms of their phonological features
- Formulate phonological rules for systematic sound changes in English using your knowledge of phonological features
- Interpret a non-English corpus and identify the ongoing phonological processes within

- **Phonetics**: The study of how humans produce and understand speech
  - **Descriptive**: phonetics describes real-world language usage
  - Subdisciplines: acoustic, articulatory, auditory phonetics
- **Phonology**: The study of sound systems
  - **Theoretical**: phonology theorizes how phonemes are fundamentally organized
  - Subdisciplines: phonotactics, phonological alternation
- Not completely separate – phonological theories are built on phonetic data

- A **phoneme** is the minimal unit of distinction between words
  - Test: minimal pairs
- Not to be confused with **grapheme** (minimal unit for a writing system)
  - Sometimes, phonemes and graphemes are the same. Less often in English 😬
- **Phonotactics:** Different languages "carve up" the acoustic space into phonemes differently
- The **International Phonetic Alphabet (IPA)** is a language-independent way to transcribe phonemes

🇦🇲

Orthography	IPA	Meaning
տակ	/tak/	*under*
տաք	/takʰ/	*hot*

minimal pairs

🇺🇸

Orthography	IPA	Meaning
talk	/tak/	*talk*
talk	/takʰ/	*...still talk*

allophones

Aspiration is phonemic in Armenian but not in English

- Speech sounds are **surface representations** of deep-seated **underlying** (phonemic) **representations**
  - Surface reps. are the spoken sounds
  - Underlying reps. are the mental organization of the sounds spoken
- For IPA, surface reps. are transcribed [in brackets] and underlying reps. are transcribed /in forward slashes/
  - 🐈 - /kæt/ vs. [kʰæt̚]
  - 👩🏻‍🏫 - /kəɹtɛf/ vs. ['kəˑɾəf]

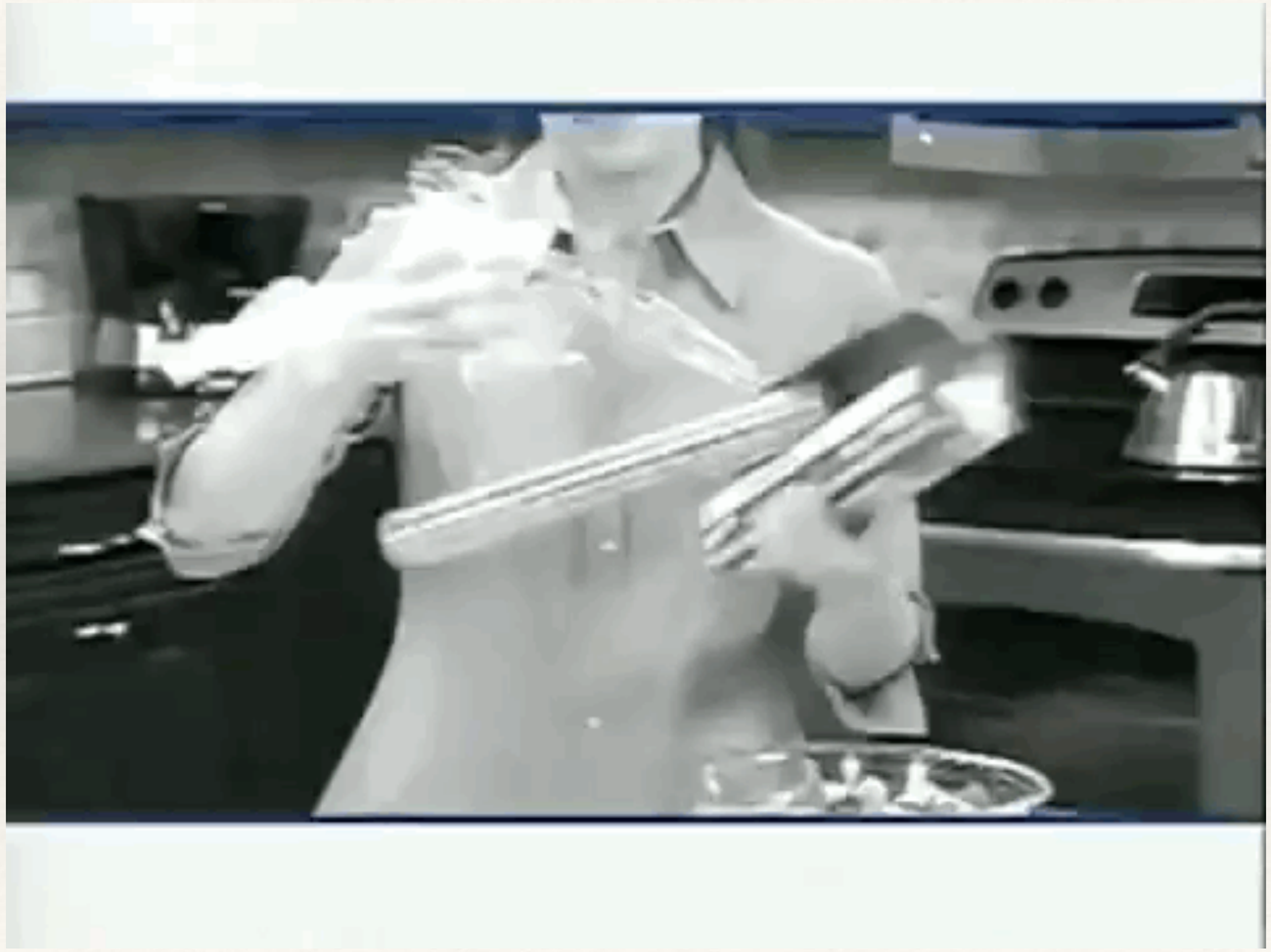
- **Phonological alternation**: The specific surface representation of an underlying representation is usually predictable given the context of the sound
  - Alternations can also be morphological or syntactic, but that's a topic for another day!
- A phonologist writes **phonological rules** to capture that sound change
  - Phonological rules tell us the context in which we can expect specific allophones
  - Context can be the start of a word (#_), the end of a word (_#), after a vowel (V_), between consonants (C_C), the list goes on...

/UR/ → [SR] / context

The typical form for a phonological rule

Description of Rule	*Example*	*Formalization*
Words that start with a vowel will have a glottal stop inserted	/æpəl/ → [ʔæpəl]	/Ø/ → [ʔ] / #_V
Intervocalic /ɹ/ is tapped	/bʌtəɹ/ → [bʌɾəɹ]	/r/ → [ɾ] / V_V
A vowel in between two nasal consonants becomes nasal itself	/nænsi/ → [næ̃nsi]	/æ/ → [æ̃] / n_n
The plural -s becomes voiced if the phoneme before it is voiced	/dɑgs/ → [dɑgz]	/s/ → [z] / g_#
The plural -s becomes voiced if the phoneme before it is voiced	/kɹoʊs/ → [kɹoʊz]	/s/ → [z] / oʊ_#

There's got to be a better way!

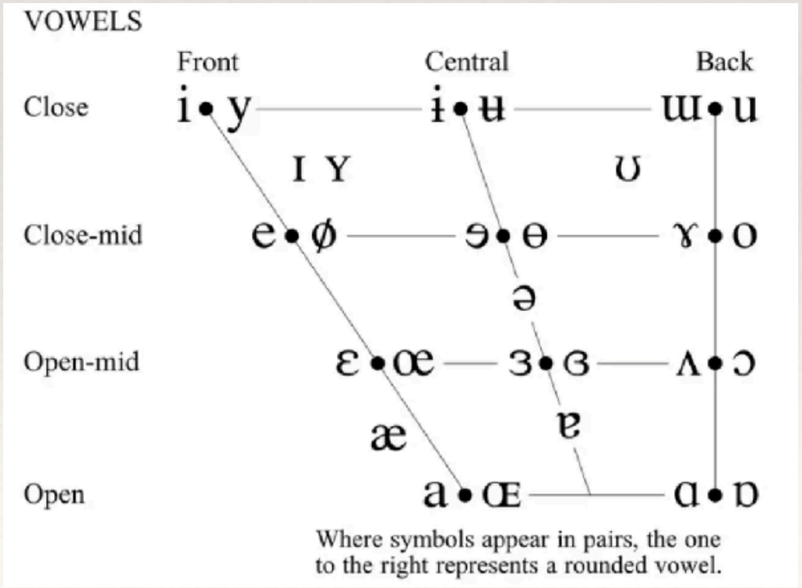


- We don't have to write out a phonological rule for every single instance of a sound change if there's some observable pattern
- Multiple phonemes can be grouped into **natural classes**
  - Phonological rules can apply to all members of a natural class
  - Consonants: place, manner, voicing
  - Vowels: height, laterality, roundness

CONSONANTS (PULMONIC) ©①◎ 2020 IPA

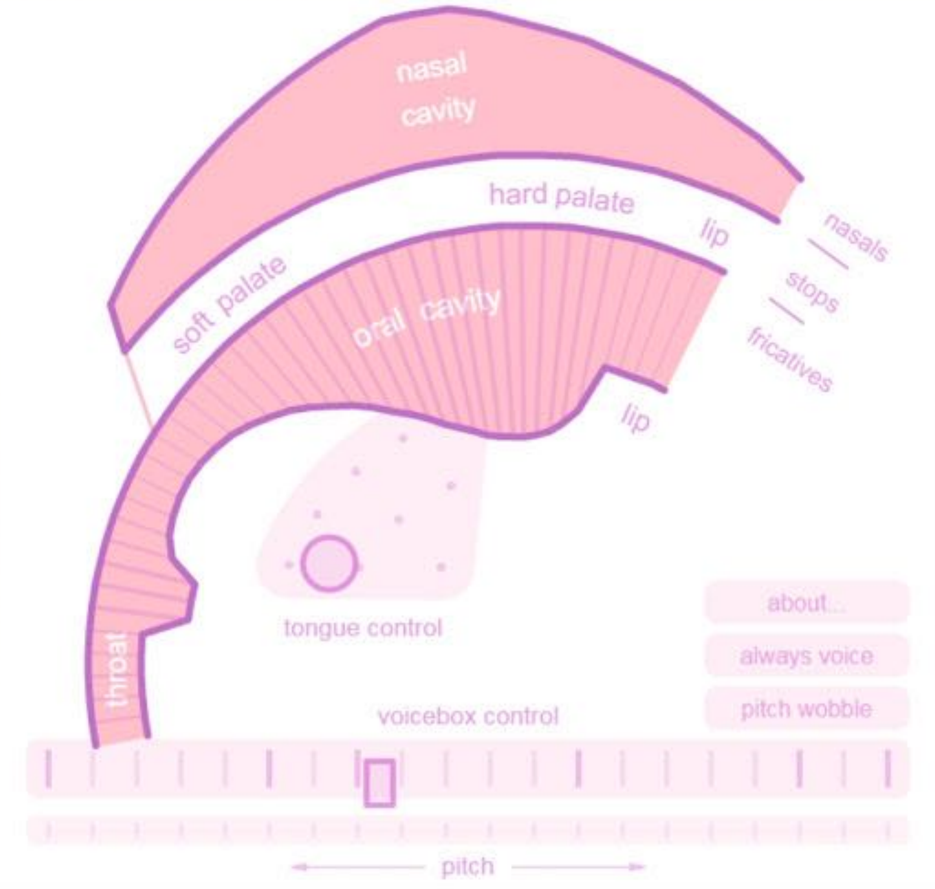
	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k g	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		
Trill	ʙ			r					ʀ		
Tap or Flap		ⱱ		ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	ʟ			

Symbols to the right in a cell are voiced, to the left are voiceless. Shaded areas denote articulations judged impossible.

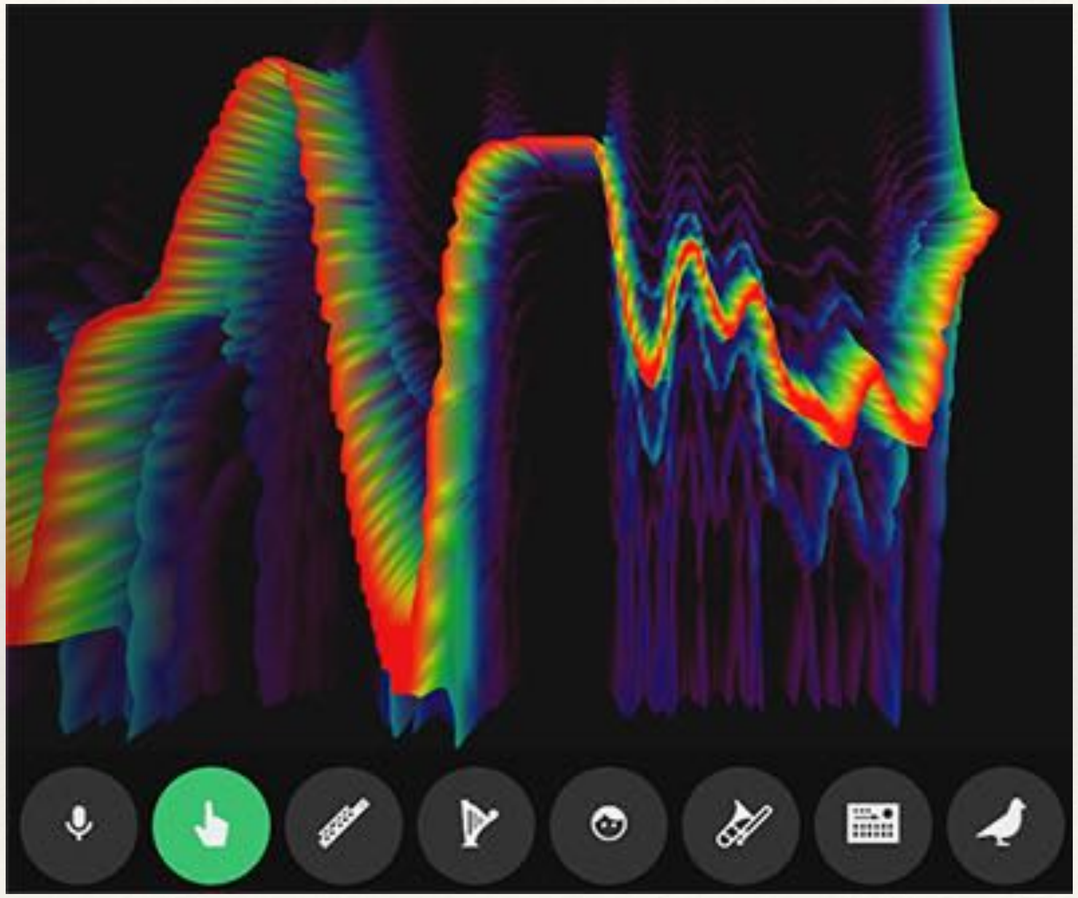


- **Place of articulation:** Where the vocal tract is constricted
  - Labial (lips)
  - Dental (teeth)
  - Coronal (hard palate)
  - Velar (soft palate)
  - Pharyngeal
  - Glottal
- **Manner of articulation:** How the vocal tract is constricted
  - Plosive (stop): complete constriction of vocal tract
  - Fricative: narrow gap in vocal tract creates turbulent airflow
  - Approximants: Very little obstruction
  - Nasals: oral tract is closed but nasal passage is open
- **Voicing:** Whether or not the vocal folds are vibrating during the sound

Visualizing place and manner



Pink Trombone

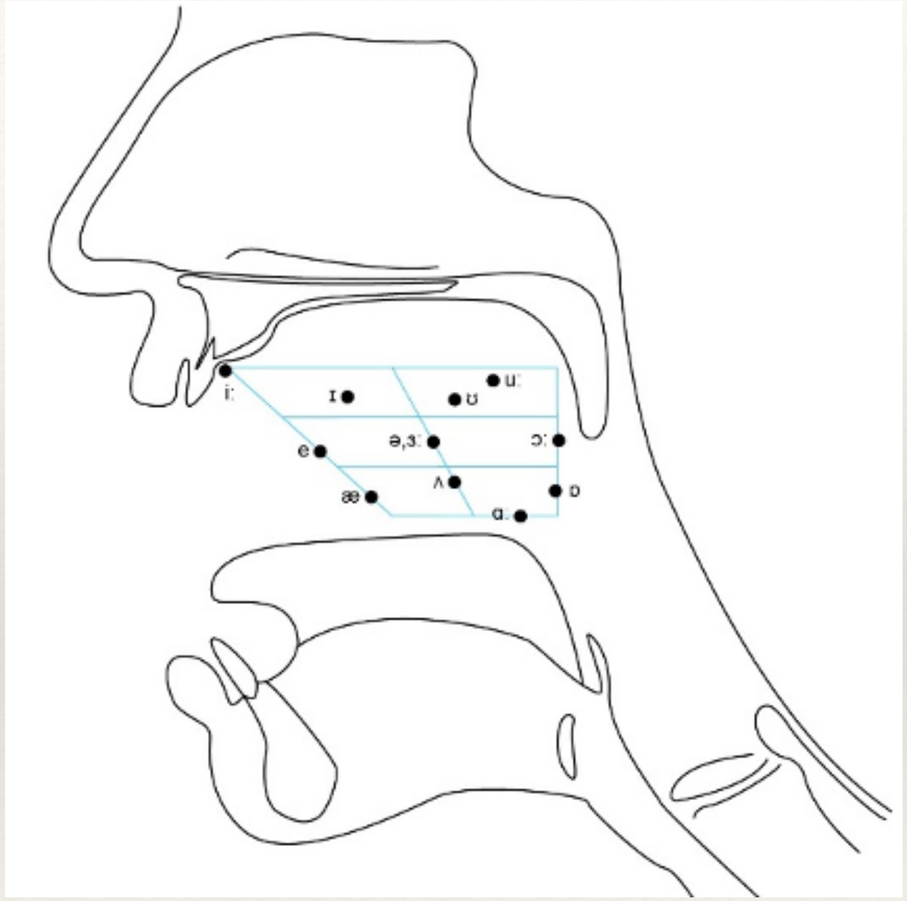


Chrome Music Labs Spectrogram

Vowel's don't have a place or manner of articulation because the vocal tract is unconstricted; instead, vowels vary in their:

- **Height** (AKA openness): up/down position of tongue in mouth
- **Backness**: the front/back position of the tongue in the mouth
- **Roundness:** whether or not the lips are rounded

(Voicing contrasts apply to vowels too, just not in English)



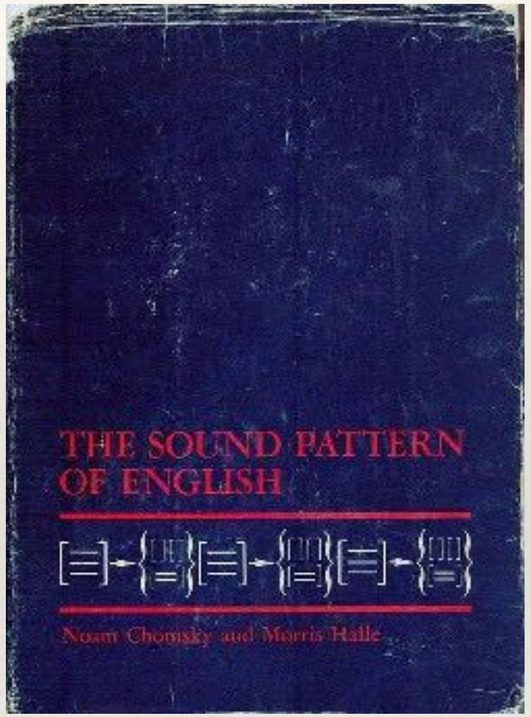
Visualizing (tasting?) vowel height and laterality

- Sometimes phonological rules apply to certain classes (place/manner/height, etc...)
- **Phonological feature theory** is a way to describe phonemes that makes generalizing rules across these **natural classes** easier
- A phoneme can be described using a **feature matrix** complementary to its IPA symbol
  - Binarized (presence/absence of features marked with +/-)

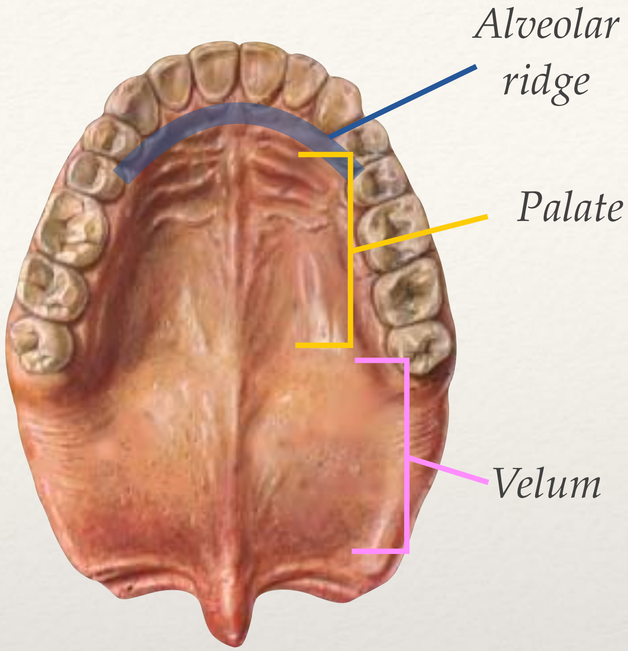
Orthog.	ram		
IPA	/ɹ/	/æ/	/m/
Ex. Feature Matrix	-syllabic +sonorant -stop +approx. -nasal +alveolar -labial +voice	+syllabic +sonorant +low -back +front -round +voice	-syllabic -sonorant +stop -approx. +nasal -alveolar +labial +voice

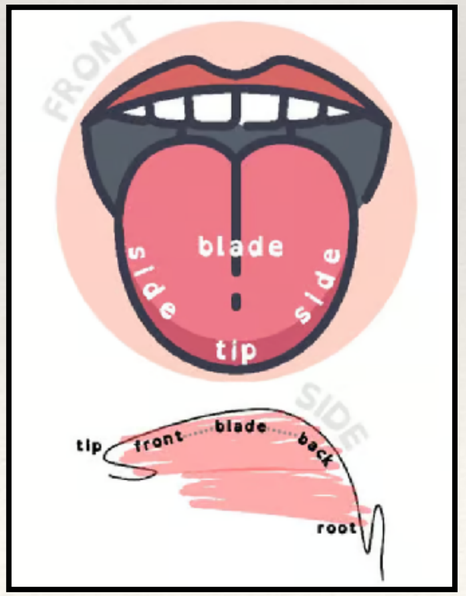
Feature	*Description*	*Ex. Phonemes (+)*	*This feature distinguishes:*
(P) labial	articulated with the lips	b, p, m, f	+: labial, labiodental -: other places
(P) labiodental	articulated with lower lip & upper teeth	f, v	+: labiodentals -: other places
(P) coronal	articulated with the tongue blade / tip	t, ʒ	*this gets its own slide*
(P) lateral	articulated with the medial tongue; air proceeds around sides	l	+: laterals -: everything else
(P) dorsal	articulated with the tongue body	k, ŋ	*this gets its own slide*
(M) continuant	whether or not there is complete *oral* closure of the vocal tract	ʃ, a, ɹ	+: fricatives -: stops & nasals
(M) delayed release	for [-continuant] sounds, when the constriction is released	tʃ, dʒ	+: affricates & fricatives -: stops
(M) trill	a consonant produced by vibrating an	r	+: trills
(M) tap	a consonant produced by a single constriction of an articulator without a pressure buildup	ɾ	+: taps -: other manners
(M) sonorant	loudness (sort of)	m, ɹ, l	*this gets its own slide*

(P) is a place of articulation feature; (M) is a manner of articulation feature



- Coronals (tongue blade/tip) can be distinguished using these features:
  - [anterior]: articulated at the alveolar ridge or further forward
  - [distributed]: articulated with the blade (+) or tip (-) of tongue
  - [strident]: reserved for coronal fricatives and affricates, which are louder than nonstrident fricatives and affricates
  - [lateral]: I covered this on the last slide but it's basically just /l/, /ɬ/, and /ɮ/
- Dorsals (tongue body) can be distinguished using the vowel height/backness features. This works because the tongue body is the primary articulator for vowels!
  - Velars: [+high, -low, -front, -back] (similar to /i/)
  - Uvulars: [-high, -low, -front, +back] (similar to /o/)
  - Pharyngeals: [-high, +low, -front, +back] (similar to /ɑ/)





- Sonority is loosely based on the loudness of a sound / degree of obstruction
- Manners of articulation are hierarchically organized according to their sonority
  - Sonority governs phonotactics - often decides how sounds are sequenced within a syllable
  - Cross-linguistically, sonority decreases towards the edge of a syllable
  - Syllables are *really complicated* and deserve their own lecture, so I'll come back to this another day
- Sonority is represented with four (!!) features

greater sonority ← → less sonority

Vowels	Glides	Liquids	Nasals	Obstruents
[+syllabic]	[–syllabic]			
[–consonantal]		[+consonantal]		
[+approximant]			[–approximant]	
[+sonorant]				[–sonorant]

Sonority is represented by the features {syllabic, consonantal, approximant, sonorant}. These four features distinguish the primary manners of articulation in the world's languages

- Vowel systems range pretty wildly in their contrasts so the exact feature space is a little variable based on context
  - English has a 5-way height split and a 3-way backness split
- **Tense** vowels are produced with greater muscular effort than their **lax** counterparts
  - Tense: less centralized, longer, narrower mouth
  - Lax: more central, shorter, wider mouth
- **Round** feature for lip rounding (No way!!!)

	[+front, –back]		[–front, –back]		[–front, +back]	
	–round	+round	–round	+round	–round	+round
[+high, –low, +tense]	i	y	ɨ	ʉ	ɯ	u
[+high, –low, –tense]	ɪ	ʏ	–	–	–	ʊ
[–high, –low, +tense]	e	ø	ɘ	ɵ	ɤ	o
[–high, –low, –tense]	ɛ	œ	ə	ɞ	ʌ	ɔ
[–high, +low]	æ	ɶ	a	–	ɑ	ɒ

Some phonologists use a [central] feature, but it's possible to just use [front] and [back] to convey centrality as in this chart (Hayes 2011).

Consult a table!

Table 4.7 Consonants I: single place of articulation

		Manner features								Laryngeal features			Place features													
		consonantal	sonorant	continuant	delayed release	approximant	tap	trill	nasal	voice	spread gl	constr gl	labial	round	labiodental	coronal	anterior	distributed	strident	lateral	dorsal	high	low	front	back	tense
bilabial	p	+	−	−	−	−	−	−	−	−	−	−	+	−	−	−	0	0	0	−	−	0	0	0	0	0
	b	+	−	−	−	−	−	−	−	+	−	−	+	−	−	−	0	0	0	−	−	0	0	0	0	0
	ɸ	+	−	+	+	−	−	−	−	−	−	−	+	−	−	−	0	0	0	−	−	0	0	0	0	0
	β	+	−	+	+	−	−	−	−	+	−	−	+	−	−	−	0	0	0	−	−	0	0	0	0	0
	m	+	+	−	0	−	−	−	+	+	−	−	+	−	−	−	0	0	0	−	−	0	0	0	0	0
	ʙ	+	+	+	0	+	−	+	−	+	−	−	+	−	−	−	0	0	0	−	−	0	0	0	0	0
labiodental	p͡f	+	−	−	+	−	−	−	−	−	−	−	+	−	+	−	0	0	0	−	−	0	0	0	0	0
	f	+	−	+	+	−	−	−	−	−	−	−	+	−	+	−	0	0	0	−	−	0	0	0	0	0
	v	+	−	+	+	−	−	−	−	+	−	−	+	−	+	−	0	0	0	−	−	0	0	0	0	0
	ɱ	+	+	−	0	−	−	−	+	+	−	−	+	−	+	−	0	0	0	−	−	0	0	0	0	0
	ʋ	−	+	+	0	+	−	−	−	+	−	−	+	−	+	−	0	0	0	−	−	0	0	0	0	0
dental	t̪	+	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	+	−	−	−	0	0	0	0	0
	d̪	+	−	−	−	−	−	−	−	+	−	−	−	−	−	+	+	+	−	−	−	0	0	0	0	0
	θ	+	−	+	+	−	−	−	−	−	−	−	−	−	−	+	+	+	−	−	−	0	0	0	0	0
	ð	+	−	+	+	−	−	−	−	+	−	−	−	−	−	+	+	+	−	−	−	0	0	0	0	0
	t	+	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	−	−	−	−	0	0	0	0	0

PDF:

Table 4.9 Vowels

	high tense						high lax			mid tense					
	i	y	ɨ	ʉ	ɯ	u	ɪ	ʏ	ʊ	e	ø	ɘ	ɵ	ɤ	o
[high]	+	+	+	+	+	+	+	+	+	−	−	−	−	−	−
[low]	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
[tense]	+	+	+	+	+	+	−	−	−	+	+	+	+	+	+
[front]	+	+	−	−	−	−	+	+	−	+	+	−	−	−	−
[back]	−	−	−	−	+	+	−	−	+	−	−	−	−	+	+
[round]	−	+	−	+	−	+	−	+	+	−	+	−	+	−	+

It's almost time to revise our rules from earlier, but first, some pointers...

- Fully explicit phonological description is often not necessary – Use only necessary features for your point
  - Does intervocalic nasalization need [+approximant] specified? (right)
- Feature description is most useful when documenting a change that affects a natural class
  - Or, you hypothesize it does

Description of Rule	*Example*	*Formalization*
A vowel in between two nasal consonants becomes nasal itself	/nænsi/ → [næ̃nsi]	/æ/ → [æ̃] / n_n

How should we specify the environment for this change?

greater sonority ← → less sonority

Vowels	Glides	Liquids	Nasals	Obstruents
[+syllabic]	[–syllabic]			
[–consonantal]		[+consonantal]		
[+approximant]			[–approximant]	
[+sonorant]				[–sonorant]

If [+syllabic] is specified, is [+approximant] still informative?

Description of Rule	*Example*	*Formalization (old)*	*Formalization (new)*
Words that start with a vowel will have a glottal stop inserted	/æpəl/ → [ʔæpəl]	/Ø/ → [ʔ] / #_V	/Ø/ → [ʔ] / # _ [+syllabic]
Intervocalic /ɹ/ is tapped	/bʌtəɹ/ → [bʌrəɹ]	/r/ → [ɾ] / V_V	[+approximant, +coronal, -anterior] → [+tap, +anterior] / [+syllabic] _ [+syllabic]
A vowel in between two nasal consonants becomes nasal itself	/nænsi/ → [næ̃nsi]	/æ/ → [æ̃] / n_n	[+syllabic] → [+nasal] / [+nasal, -continuant] – [+nasal, -continuant]
The plural -s becomes voiced if the phoneme before it is voiced	/dɑgs/ → [dɑgz]	/s/ → [z] / g_#	/s/ → [z] / [+syllabic] _ #
The plural -s becomes voiced if the phoneme before it is voiced	/kɹoʊs/ → [kɹoʊz]	/s/ → [z] / oʊ_#	

- **nasalization**
- **assimilation**
- **vowel harmony**
- **epenthesis**

- allophones – in a given language, two speech sounds that do not phonemically contrast (e.g., /k/ and /kʰ/ in English)
- grapheme – smallest unit of a language's writing system (e.g., a letter)
- IPA – international phonetic alphabet, a useful standard for phonetically transcribing the speech sounds of any language
- manner of articulation – the degree of constriction of the vocal tract during production of a consonant
- minimal pair – two words that differ by only one phoneme
- natural class – a group of phonemes that share some feature, and are usually acted on equally by phonological rules
- openness – see *vowel height*
- phoneme – smallest unit of a language's sound system (e.g., /p/)
- phonetics – the study of how how humans produce and understand speech sounds
- phonology – the study of the sound systems of the world's languages
- phonotactics – the study of the constraints of a given language's sound system
- place of articulation – the point in the vocal tract a constriction is made during the production of a consonant
- surface representation – the phonetic realization of a word as it is spoken in a given context
- underlying representation – the phonemic representation of a word before it is transformed by phonological rules as it is spoken
- voicing – whether or not the vocal folds are vibrating during production of a consonant or vowel
- vowel backness – the front/back position of the tongue in the mouth during production of a vowel
- vowel height – the height of the tongue in the mouth during production of a vowel. Sometimes called *openness*