جامعة نيويورك أبوظبي

NYU | ABU DHABI

PSYCH-UH 2218: Language Science

Class 3: Describing segments using Articulatory Features

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Psychology

What are the sounds of your language?

What would you do if I asked you to list all of the sounds of your language?

If your writing system represents sounds (not all do!), then you might try to use that to list the sounds of your language:

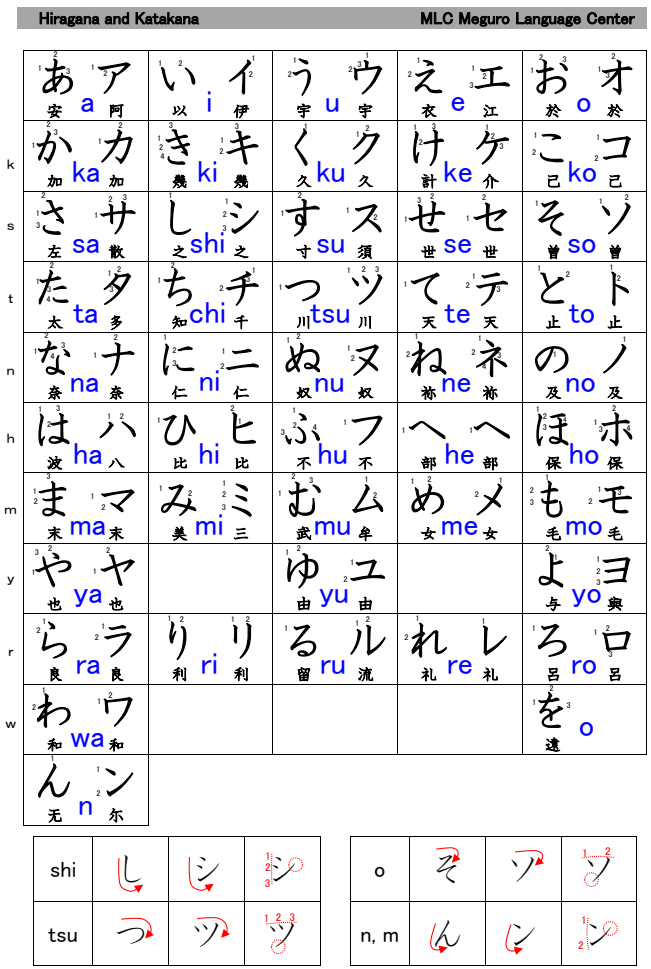
Arabic (abjad)

ر	ذ	د	خ	ح	ج	ث	ت	ب	ا
راء	ذال	دال	خاء	حاء	جيم	ثاء	تاء	باء	ألف
rāʾ	ḏāl	dāl	ḫāʾ	ḥāʾ	ǧīm	ṯāʾ	tāʾ	bāʾ	ʾalif
r	ḏ	d	ḫ	ḥ	ǧ	ṯ	t	b	ʾ(a)
[r~ɾ]	[ð]	[d]	[x~χ]	[ħ]	[ʤ]	[θ]	[t]	[b]	[ʔ]
ف	ع	ع	ظ	ط	ض	ص	ش	س	ز
فاء	غين	عين	ظاء	طاء	ضاد	صاد	شين	سين	زاي
fāʾ	ġayn	ʿayn	ẓāʾ	ṭāʾ	ḍād	ṣād	šīn	sīn	zāy
f	ġ	ʿ	ẓ	ṭ	ḍ	ṣ	š	s	z
[f]	[ɣ~ʁ]	[ʕ]	[ðˤ]	[tˤ]	[dˤ]	[sˤ]	[ʃ]	[s]	[z]
	ء	ي	و	ه	ن	م	ل	ك	ق
	همزة	ياء	واو	هاء	نون	ميم	لام	كاف	قاف
	hamza	yāʾ	wāw	hāʾ	nūn	mīm	lām	kāf	qāf
		y	w	h	n	m	l	k	q
		[j]	[w]	[h]	[n]	[m]	[l~ɬ]	[k]	[q]

Cyrillic (alphabet)

А а	Б б	Ч ч	Д д	Е е	Ф ф	Г г	Х х	И и
ao	ban	chi	desu	eien	furai	gin	himitsu	imi
a	b	ch	d	e	f	g	h	i
[a]	[b]	[ʧ]	[d]	[e]	[f]	[g]	[h]	[ɪ]
Џ џ	К к	Л л	М м	Н н	О о	П п	Р р	С с
jodan	kin	lamia	minna	nihon	ojou	pan	ramen	sushi
j	k	l	m	n	o	p	r	s
[ʤ]	[k]	[l]	[m]	[n]	[o]	[p]	[r]	[s]
Ш ш	Т т	У у	В в	Ў ў	Қ қ	Ј ј	З з	
shiro	tatsu	umi	virus	warau	ekkusu	yume	zettai	
sch	t	u	v	w	x	y	z	
[ʃ]	[t]	[u]	[v]	[w]	[ks]	[j]	[z]	
Э э	Ң ң	Ц ц	Ж ж	Ћ ћ	Ђ ђ			
ae	nga	tsugi	zha	tho	dha			
ä	ng	ts	zh	th	dh			
[æ]	[ŋ]	[ʦ]	[ʒ]	[θ]	[ð]			

Japanese (syllabaries)



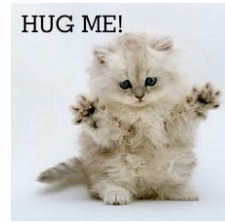
But writing was not designed to be precise

Writing systems are cultural objects. They were shaped by cultural forces to perform various functions. Writing systems were not designed to be used to precisely describe language as a cognitive object.

We will have an entire day on writing systems later in the semester, but for now we can illustrate this imprecision with the Roman alphabet:

1. Some letters represent more than one sound:

   The c in cat is [k], and the c in centipede is [s].



2. Some sounds can be represented more than one letter:

   The [k] sound can be a c, k, or q.

3. Some letters can represent two sounds at once:

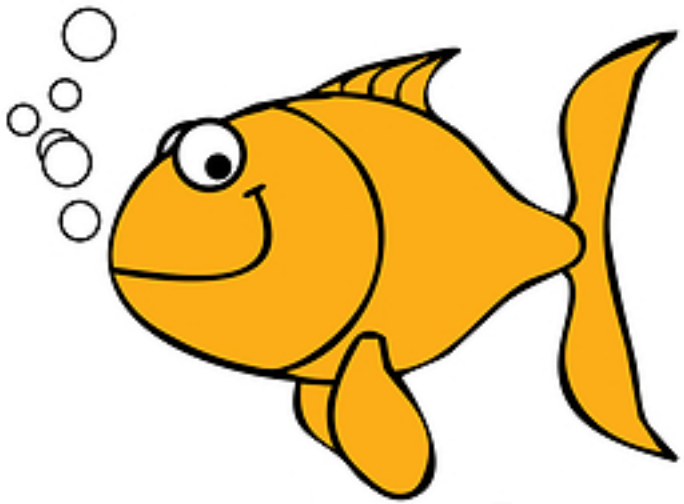
   The x in expel is [k] and [s]

4. Some sounds aren't represented by any letters at all: "uh-oh"

A terrible linguistics joke…

The many-to-many relationship between letters and sounds has led to really terrible jokes like this:

How do you pronounce this word in English?



GHOTI

F I SH

enough → f

women → i

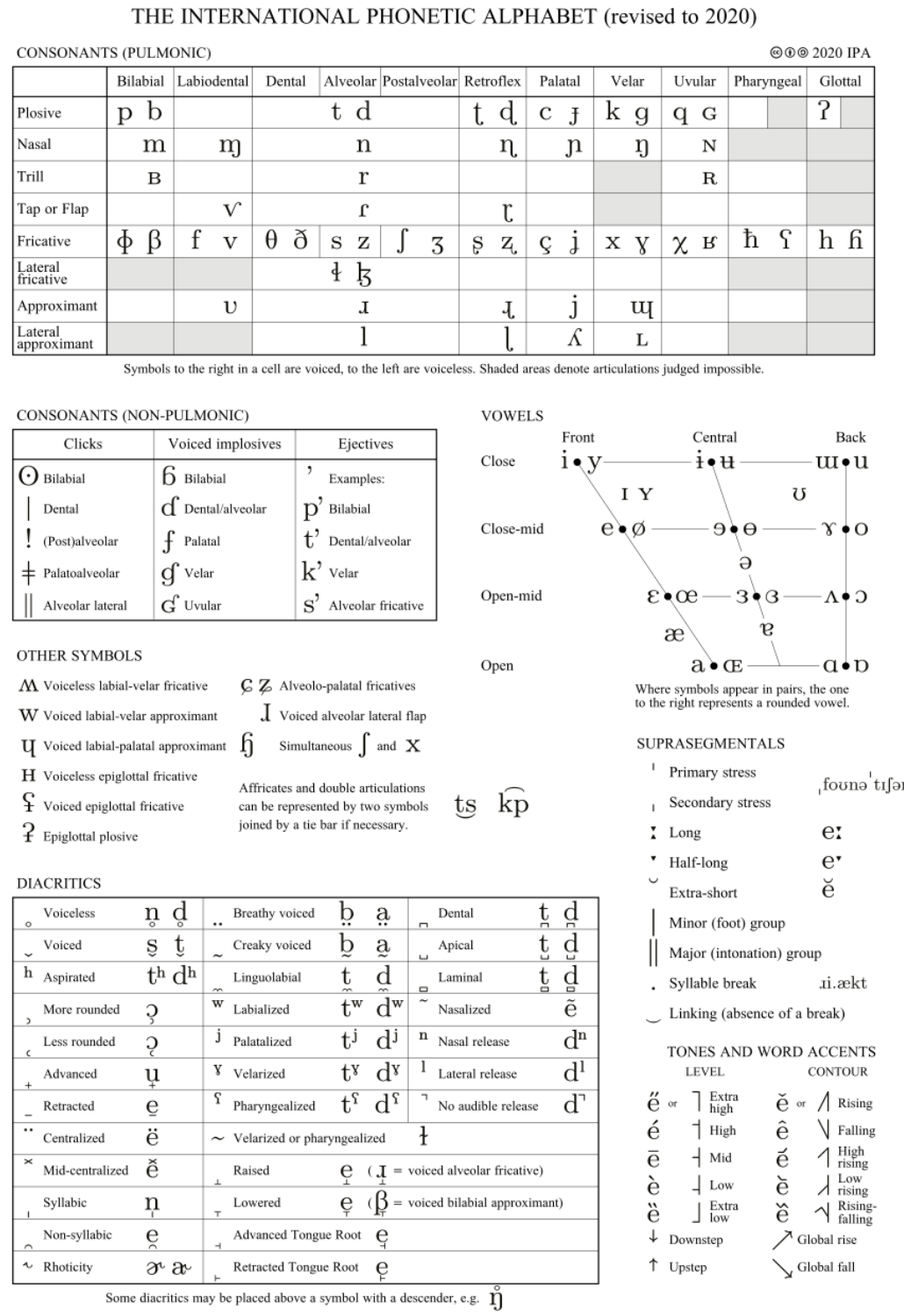
nation → sh

The **I**nternational **P**honetic **A**lphabet (IPA) was created so that we can refer to spoken sounds with precision. Every sound that occurs in a language in the world is given one symbol. And each symbol is used only once so there is no confusion!

The IPA is based on how the sounds are articulated. So, to learn how to use the IPA, we have to learn about the articulation of sounds.

Don’t worry — this will also become the foundation of our cognitive theory of the mental representations of sounds!

An online keyboard for typing in IPA: https://ipa.typeit.org/full/



THE INTERNATIONAL PHONETIC ALPHABET (revised to 2020)

CONSONANTS (PULMONIC) — ©①⑤ 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.

CONSONANTS (NON-PULMONIC)

Clicks	Voiced implosives	Ejectives
ʘ Bilabial	ɓ Bilabial	’ Examples:
ǀ Dental	ɗ Dental/alveolar	pʼ Bilabial
ǃ (Post)alveolar	ʄ Palatal	tʼ Dental/alveolar
ǂ Palatoalveolar	ɠ Velar	kʼ Velar
ǁ Alveolar lateral	ʛ Uvular	sʼ Alveolar fricative

OTHER SYMBOLS

ʍ Voiceless labial-velar fricative
w Voiced labial-velar approximant
ɥ Voiced labial-palatal approximant
ʜ Voiceless epiglottal fricative
ʢ Voiced epiglottal fricative
ʡ Epiglottal plosive

ɕ ʑ Alveolo-palatal fricatives
ɺ Voiced alveolar lateral flap
ʧ Simultaneous ʃ and x

Affricates and double articulations can be represented by two symbols joined by a tie bar if necessary.

t͡s k͡p

VOWELS

Where symbols appear in pairs, the one to the right represents a rounded vowel.

SUPRASEGMENTALS

ˈ Primary stress — ˌfoʊnəˈtɪʃən
ˌ Secondary stress
ː Long — eː
ˑ Half-long — eˑ
◡ Extra-short — ĕ
| Minor (foot) group
‖ Major (intonation) group
. Syllable break — ɹi.ækt
‿ Linking (absence of a break)

TONES AND WORD ACCENTS

LEVEL		CONTOUR	
é or ˥	Extra high	ě or ˩˥	Rising
é ˦	High	ê ˥˩	Falling
ē ˧	Mid	ě ˧˥	High rising
è ˨	Low	ě ˨˩	Low rising
ȅ ˩	Extra low	ȇ ˥˩˧	Rising-falling
↓ Downstep		↗ Global rise	
↑ Upstep		↘ Global fall	

DIACRITICS

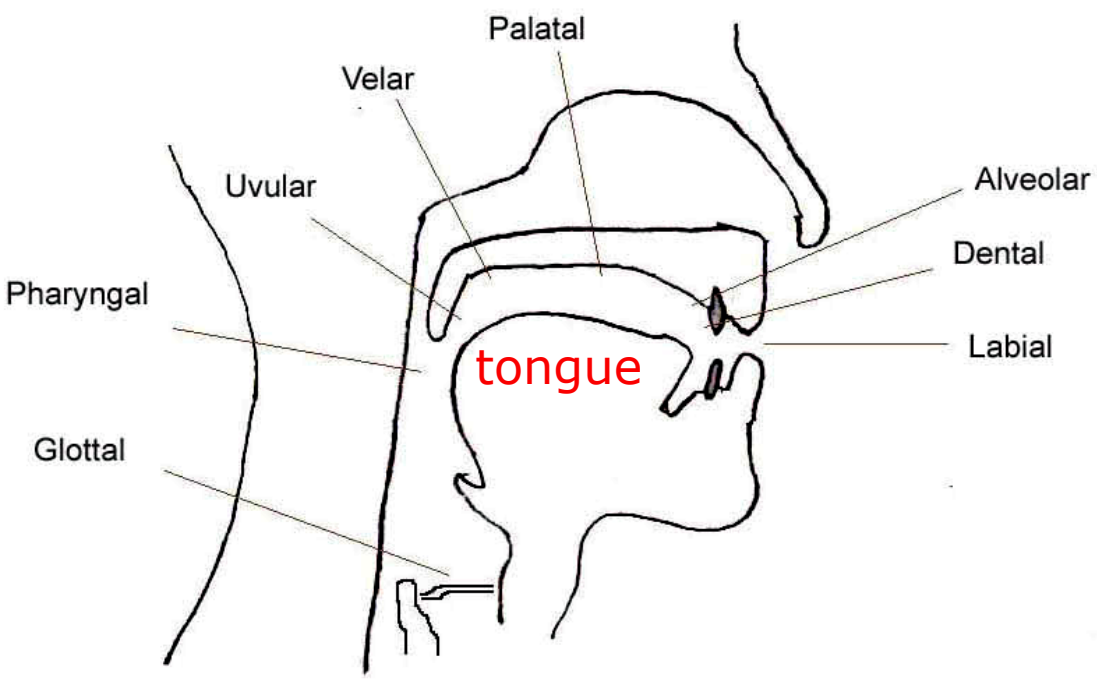
◌̥ Voiceless	n̥ d̥	◌̤ Breathy voiced	b̤ a̤	◌̪ Dental	t̪ d̪
◌̬ Voiced	s̬ t̬	◌̰ Creaky voiced	b̰ a̰	◌̺ Apical	t̺ d̺
◌ʰ Aspirated	tʰ dʰ	◌̼ Linguolabial	t̼ d̼	◌̻ Laminal	t̻ d̻
◌̹ More rounded	ɔ̹	◌ʷ Labialized	tʷ dʷ	◌̃ Nasalized	ẽ
◌̜ Less rounded	ɔ̜	◌ʲ Palatalized	tʲ dʲ	◌ⁿ Nasal release	dⁿ
◌̟ Advanced	u̟	◌ˠ Velarized	tˠ dˠ	◌ˡ Lateral release	dˡ
◌̠ Retracted	e̠	◌ˤ Pharyngealized	tˤ dˤ	◌̚ No audible release	d̚
◌̈ Centralized	ë	~ Velarized or pharyngealized	ɫ		
◌̽ Mid-centralized	e̽	◌̝ Raised	e̝ (ɪ̝ = voiced alveolar fricative)		
◌̩ Syllabic	n̩	◌̞ Lowered	e̞ (β̞ = voiced bilabial approximant)		
◌̯ Non-syllabic	e̯	◌̘ Advanced Tongue Root	e̘		
◌˞ Rhoticity	ə˞ a˞	◌̙ Retracted Tongue Root	e̙		

Some diacritics may be placed above a symbol with a descender, e.g. ŋ̊

Articulatory features of speech sounds

Articulatory features

Articulation is just a fancy way of saying "produce". And **feature** is just a fancy way to say "property". The big idea is that each sound segment can be described by the way it is produced! You can think of articulatory features like general motor commands for producing a segment:



These motor commands will refer to the components of the vocal tract: the tongue, the vocal folds, and locations in the pharynx and oral cavity.

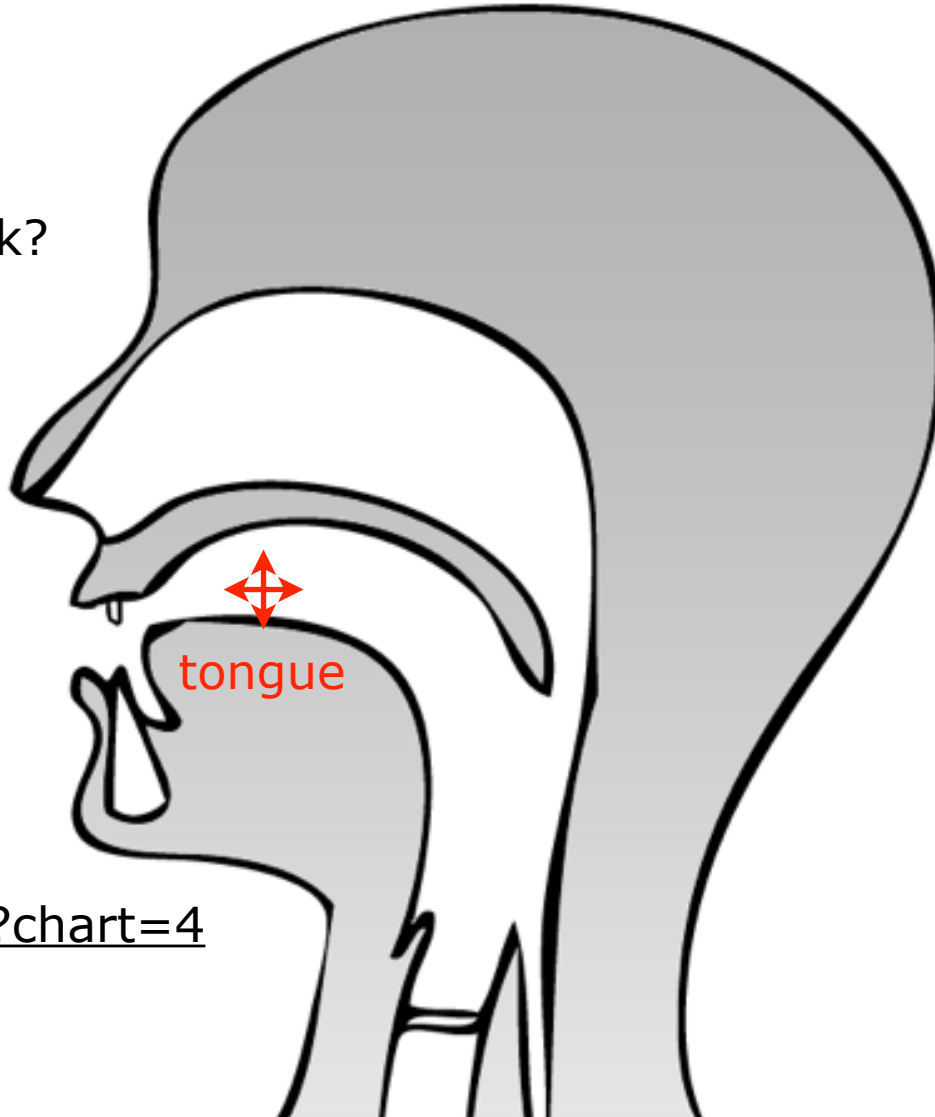
We will see how each of these components work for vowels and consonants in the coming slides. (Don't try to memorize it now!)

Articulatory features of vowels

Linguists have been able to identify **two types** of articulatory features for vowels. Both are related to the position of the tongue during production:

1. **Height**: Is the tongue low or high

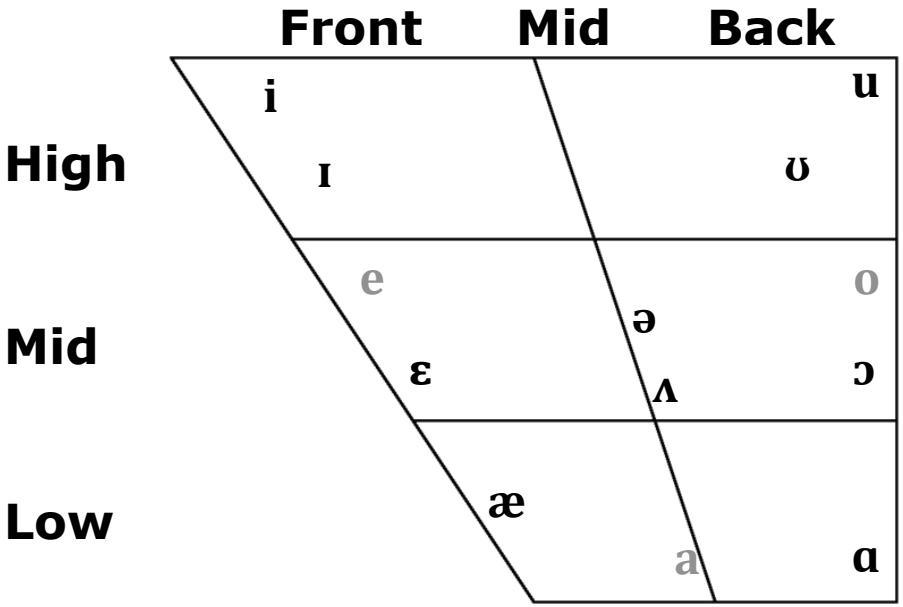
2. **Backness:** Is the tongue forward or back?

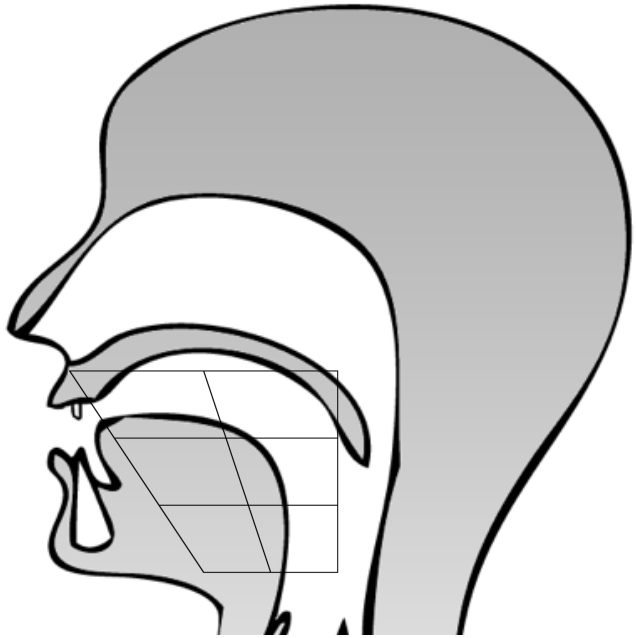


And here is an interactive chart with MRIs of a real human producing speech sounds (it also has animations)

https://www.seeingspeech.ac.uk/ipa-charts/?chart=4

This is a vowel chart



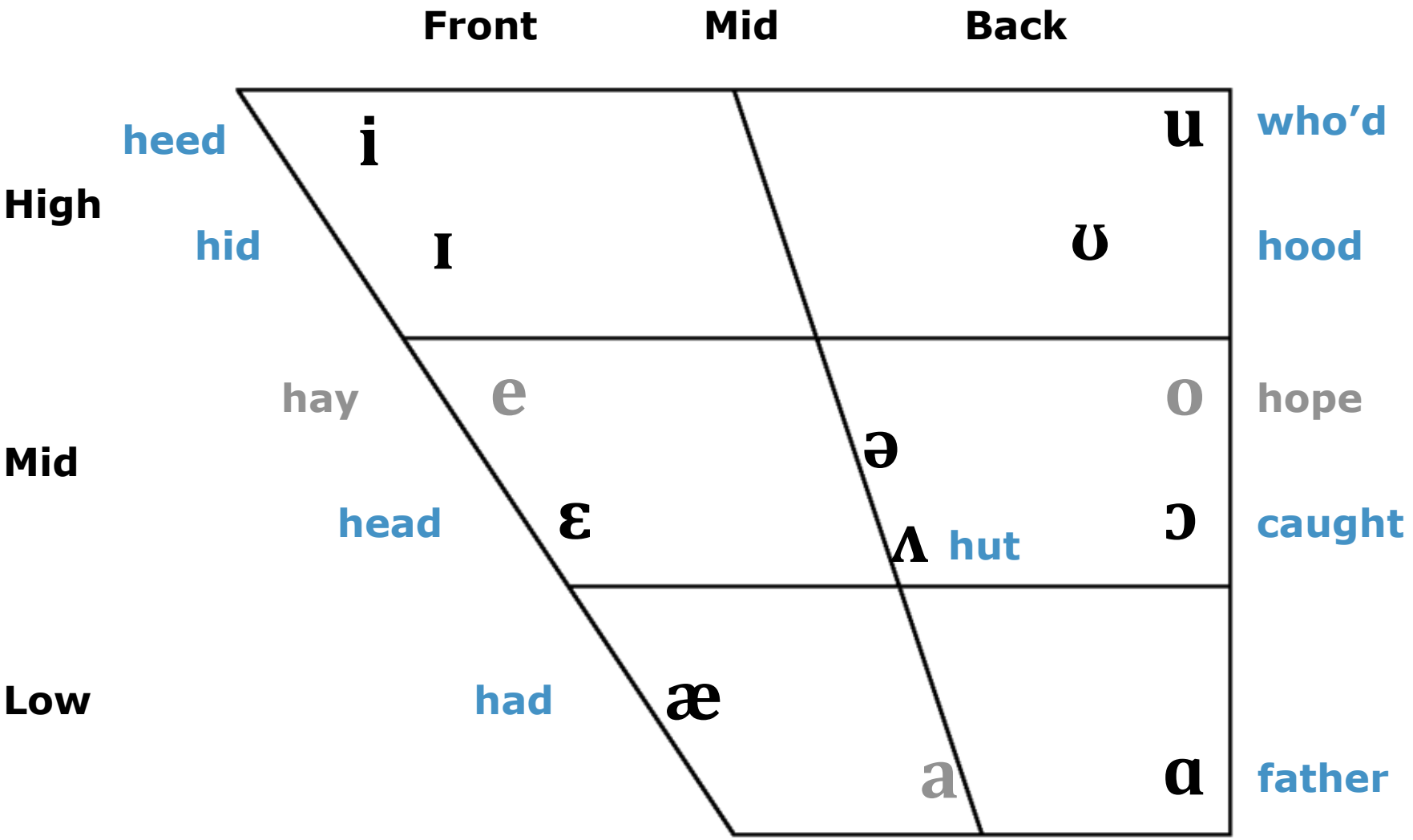


The idea behind a vowel chart is that it represents a human mouth pointing to the left. We then write the IPA symbol for a vowel in the location that the tongue would be in the mouth when that vowel is produced!

So, if the tongue would be high in the mouth, the symbol is written high in the chart; if the tongue would be front in the mouth, then the symbol is written toward the left of the chart.

Finally, the space is divided into sections so that the features can have values: front/mid/back for the backness feature, and high/mid/low for the height feature.

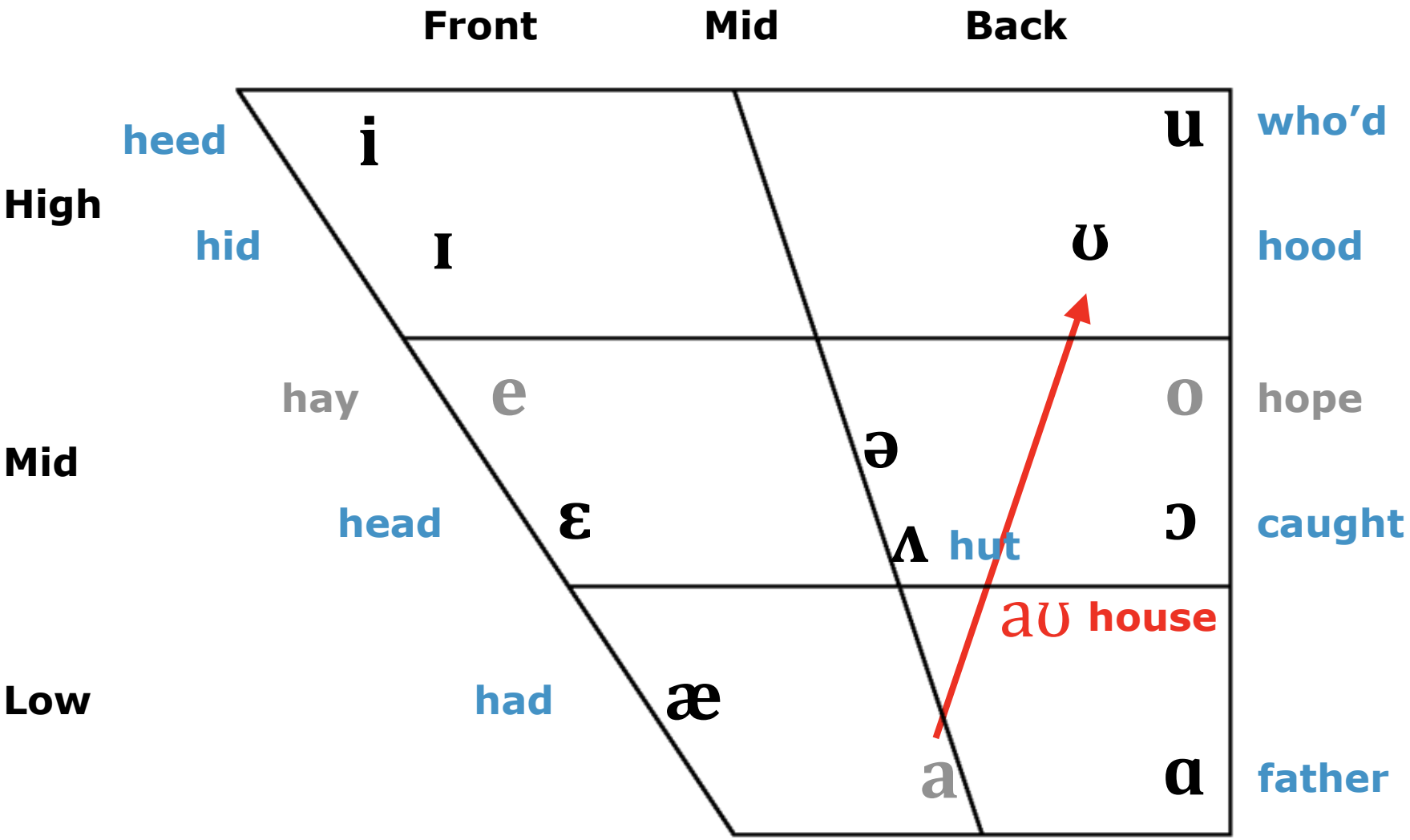
Monophthongs: fancy word for single vowels



The ones in gray don't really occur in US English alone, but we use them in diphthongs so I have included them here.

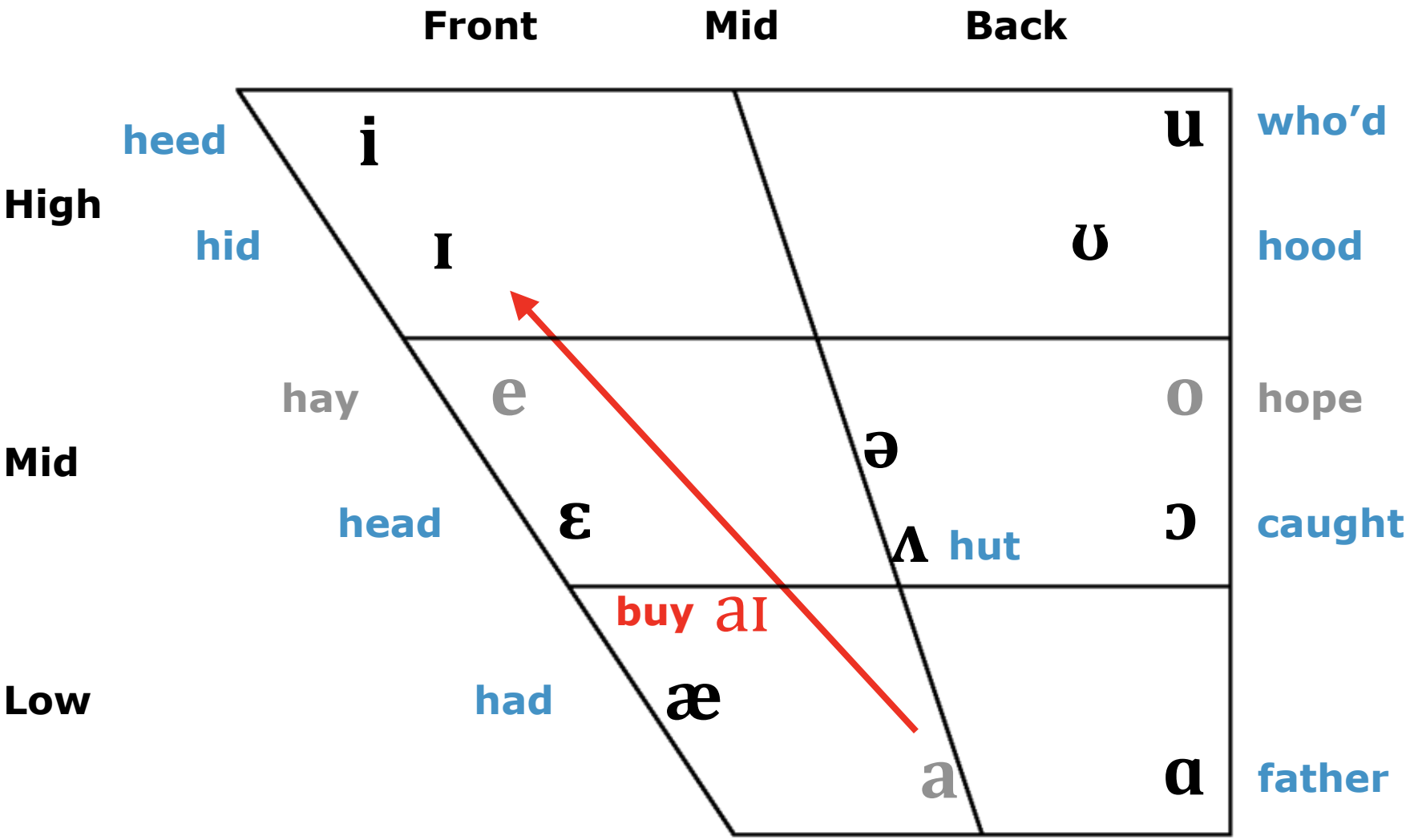
https://www.seeingspeech.ac.uk/ipa-charts/?chart=4

Diphthongs: double vowels!



A diphthong is a vowel that starts with the tongue in one location in the mouth, and ends with it in a second location. But crucially, the movement is done very quickly, so the entire articulation only takes the place of a single vowel! (http://www.paulmeier.com/diphthongs-and-triphthongs/)

Diphthongs: double vowels!



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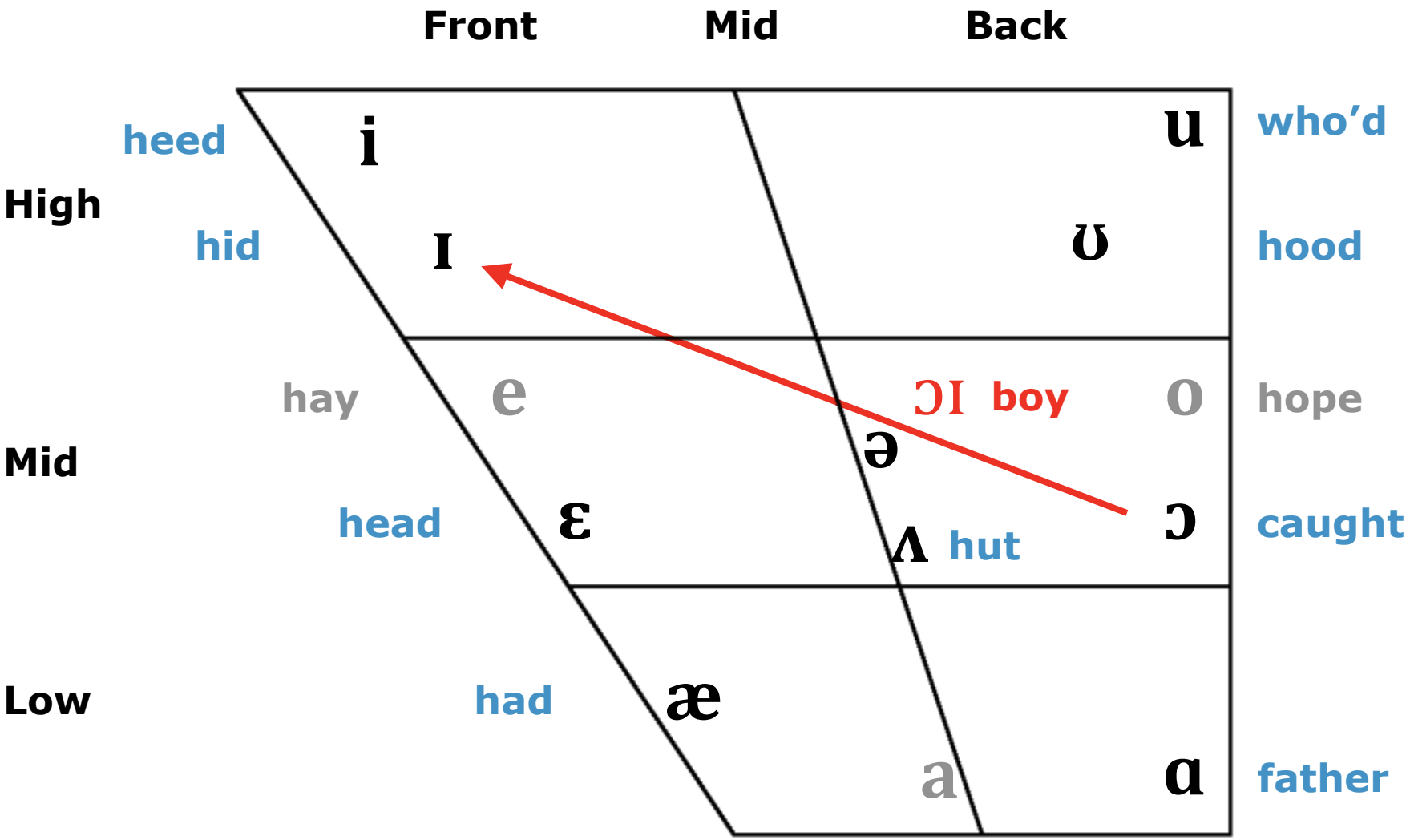

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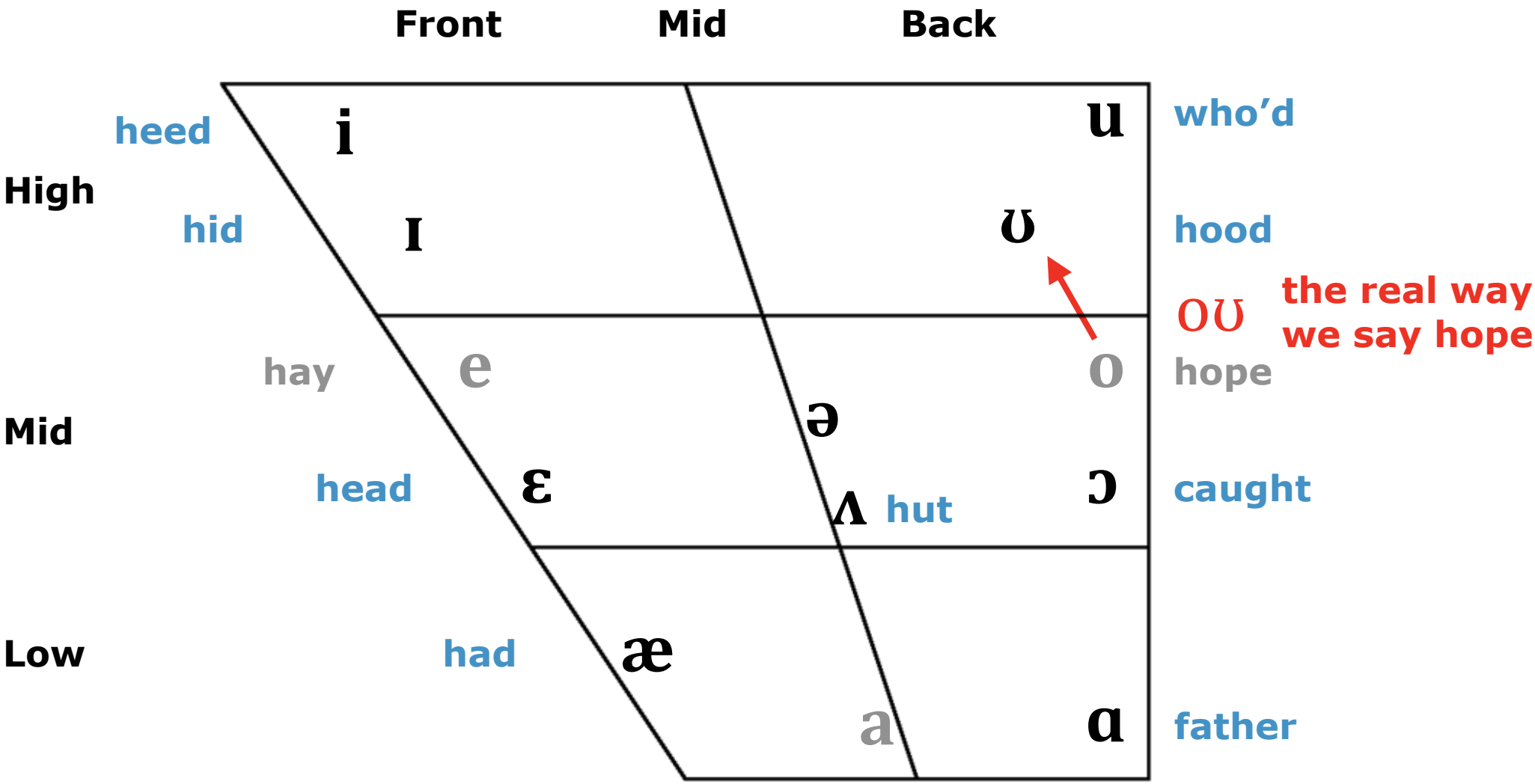
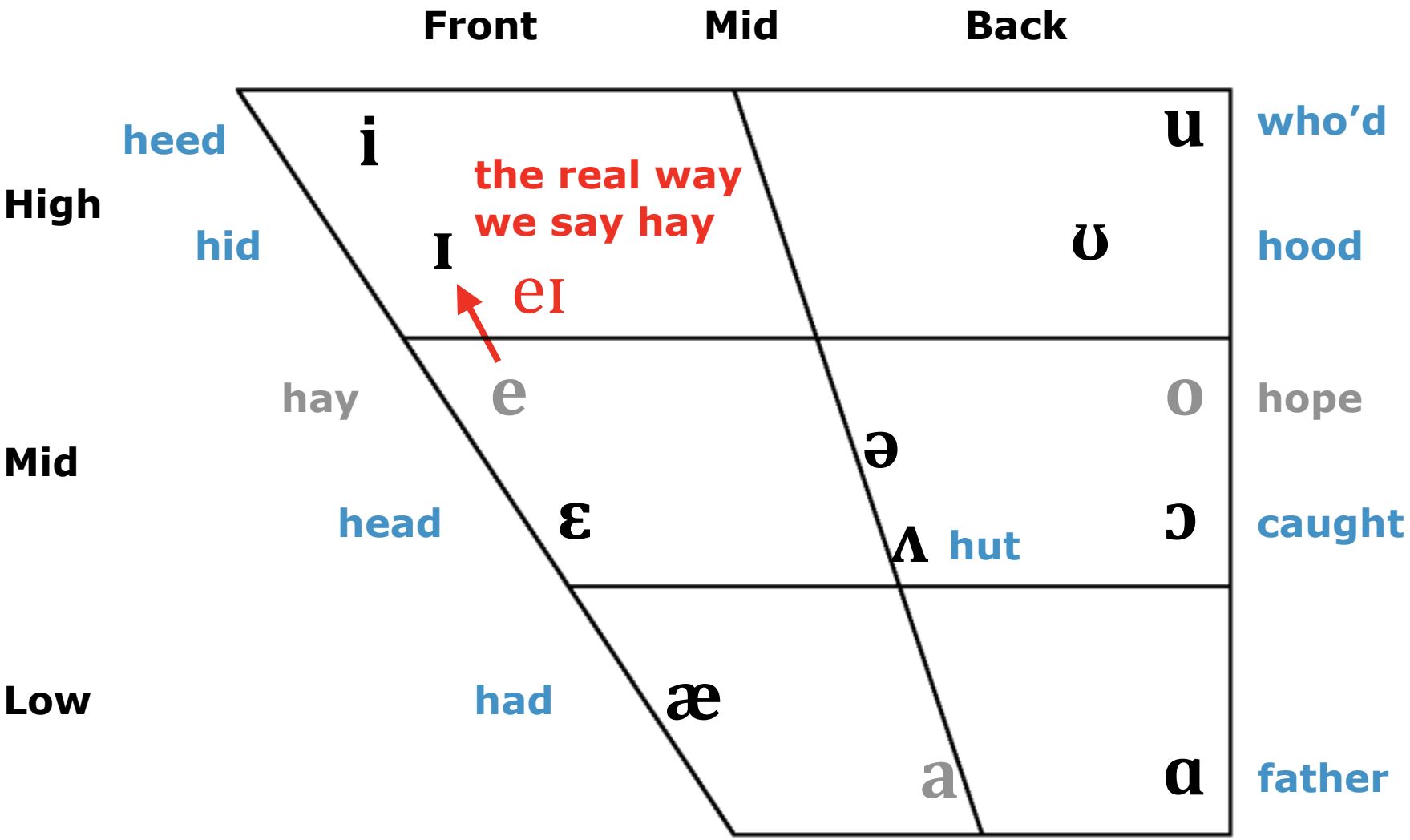
Diphthongs: double vowels!



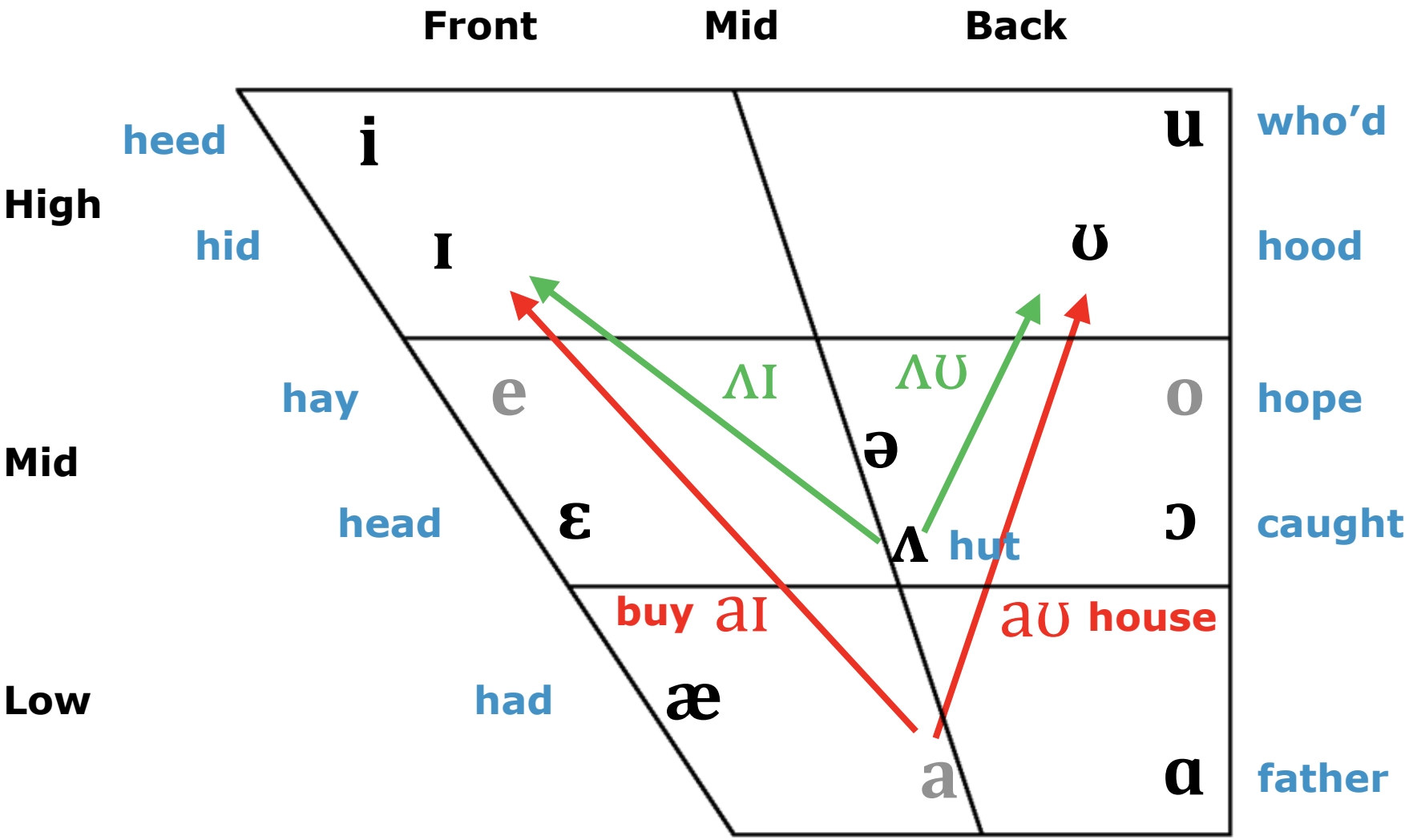
In common speech, we will often talk about English having a vote "o", but it is in fact a diphthong, whereas many other languages (such as Romance languages) would have a monophthong. This contributes to the accent that many English speakers have when first learning other languages.

Diphthongs: double vowels!



In common speech, we will often talk about English having a vote "e" (pronounced "a"), but it is in fact a diphthong, whereas many other languages (such as Romance languages) would have a monophthong. This contributes to the accent that many English speakers have when learning other languages.

Why do Canadians sound different than Americans?



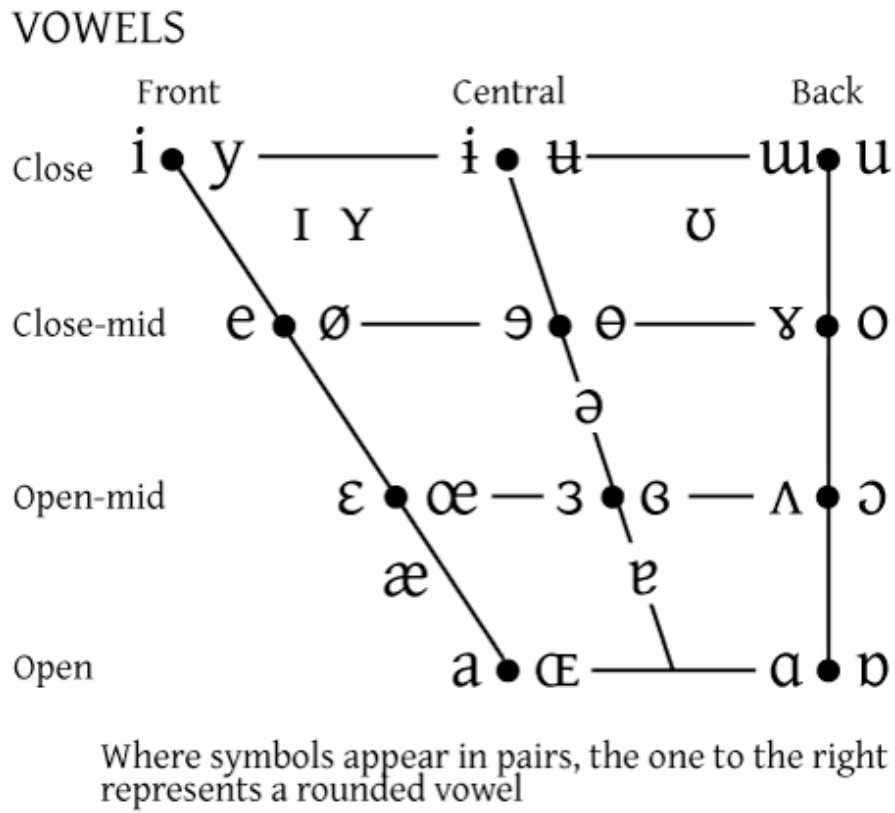
For two common diphthongs in English, Canadians begin the diphthong with their tongues a bit higher than Americans. Canadians end in the same place, but start higher. Linguists call this Canadian Raising.

Class Exercise: Finding your vowels!

Let's take a few minutes to try to identify some of the vowels in your language. We will focus on monophthongs for now. You can use this link to hear and see each vowel if you want:

https://www.seeingspeech.ac.uk/ipa-charts/?chart=4

Notice that the IPA uses "close" instead of "high" and "open" instead of "low". That is like opening/closing your oral cavity with your tongue. I don't care which terminology you use for this feature!



The Articulatory Features of Consonants

Articulatory features of consonants

Linguists have been able to identify **three types** of articulatory features for consonants.

1. **Place of Articulation**:

   Where in the vocal tract is the airflow being obstructed?

2. **Manner of Articulation**:

   How is the airflow being obstructed?

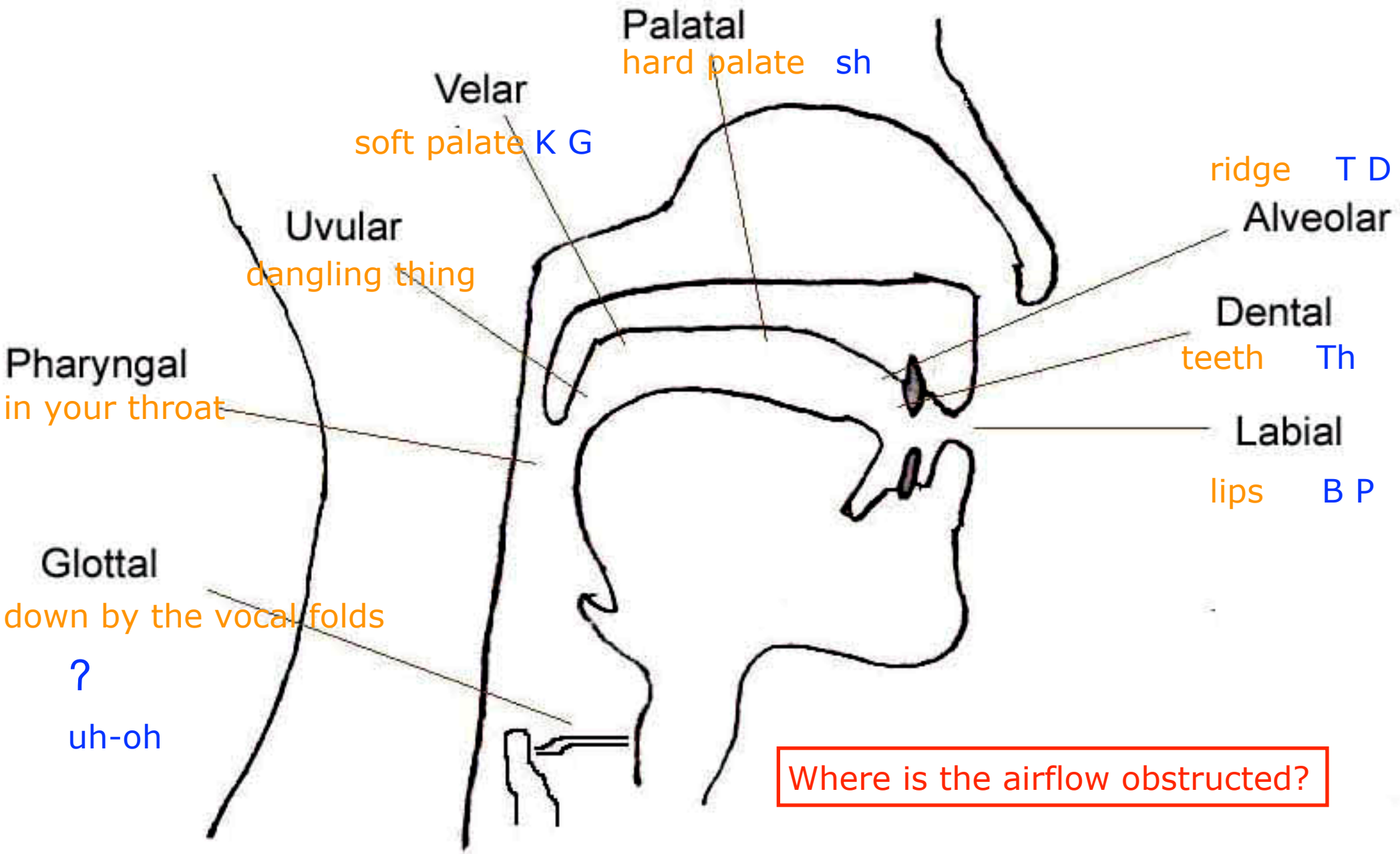
3. **Voicing**:

   Are the vocal folds vibrating during this obstruction or not?

And here is an interactive chart with MRIs of a real human producing speech sounds (it also has animations)

https://www.seeingspeech.ac.uk/ipa-charts/?chart=1

Place of Articulation



Manners of Articulation

Stops (Plosives) - the airflow is completely obstructed

B P T D G K

Nasals - the airflow is diverted to the nasal cavity

N M

Fricatives - the airflow is disturbed, but not completely stopped

F V Th Sh

Affricates - a stop + fricative

Ch J

Laterals - the tongue blocks the air, but air escapes around the sides

L

Approximants - not much obstruction, very similar to vowels

R Y

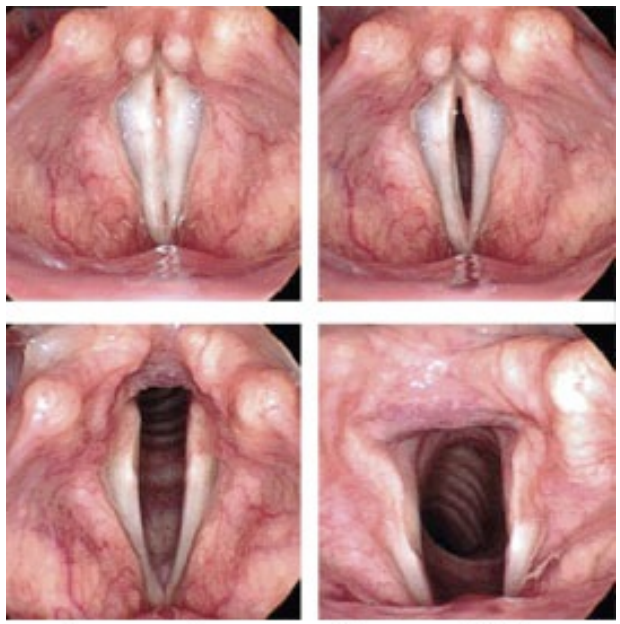
How is the airflow obstructed?

Voicing

The vocal folds must vibrate to create the sound energy of speech (we will see more of this next time!

Here is a video of the vocal folds of four people singing: http://www.youtube.com/watch?v=-XGds2GAvGQ

Voiced: Let the vocal folds vibrate during the obstruction
Voiceless: Stop the vocal folds from vibrating during the obstruction



Stroboscopical imaging of the vocal fold movement using the LED laryngoscope

Voiced Stops	**Voiceless Stops**
B D G	P T K

Are the vocal folds vibrating during this obstruction?

A feature-based consonant chart, filled in for English

Manner of Articulation \ Place of Articulation	Bilabial		Labio-dental		Inter-dental		Alveolar		Post-Alveolar		Palatal		Velar		Glottal	
Stop	p	b					t	d					k	g	ʔ	
Fricative			f	v	θ	ð	s	z	ʃ	ʒ					h	
Affricate									ʧ	ʤ						
Flap								ɾ								
Nasal		m						n						ŋ		
Lateral Liquid								l								
Retroflex Liquid								ɹ								
Glide	ʍ	w[3]										j				

State of the Glottis: Voiceless | Voiced

Places of Articulation form the column labels

Manners of Articulation form the row labels

Voicing is delineated by the pairs: the one on the right is voiced

Class Exercise: Finding your consonants!

Now let's try to identify some of the consonants. You can use this chart to see and hear them:

https://www.seeingspeech.ac.uk/ipa-charts/?chart=1

THE INTERNATIONAL PHONETIC ALPHABET (revised to 2020)

CONSONANTS (PULMONIC) CC BY SA 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.

I'd recommend working row-by row (so, based on manner of articulation). Work across a row to see which of the sounds you have in your language.

Additional articulations represented by diacritics

Additional articulations

The consonant chart only lists three features. These are the major features for consonants, and do a good job of capturing most of the consonants in language.

But there are additional articulations that can happen with some consonants. These are symbolized with diacritics on the main IPA symbol. Here are two common ones:

Aspirated means to blow out when producing the sound.

These are co-articulations that add a second place of articulation to the consonant. Arabic has some pharyngealized consonants! English does too - the [l] at the end of words like "pull"!

Syllabic means the consonant forms its own syllable - like "kitten".

DIACRITICS

◌̥	Voiceless	n̥ d̥	◌̤	Breathy voiced	b̤ a̤	◌̪	Dental	t̪ d̪
◌̬	Voiced	s̬ t̬	◌̰	Creaky voiced	b̰ a̰	◌̺	Apical	t̺ d̺
◌ʰ	Aspirated	tʰ dʰ	◌̼	Linguolabial	t̼ d̼	◌̻	Laminal	t̻ d̻
◌̹	More rounded	ɔ̹	◌ʷ	Labialized	tʷ dʷ	◌̃	Nasalized	ẽ
◌̜	Less rounded	ɔ̜	◌ʲ	Palatalized	tʲ dʲ	◌ⁿ	Nasal release	dⁿ
◌̟	Advanced	u̟	◌ˠ	Velarized	tˠ dˠ	◌ˡ	Lateral release	dˡ
◌̠	Retracted	e̠	◌ˤ	Pharyngealized	tˤ dˤ	◌̚	No audible release	d̚
◌̈	Centralized	ë	◌̴	Velarized or pharyngealized	ɫ			
◌̽	Mid-centralized	e̽	◌̝	Raised	e̝	(ɹ̝ = voiced alveolar fricative)		
◌̩	Syllabic	n̩	◌̞	Lowered	e̞	(β̞ = voiced bilabial approximant)		
◌̯	Non-syllabic	e̯	◌̘	Advanced Tongue Root	e̘			
◌˞	Rhoticity	ɚ a˞	◌̙	Retracted Tongue Root	e̙			

Some diacritics may be placed above a symbol with a descender, e.g. ŋ̊

Looking up the sounds in your language!

The cross-linguistic study of sounds

The system of articulatory features is intended to be (nearly) universal - it can be used to describe the segment inventories in all of the worlds languages (with a handful of expansions that we did not cover here).

This website from UCLA tries to document all of the sound inventories in the world's languages. It is not complete because have only studied a fraction of the approximately 7000 languages in the world. But it is still a really cool resource:

https://phoible.org/

You should take some time to explore it — look at all the cool ways that languages vary!

Though PHOIBLE does have language-specific IPA charts, they are in a format for professional researchers that may not be helpful for the exercises we do in class. This website has IPA charts in a format that is a bit better for what we want to do: http://accent.gmu.edu/browse_native.php

The distribution of consonants

This is from a study of 451 languages done in the 1980s.

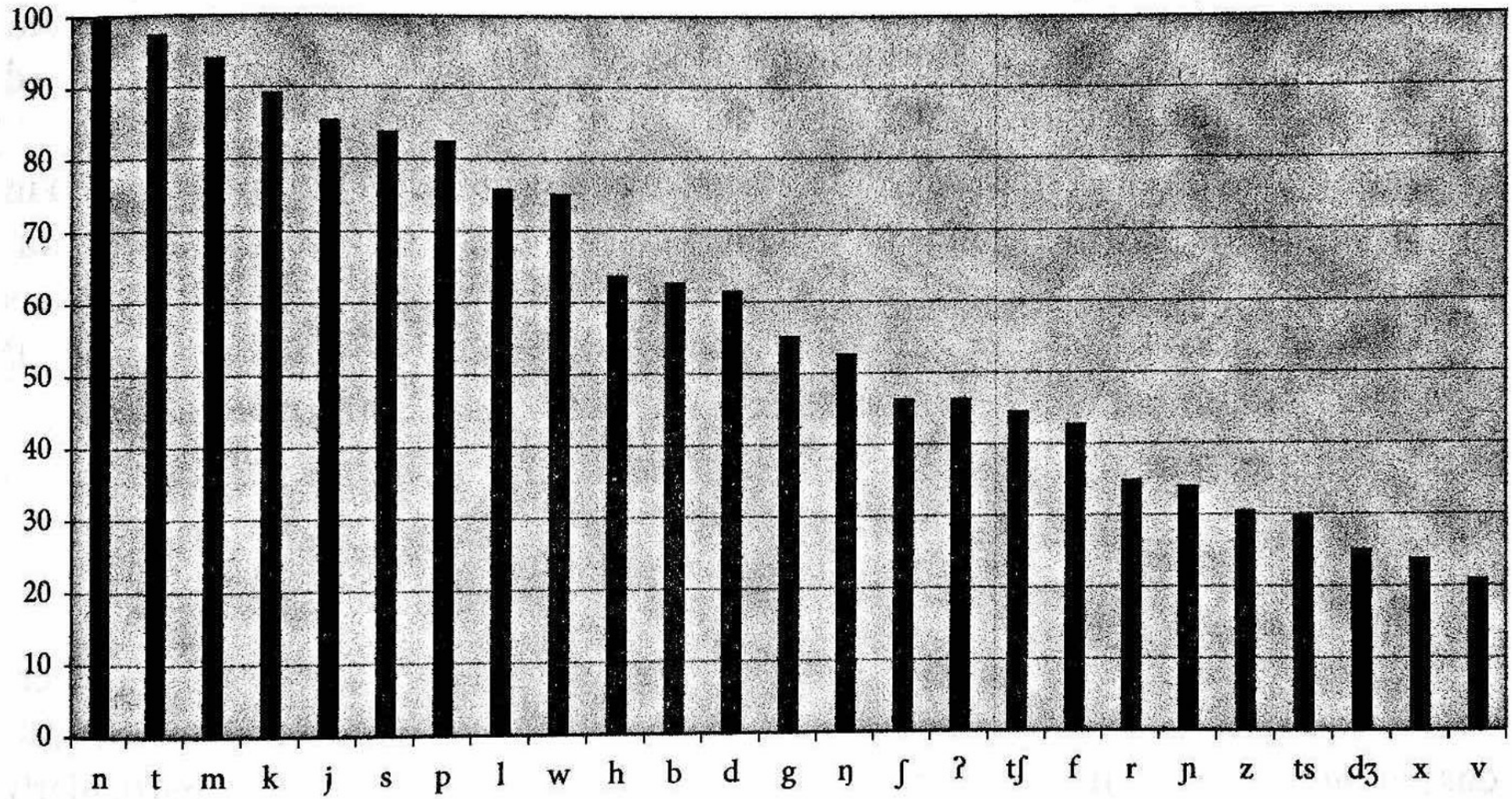


FIGURE 3.1. The percentage of languages possessing the 25 most common consonants (Maddieson 1984)

The distribution of vowels

This is from a study of 451 languages done in the 1980s.

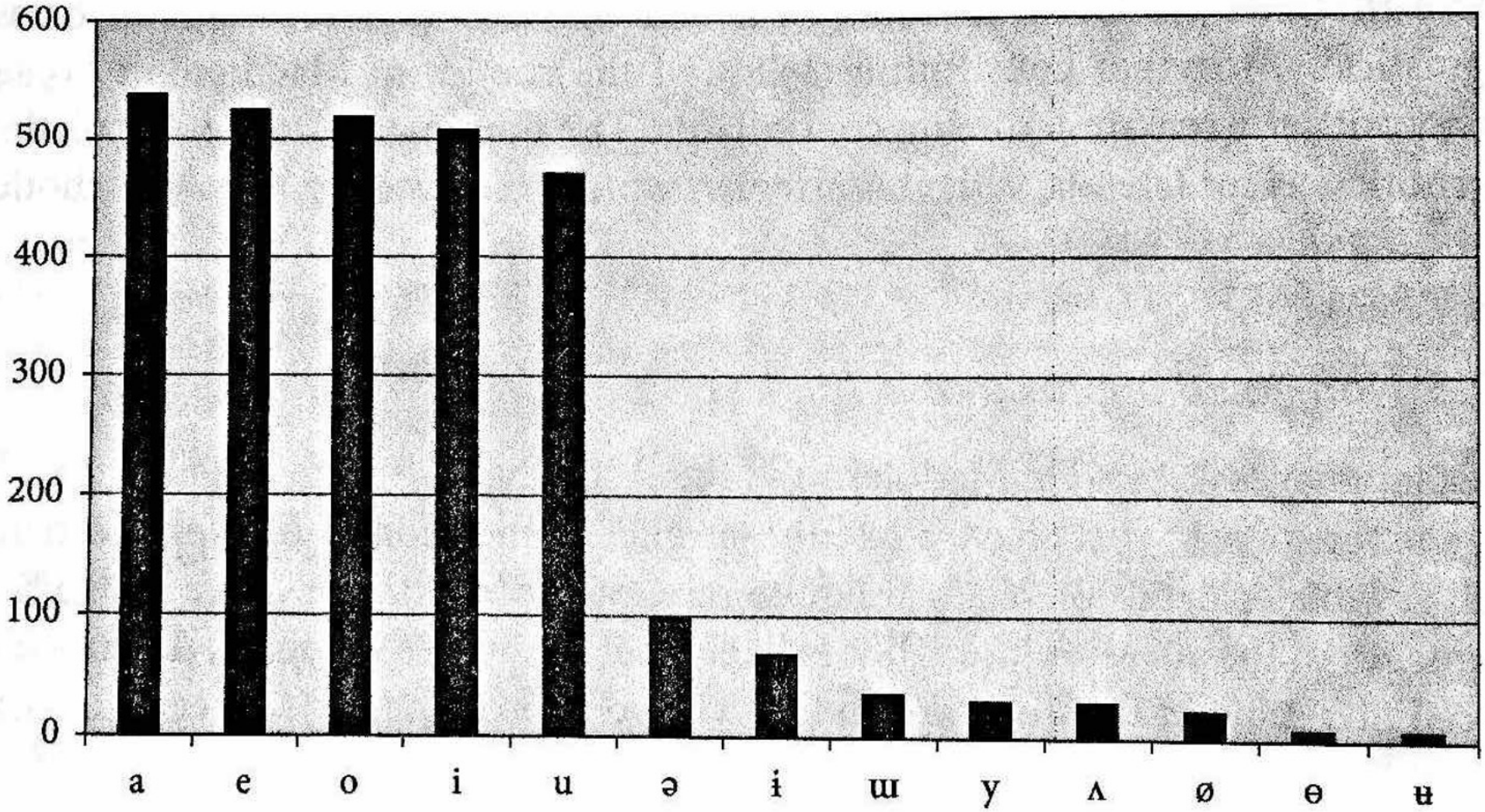


FIGURE 3.6. The number of languages in the 451-language UPSID survey (<http://web.phonetik.uni-frankfurt.de/upsid.html>) possessing the 13 most common vowels

And here is a rapper putting it all together

https://www.youtube.com/watch?v=_LGkbvkCS3I