phonetics 101: how to pronounce anything

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CONSONANTS

THE INTERNATIONAL PHONETIC ALPHABET (revised to 2015)

CONSONANTS (PULMONIC) © 2015 IPA

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k g	q G		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	N		
Trill	B			r					R		
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.

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

ʗ ʖ 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.

		Labial	Dental	Alveolar	Post-alveolar	Palatal	Velar	Glottal
Nasal		m[a]		n[a]			ŋ	
Plosive	fortis	p		t	tʃ		k	
	lenis	b		d	dʒ		g	
Fricative	fortis	f	θ[b]	s	ʃ		(x)[c]	h[d]
	lenis	v	ð[b]	z	ʒ			
Approximant				l[a]	r[e]	j[f]	w[g]	

1. (how many consonant sounds does English have?) let's start with sounds from the course description
    a. b & d (one at a time)
        i. imagine you are teaching someone who is deaf and blind how to pronounce these sounds (so they can't copy what you hear or what you see, but *they have human anatomy*, and they can follow written instructions (and feel too- sure, i guess))
        ii. look for answers resembling: *voiced, plosive, bilabial/alveolar*
        iii. list phonemes as we figure them out, e.g. "b – voiced bilabial plosive"
    b. m & n
        i. what features do these have in common with b & d? *place, voicing*
        ii. what feature is different? *manner*. how would you describe this new feature? *nasal*.
    c. so why *do* these pairs sound so similar? *they only differ in one feature!*

2. going the other way (description -> phoneme)
    a. change voiced to voiceless -> p, t
    b. try pronouncing at velum (soft palate) -> k, g, ŋ

3. start building a periodic table
    a. 3 dimensions: place, manner, voice
        i. ±voice is binary, so just list side-by-side

4. collect phonemes we haven't done yet
    a. (save approximants for later: ɹ, j, l, w)
    b. look for fricatives: f, v, θ, ð, s, z, ʃ, ʒ, h
        i. affricates: analyze as plosive + fricative (even though it's a bit different (i.e. delayed release of plosive))
    c. what feature do these have in common? *fricative*
    d. where would they go on our chart? create new row for fricative + figure out places (labiodental, dental, alveolar, postalveolar, glottal)
        i. would be nice for dental and especially labiodental to go description -> phoneme instead of phoneme -> description

5. approximants
    a. we have 4 more phonemes. identify: ɹ, l, j, w
    b. not plosive, not nasal, not fricative; a new row (i.e. manner), *approximant* (the articulatory parts don't really touch/touch at defined places)
    c. can we identify their places?
        i. ɹ, l: alveolar; based on student suggestion, distinguish eiþer by
            1. ɹ is postalveolar, or
            2. l is lateral: airflow on both sides
        ii. j is a new place: palatal (hard palate)
        iii. w: labiovelar :o

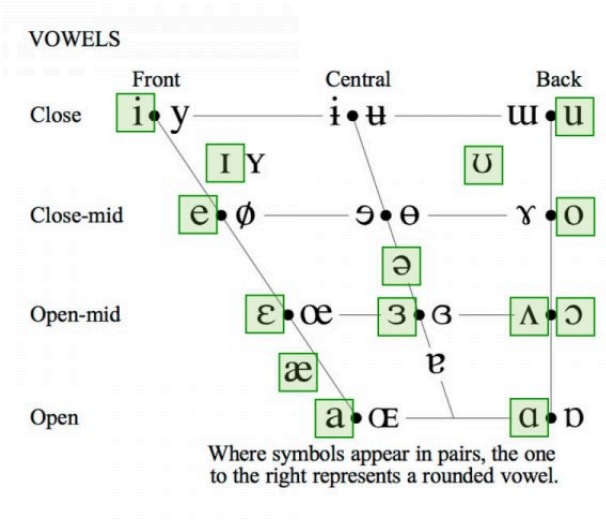
6. show actual ipa consonant chart + wikipedia english consonant chart; what's different? highlight different analyses, especially for approximants (cf. 5.c.i)
    a. also mention glottal stop/plosive

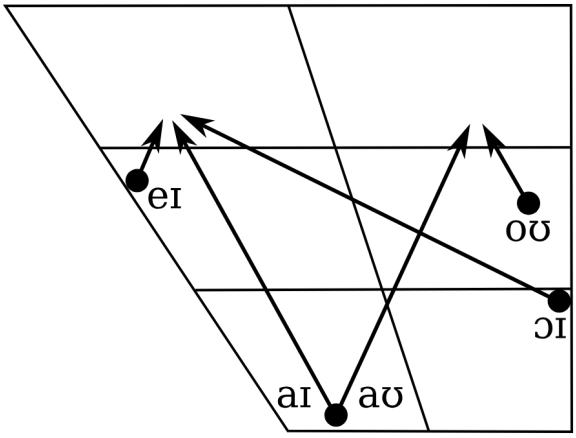
7. pronouncing non-english sounds!
    a. labiodental nasal my beloved
    b. bilabial & velar fricatives
    c. let students pick!
        i. new (i.e. non-english*) manners to try: trill, *tap, lateral fricative
        ii. new places to try: retroflex, palatal, uvular, pharyngeal

8. larger groupings/formal features?

a. manner: sonorant/obstruent
b. manner: ±continuant
c. place: strident/sibilant
d. place: labial coronal dorsal?

VOWELS





Full monophthongs

LS	RP	GA
TRAP	æ	æ
BATH	ɑː	
PALM		ɑ
LOT	ɒ	
CLOTH		ɔ, ɑ
THOUGHT	ɔː	
KIT	ɪ	
DRESS	e[a]	ɛ
STRUT	ʌ	
FOOT	ʊ	

Diphthongs in many dialects[43]

LS	RP	GA
FACE	eɪ	
GOAT	əʊ	oʊ
FLEECE	iː	i
GOOSE	uː	u

Full diphthongs

LS	RP	GA
PRICE	aɪ	
CHOICE	ɔɪ	
MOUTH	aʊ	

Vowels + historical /r/

LS	RP	GA
NURSE	ɜː	ɜr[b]
START	ɑː	ɑr
NORTH	ɔː	ɔr
FORCE		
NEAR	ɪə	ɪr
SQUARE	ɛː	ɛr
CURE	ʊə, ɔː	ʊr

Reduced vowels

LS	RP	GA
COMMA	ə	ə
LETTER		ər
HAPPY	i	

æ ɑ (ɔ) ɪ ɛ ʌ/ɜ ʊ eɪ oʊ i u aɪ ɔɪ aʊ ə

1. (how many vowel sounds does English have?) let's start by listing vowel sounds (not vowel letters) we know exist in english
    a. (spell with example word + underline for now (not ipa))
    b. "short vowels": bath, dress, kit, lot, strut (æ ɛ ɪ ɑ ʌ)
    c. "long vowels": face, fleece, price, goat, goose (eɪ i aɪ oʊ u)

d. others: f<u>oo</u>t, ch<u>oi</u>ce, m<u>ou</u>th, th<u>ough</u>t (ʊ ɔɪ aʊ (ɔ)) (ignoring ə/ɜ)

2. let's focus on monophthongs first (now introduce ipa): æ ɛ ɪ ɑ ʌ i u ʊ (ɔ)
    a. can we divide the non-ə vowels into 2 groups? (maybe difficult; if not, it's okay; just give)
        i. front (in increasing height order): æ ɛ ɪ i
        ii. back (in increasing height order): ɑ ʌ(ɜ) ʊ(ɤ) u(ʉ)
    b. within each group, what feature varies? *tongue height/mouth openness* (plot)
    c. ə/ɜ is an outlier; place in middle

3. diphthongs: eɪ aɪ oʊ ɔɪ aʊ; smooth glide between two vowels
    a. introduce [e], [a], [o], [ɔ]: when we start pronouncing these diphthongs (and "hold it"), the first vowels we encounter are different from all the monophthongs we've seen so far
        i. plot (note rounding distinction between ʌ and ɔ)
    b. where does each diphthong glide to? draw arrows

4. show actual ipa vowel chart & compare
    a. trapezoidal by convention, but it does happen to align with something we'll see later (formants)
    b. pronouncing non-english vowel sounds: just alter the rounding of vowels we know; ex. i → y, etc.

(3-minute break)

ACOUSTICS

1. for consonants, we can just use waveforms (amplitude/loudness vs. time)
    a. what might different manners' waveforms look like? *(see below)*. then, show examples; what regions correspond to what sounds?
        i. vowels: loud
        ii. plosives (-son -cont): big spike (or stop)
        iii. fricatives (-son +cont): sustained & soft; friction; "hissing/buzzing"
            1. sibilants/stridents: louder
        iv. nasals (+son -cont): sustained & loud; voiced
        v. approximants (+son +cont): not really distinguishable from nasals in loudness
            1. once we get to formants, note that nasals have a softer/muffled F2 & F3 (-cont)
            2. glides (/j, w/ in english) look like quick /i, u/
    b. i guess place of articulation isn't really clear

2. for vowels, this doesn't suffice - at same frequency and amplitude, waveforms look the same!
    a. is everyone familiar with the notion of frequency? if not, explain (in terms of physics)
    b. sound waves are not actually a single frequency (i.e. not a pure sine wave)!

i. they are actually a sum of "pure" (sine) waves, each having a frequency that is an integer multiple of the fundamental (main) frequency you hear
    1. the component pure sine waves have different weights/coefficients: $a_1\sin(x) + a_2\sin(2x) + \ldots$ [graph in desmos]
        a. these different weights are responsible for the different timbres of different instruments
    2. you ear *hears* all of these, but your brain only *perceives* the greatest common factor - the *fundamental frequency*
ii. well, non-integer multiples are also represented, but they don't contribute as much

c. looking at the amplitude vs. frequency graph (← periodic amplitude vs. time graph; Fourier transform), we see peaks at these *harmonics* (integer multiples)
d. looking at the contour of these peaks, the peaks of the peaks are *formants*
e. vowels can be characterized by their F1 & F2 (show plot)
f. consonants can also be characterized by formants
    i. fricatives with a mess of high formants (and weak low formants)
    ii. nasals (-cont) have a softer/muffled F2 & F3 compared to approximants (+cont)

(links)

- https://www.ipachart.com/
- https://spectrogram.sciencemusic.org/
- Praat
    - https://www.fon.hum.uva.nl/praat/download_win.html
    - https://www.fon.hum.uva.nl/praat/download_mac.html
    - https://www.fon.hum.uva.nl/praat/download_linux.html

monophthongs

front	**back (-front)**
fleece	goose
kit	foot
dress	strut
trap/bath	palm/lot/cloth/thought

diphthongs

-i	-u
face	goat
price	mouth
choice	