LING 520 Introduction to Phonetics I
Fall 2008

Week 1

Introduction
Anatomy of speech production
Consonants and vowels
Phonetic transcription

Sep. 8, 2008

What is phonetics?

- Phonetics is the study of speech sounds.

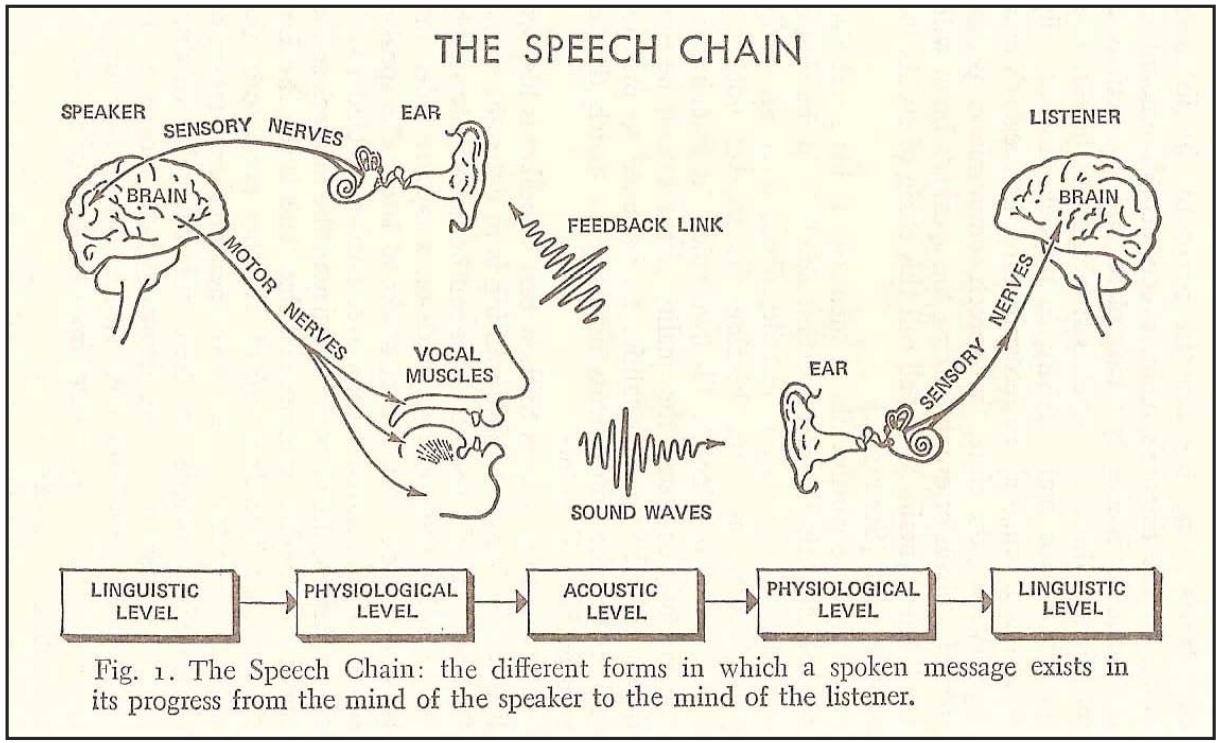


Fig. 1. The Speech Chain: the different forms in which a spoken message exists in its progress from the mind of the speaker to the mind of the listener.

(from Denes & Pinson, 1993)

- Articulatory phonetics, acoustic phonetics, auditory phonetics.

Articulatory phonetics

- How are speech sounds produced?
- How do we classify and transcribe speech sounds?

THE INTERNATIONAL PHONETIC ALPHABET (revised to 1993, corrected 1996)

CONSONANTS (PULMONIC)

	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				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			

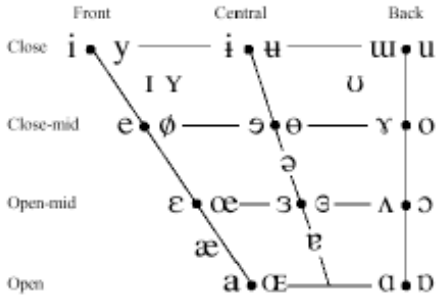
Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

CONSONANTS (NON-PULMONIC)

Clicks		Voiced implosives		Ejectives	
ʘ	Bilabial	ɓ	Bilabial	’	Examples:
|	Dental	ɗ	Dental/alveolar	p’	Bilabial
!	(Post)alveolar	ʄ	Palatal	t’	Dental/alveolar
ǂ	Palatoalveolar	ɠ	Velar	k’	Velar
‖	Alveolar lateral	ʛ	Uvular	s’	Alveolar fricative

This reference card was printed by Cascadilla Press.
For details on our linguistics books and software, call us at 1-617-776-2370 or go to http://www.cascadilla.com.

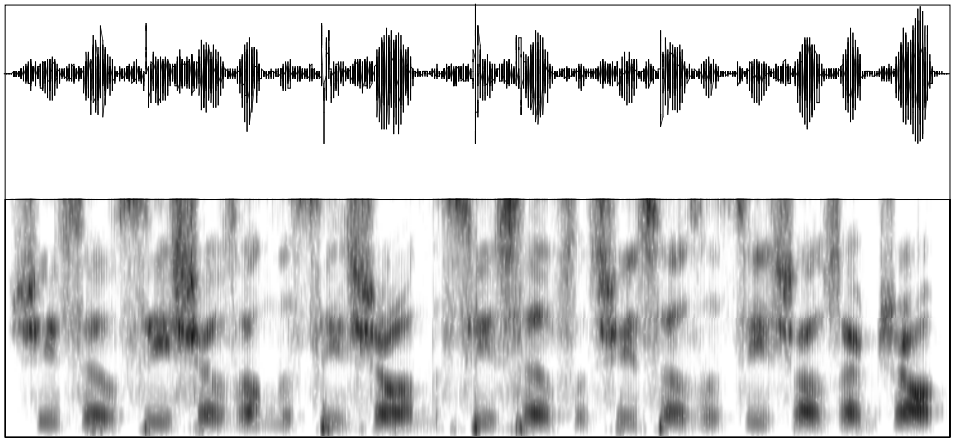
VOWELS



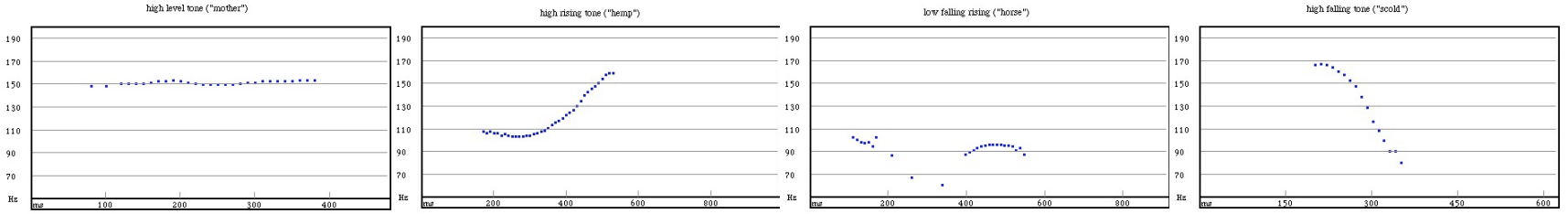
Where symbols appear in pairs, the one to the right represents a rounded vowel.

Acoustic phonetics

- The acoustic properties of speech sounds.



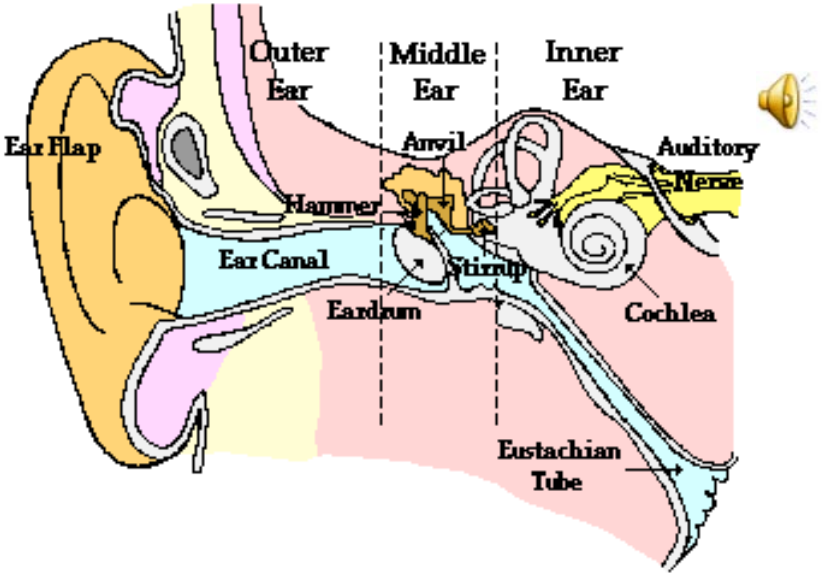
She sells seashells on the seashore and the seashells that she sells are seashells I'm sure (consonants and vowels).



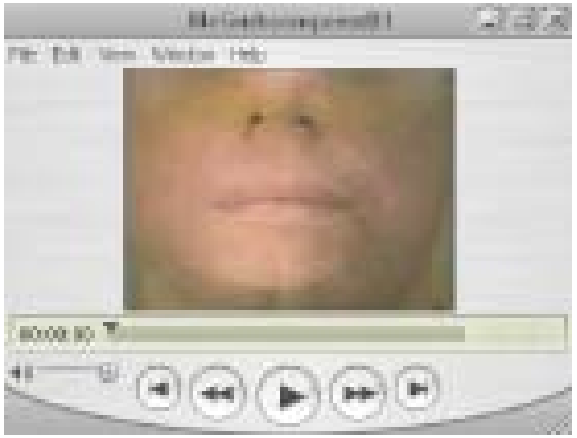
Mandarin tones
http://www.uiowa.edu/~linguist/faculty/beckman/lotw01/mantone.html

Auditory phonetics

- How are speech sounds received and perceived?

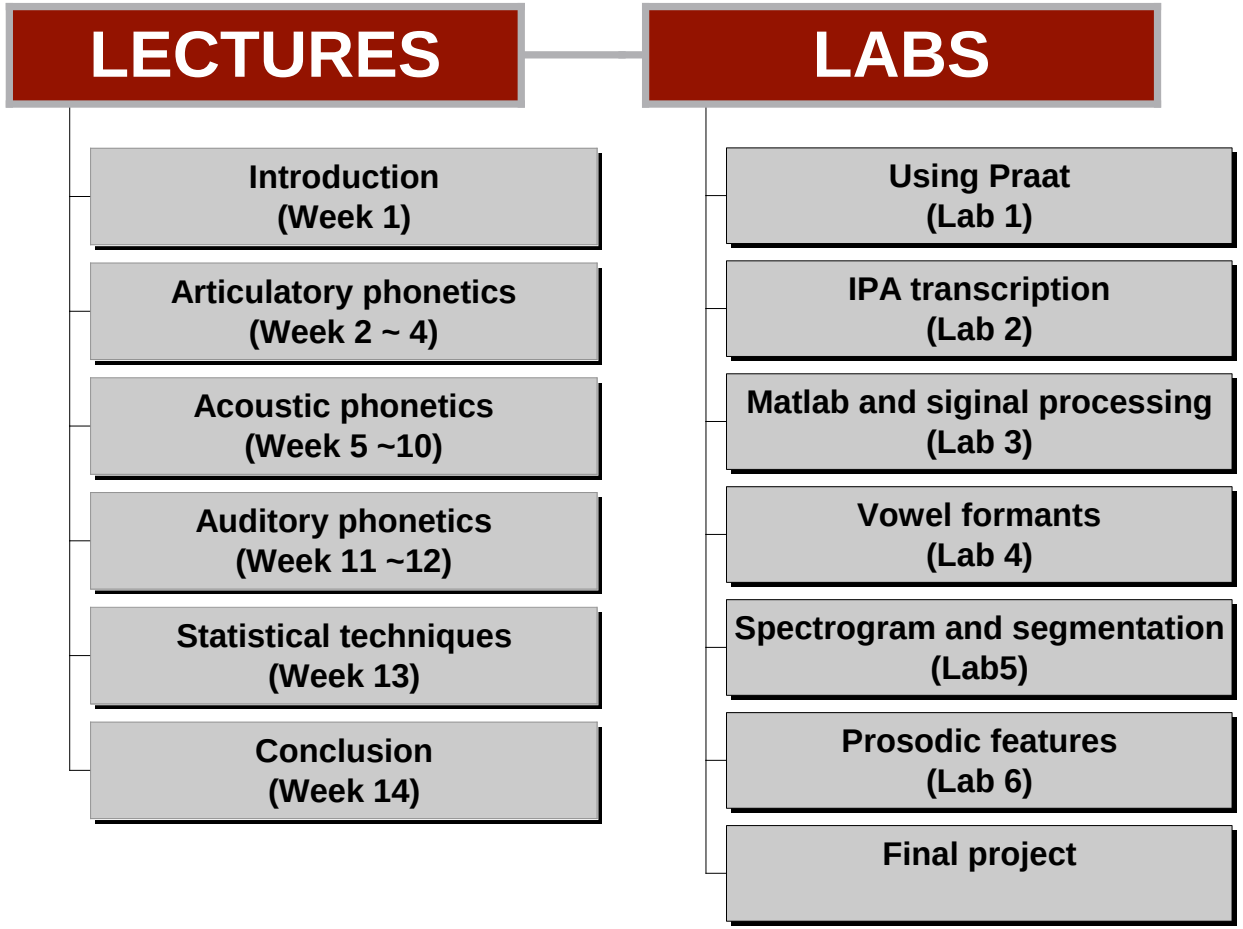


http://www.glenbrook.k12.il.us/gbssci/phys/Class/sound/u11l2d.html



McGurk Effect:
http://www.faculty.ucr.edu/~rosenblu/VSMcGurk.html

Course outline



TOOLS: Praat, Matlab, R

Speech organs

Nasal Cavity

Oral Cavity

Pharynx

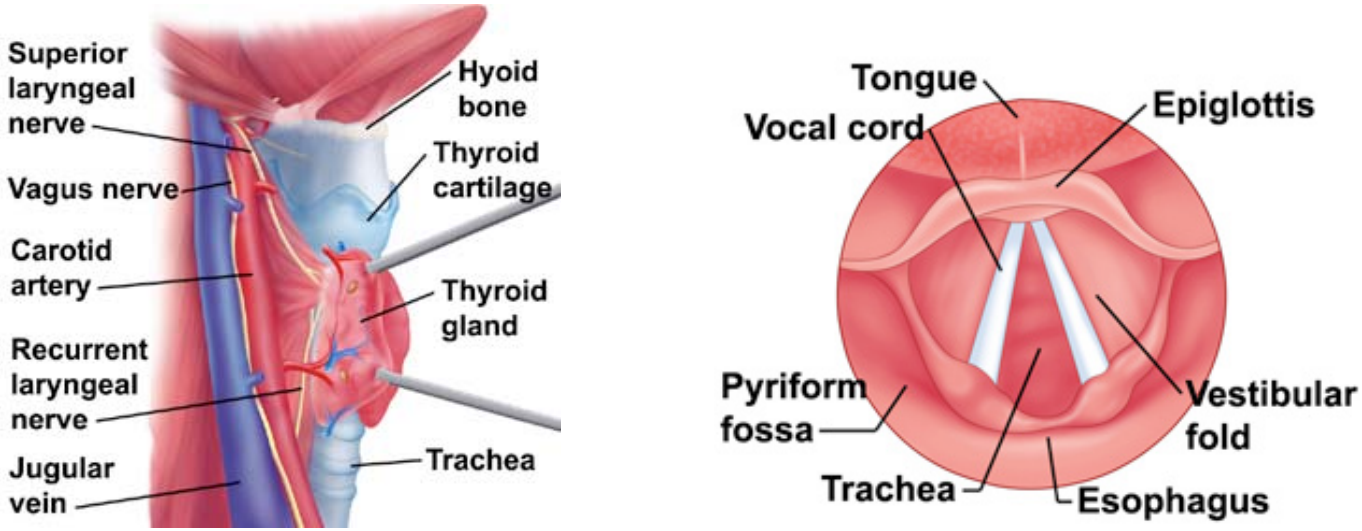
Larynx: vocal folds in it

Trachea: the windpipe

Lung: supply airstream

Sagittal section of the vocal tract (Techmer 1880)
[From: Dan Jurafsky slide]

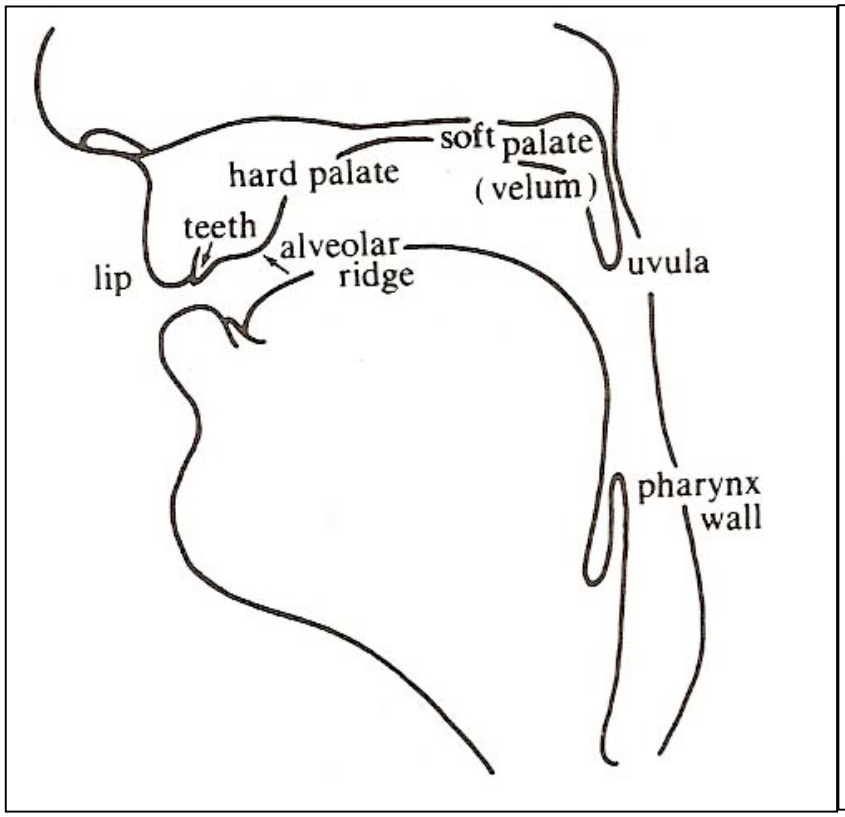
Larynx and vocal folds

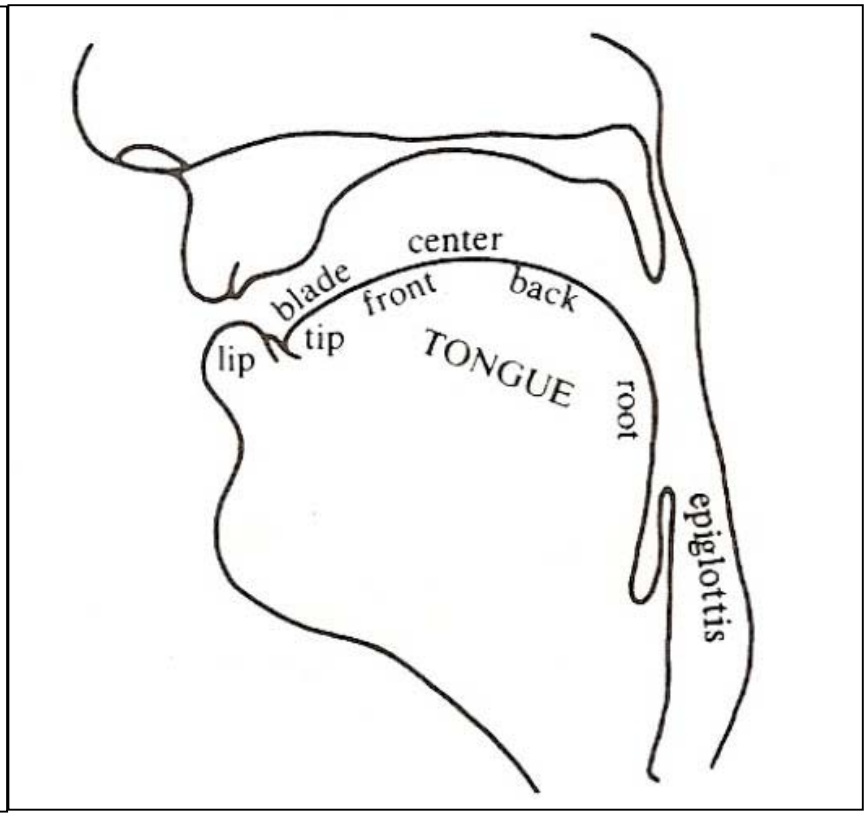


The anatomy of the larynx and vocal cords
[From: www.yoursurgery.com]

- Vocal Folds (vocal cords)
  - Two bands of muscle and tissue in the larynx
  - Sounds produced when the vocal folds are vibrating are said to be voiced, those produced when the vocal folds are apart are voiceless

Articulators





Upper Surface

Lower Surface

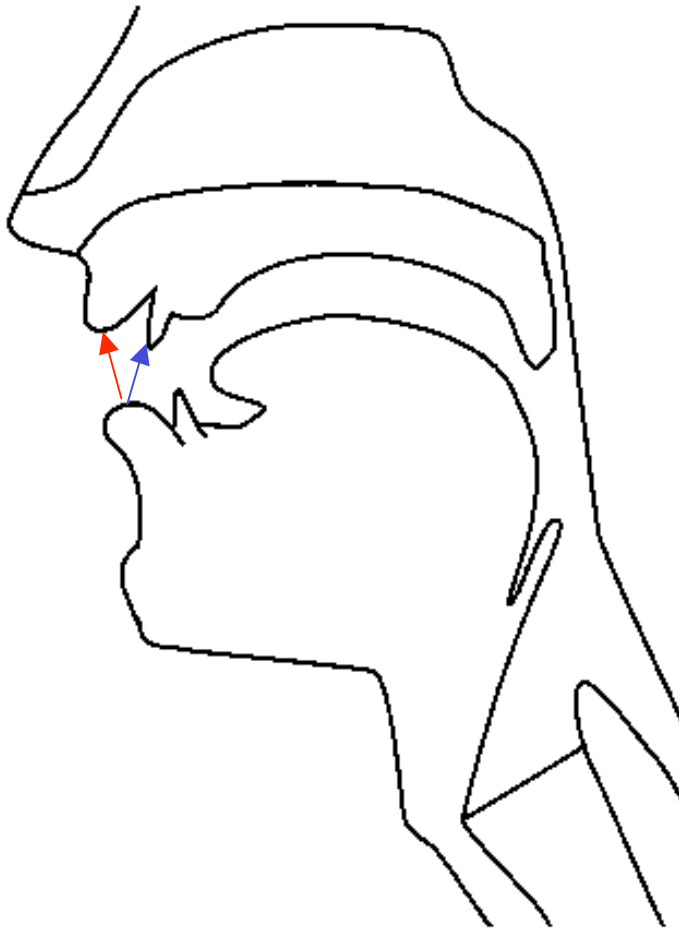
Articulation of consonants

- Places of articulation: which active articulator is making the articulation, and what part of the upper vocal tract is involved.
  - Bilabial, labiodental, dental, alveolar, Retroflex, Paloto-Alveolar, Palatal, Velar, etc.

- Manners of articulation: the ways in which consonants are produced. The articulators may close off the oral tract, or may narrow the space considerably.
  - Oral stop, nasal stop, fricative, approximant, lateral approximant, tap/flap, affricate, etc.

Places of articulation: labial

- Bilabial: made with two lips (*pie*, *buy*, *my*)
- Labiodental: lower lip and Upper front teeth (*fie*, *vie*).



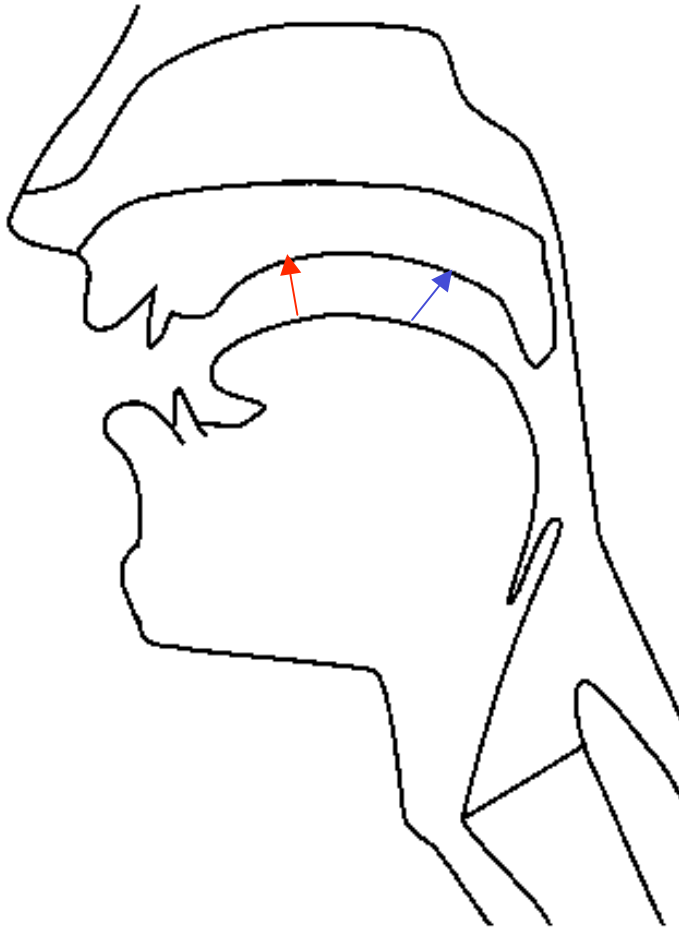
Places of articulation: coronal

- Dental: tongue tip or blade and upper front teeth (*thigh*, *thy*). (interdental: the tip of the tongue protrudes between the upper and the lower front teeth).
- Alveolar: tongue tip or blade and the alveolar ridge (*tie*, *die*, *nigh*, *sigh*, *zeal*, *lie*).
- Retroflex: tongue tip and back of the alveolar ridge (*rye*, *row*, *ray*).
- Palato-Alveolar (post-alveolar): tongue blade and the back of the alveolar ridge (*shy*, *she*, *show*).

Places of articulation: dorsal

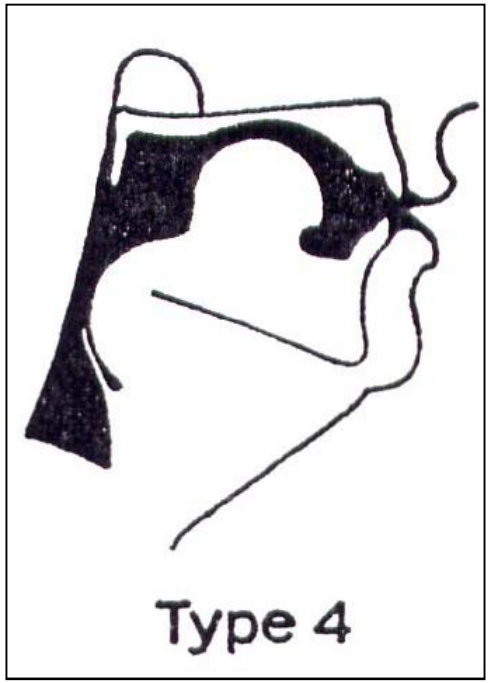
- Palatal: front of the tongue and hard palate (*you*). Palatal sounds are sometimes classified as coronal.

- Velar: back of the tongue and the soft palate (*hack*, *hag*, *hang*).



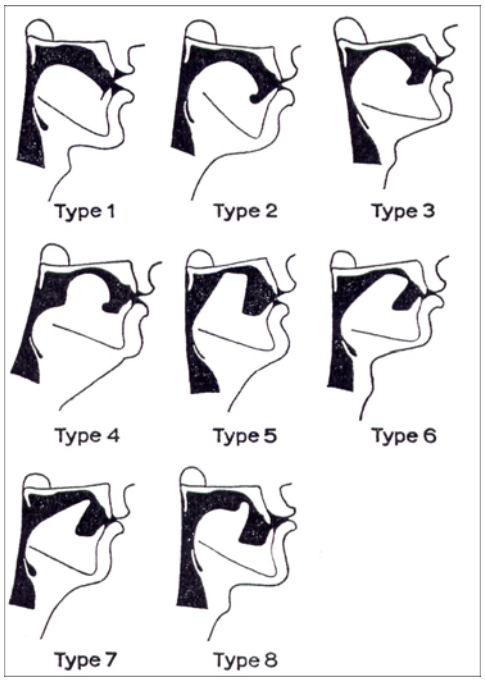
American English /r/

- American English /r/ has a variety of perceptually indistinct articulatory strategies.
- The Delattre and Freeman (1968) taxonomy:



bunched

retroflex



Manners of articulation

- **Stop:** complete closure of articulators, so no air escapes through mouth

- **Oral stop:** In addition to the articulatory closure in the mouth, the soft palate is raised so that the nasal tract is blocked off, no air escapes through nose. Air pressure builds up behind closure, explodes when released.
  - *pie*, *buy* (bilabial closure), *tie*, *dye* (alveolar closure), *kye*, *guy* (velar closure).

- **Nasal stop:** oral closure, but soft palate is lowered, air escapes through nose.
  - *my* (bilabial closure), *nigh* (alveolar closure), *sang* (velar closure).

Oro-nasal process

[From: Dan Jurafsky slide]

- Oral sounds: The soft palate is raised so there is a velic closure.
- Nasal sounds: The soft palate is lowered so air escapes from nose.

Manners of articulation

- **Fricative:** Close approximation of two articulators, resulting in turbulent airflow between them, producing a hissing sound.
  - *fie, vie* (labiodental), *thigh, thy* (dental), *sigh, zoo* (alveolar), *shy* (palato–alveolar).
  - The higher–pitched sounds with a more obvious hiss, such as those in *sigh*, *shy*, are called sibilants.
- **Approximant:** One articulator is close to another, but without the vocal tract being narrowed to such an extent that a turbulent airstream is produced.
  - *yes* (approximation in the palatal area), *we* (approximation between the lips and in the velar region), *raw* (approximation in the alveolar region).
- **Lateral approximant:** Obstruction of airstream along center of oral tract, with opening around one or both sides of the tongue.
  - *lie*, *laugh* (alveolar lateral)

Manners of articulation

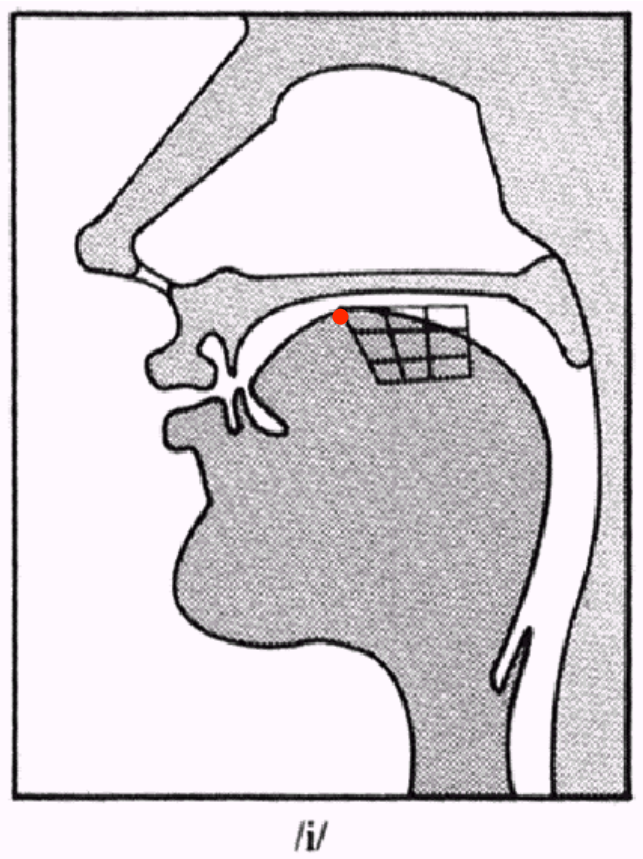
- **Tap or flap**
  - Tongue makes a single tap against the alveolar ridge
    - *pity*, *butter*

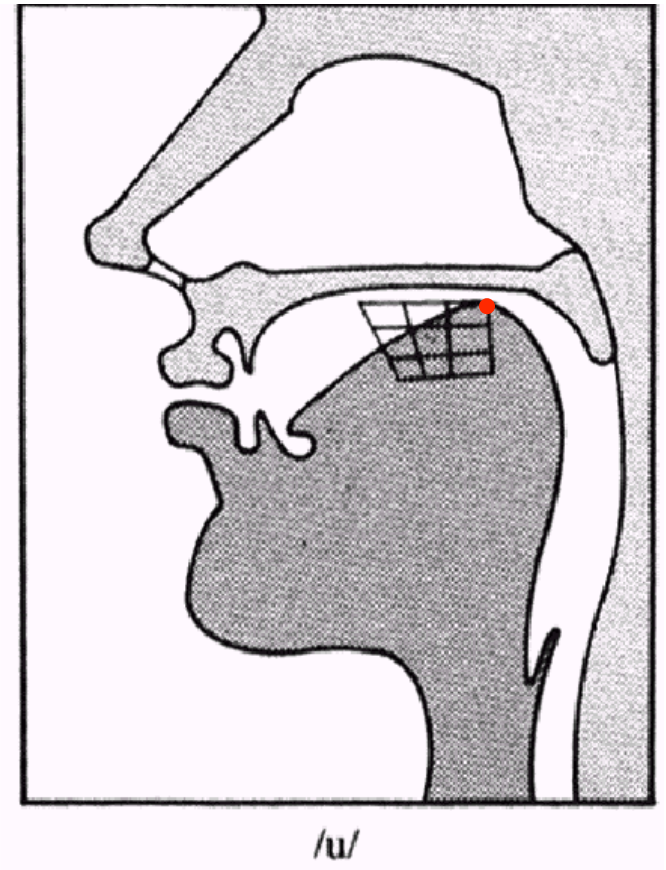
- **Affricate**
  - A combination of a stop immediately followed by a fricative (controversial)
    - *church*, *judge*

Articulation of vowels

- Position of the highest point of the tongue (controversial):
  - Front vs. back
  - high vs. low
- Position and shape of the lips:
  - Rounded vs. unrounded
- Diphthong:
  - A vowel in which there is a change in quality during a single syllable, as in English *high*.

Articulation of vowels



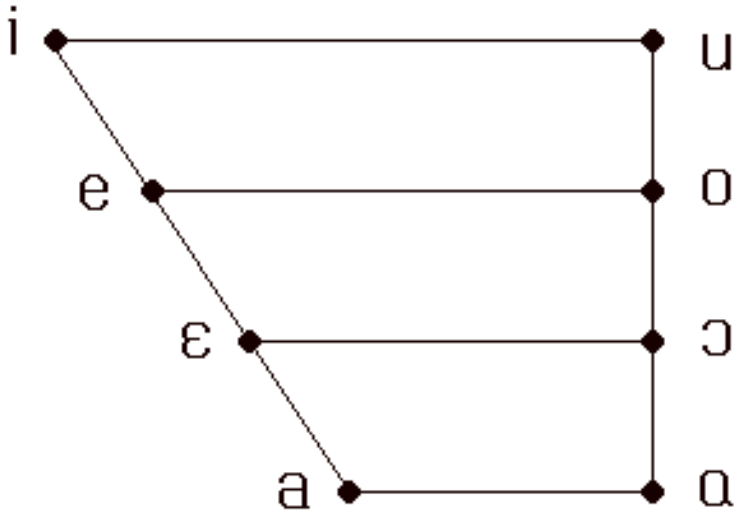


he *who*

From: Jennifer Venditti slide

Cardinal vowels

- A set of reference vowels evenly spaced between the two most extreme tongue body positions: high front [i] and low back [ɒ]. Other vowels are placed on the vowel chart using these cardinal vowels as landmarks.



Produced by Daniel Jones

Produced by Peter Ladefoged

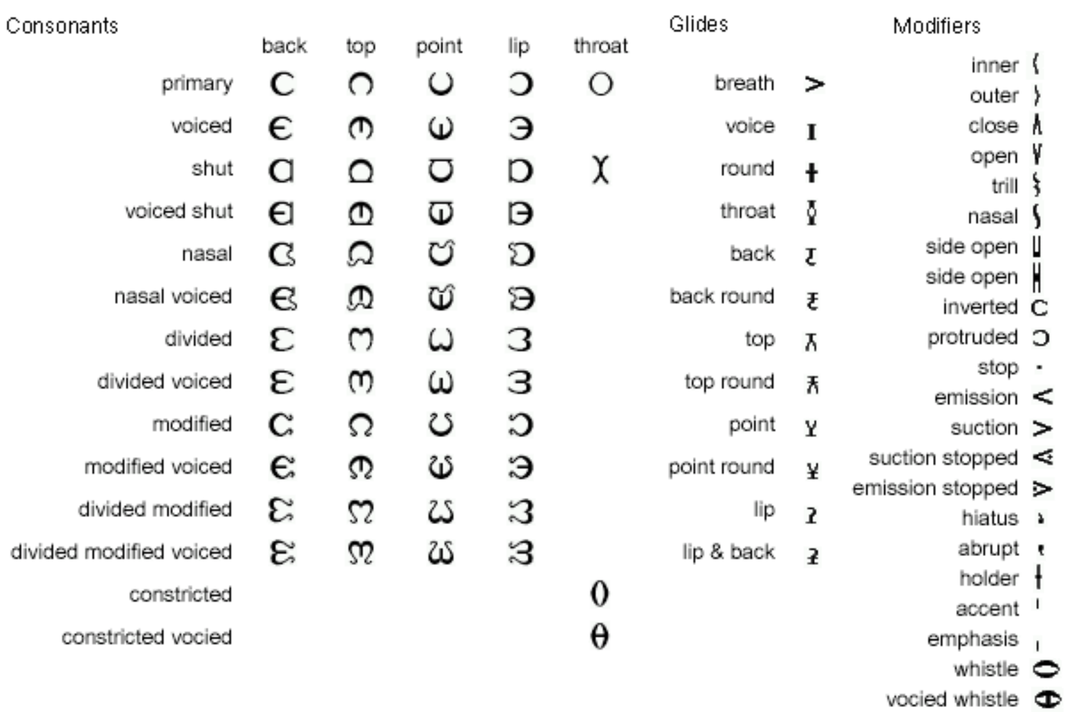
Phonetic transcription

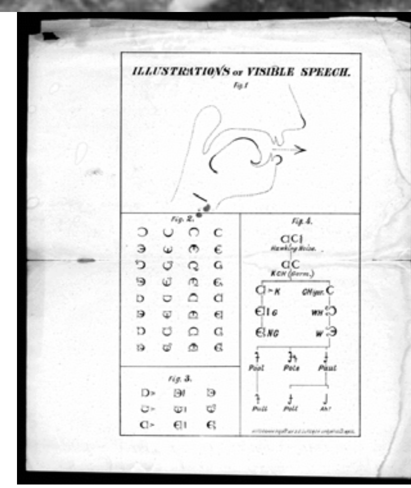
- Phonemes and allophones
  - Phoneme: one of a set of abstract units that can be used for writing a language down in a systematic and unambiguous way.
  - Allophone: a variant of a phoneme. The allophones of a phoneme form a set of sounds that do not change the meaning of a word and are all very similar to one another. For example, *study* and *tie*.
  - Phonemes and allophones are language-specific.

- Broad vs. narrow transcription
  - **Narrow transcription:** captures as many aspects of a specific pronunciation as possible and ignores as few details as possible.
  - **Broad transcription** (or **phonemic transcription**): ignores as many details as possible, capturing only enough aspects of a pronunciation to show how that word differs from other.

Phonetic transcription

- **Visible Speech** (Alexander Melville Bell 1819 – 1905): the first notation system for the sounds of speech independent of a particular language or dialect.





Phonetic transcription

- **Romic Alphabet** (Henry Sweet 1845 – 1910): It is the direct ancestor of the modern IPA (International Phonetic Alphabet). The alphabet differs from previously proposed spelling reforms by favoring using the Roman alphabet and the original Latin sound values.

aa: papa, far, glass, after, aunt.
æ: man.
ae: aerate, bear, fate. [Always f
ai: Isaiah, aisle, wine.
ao: extraordinary, broad, more.
au: Faust, now, noun.
e: red.
ei: they, veil, name.
i: ill, fishes.
ii, iy: machine, feel.
o: not, cloth, cross, soft. [Often
oi: boy, boil.
ou: flow, soul, stone.
u: full, put, good.
uu, uw: truth, rue, fool.
ʌ: up, come; father, here.
oe: her, turn, heard.

c: church, catch.
dh: then, with.
j: judge, gentle.
q: sing, finger.
sh: fish.
th: think.
x: six, wrecks.
y: young.
zh: rouge, pleasure.

Phonetic transcription

- International Phonetic Alphabet: the first IPA chart was published in 1888.

ði intəˈnæʃənəl fəˈnɛtɪk əsousiˈeiʃn

	Bi-labial	Labio-dental	Dental and Alveolar	Retroflex	Palato-alveolar	Alveolo-palatal	Palatal	Velar	Uvular	Pharyngal [sic]	Glottal
Plosive	p b		t d	ʈ ɖ			c ɟ	k ɡ	q ɢ		ʔ
Nasal	m	ɱ	n	ɳ			ɲ	ŋ	ɴ		
Lateral Fricative			ɬ ɮ								
Lateral Non-Fricative			l	ɭ			ʎ				
Rolled			r						ʀ		
Flapped			ɾ	ɽ					ʀ		
Fricative	ɸ β	f v	θ ð s z ɹ	ʂ ʐ	ʃ ʒ	ɕ ʑ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Frictionless Continuants	w ɥ	ʋ	ɹ				j (ɥ)	(w)	ʁ		

		Front	Central	Back
Close	(y ʉ u)	i y	ɨ ʉ	ɯ u
	(ʏ ɷ)	ɪ ʏ		ɷ
Half-close	(ø ɵ o)	e ø	ɵ	ɤ o
			ə/ɜ	
Half-open	(œ ɔ)	ɛ œ		ʌ ɔ
		æ	ɐ	
Open	(ɒ)		a	ɑ ɒ

Other sounds

pʼ ʅ ʒ ʄ ƫ ʑ = ʐ ʘ ʗ ʘ ǫ ʞ ʘ̃ ʓ ɺ ǃ ʖ ɕ

1932 Version

IPA: consonants (1)

Consonants (pulmonic)

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

IPA: consonants (2)

Consonants (non-pulmonic)

Anterior click releases (require posterior stops)	Voiced implosives	Ejectives
ʘ bilabial fricated	ɓ Bilabial	’ examples:
ǀ Laminal alveolar fricated ("dental")	ɗ Dental or alveolar	pʼ Bilabial
ǃ Apical (post)alveolar abrupyt ("retroflex")	ʄ Palatal	tʼ Dental or alveolar
ǂ Laminal postalveolar abrupt ("palatal")	ɠ Velar	kʼ Velar
ǁ Lateral alveolar fricated ("lateral")	ʛ Uvular	sʼ Alveolar fricative

Consonants (co-articulated)

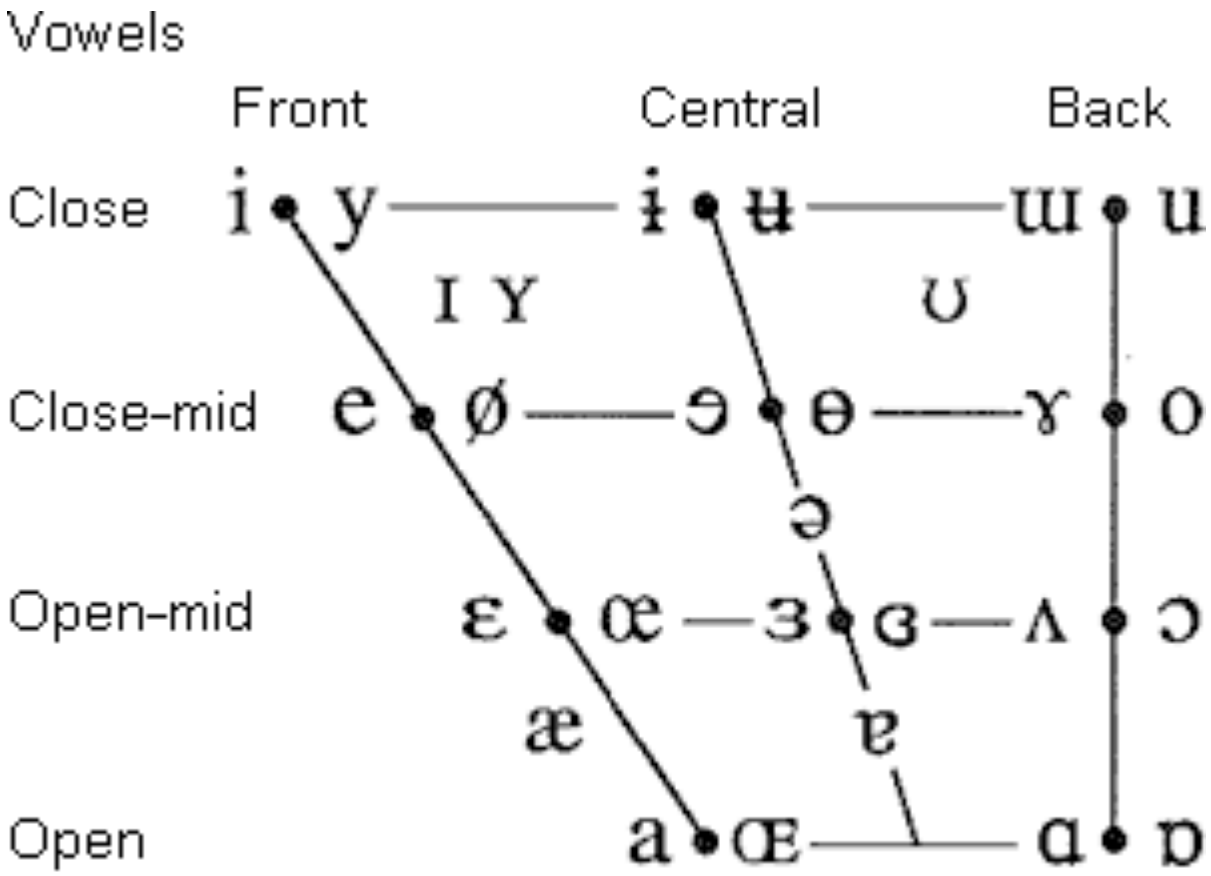
ʍ	Voiceless labialized velar approximant
w	Voiced labialized velar approximant
ɥ	Voiced labialized palatal approximant
ɕ	Voiceless palatalized postalveolar (alveolo-palatal) fricative
ʑ	Voiced palatalized postalveolar (alveolo-palatal) fricative
ɧ	simultaneous x and ʃ
k͡p	Affricatives and double articulations can be joined by a tie bar

IPA: diacritics

Diacritics

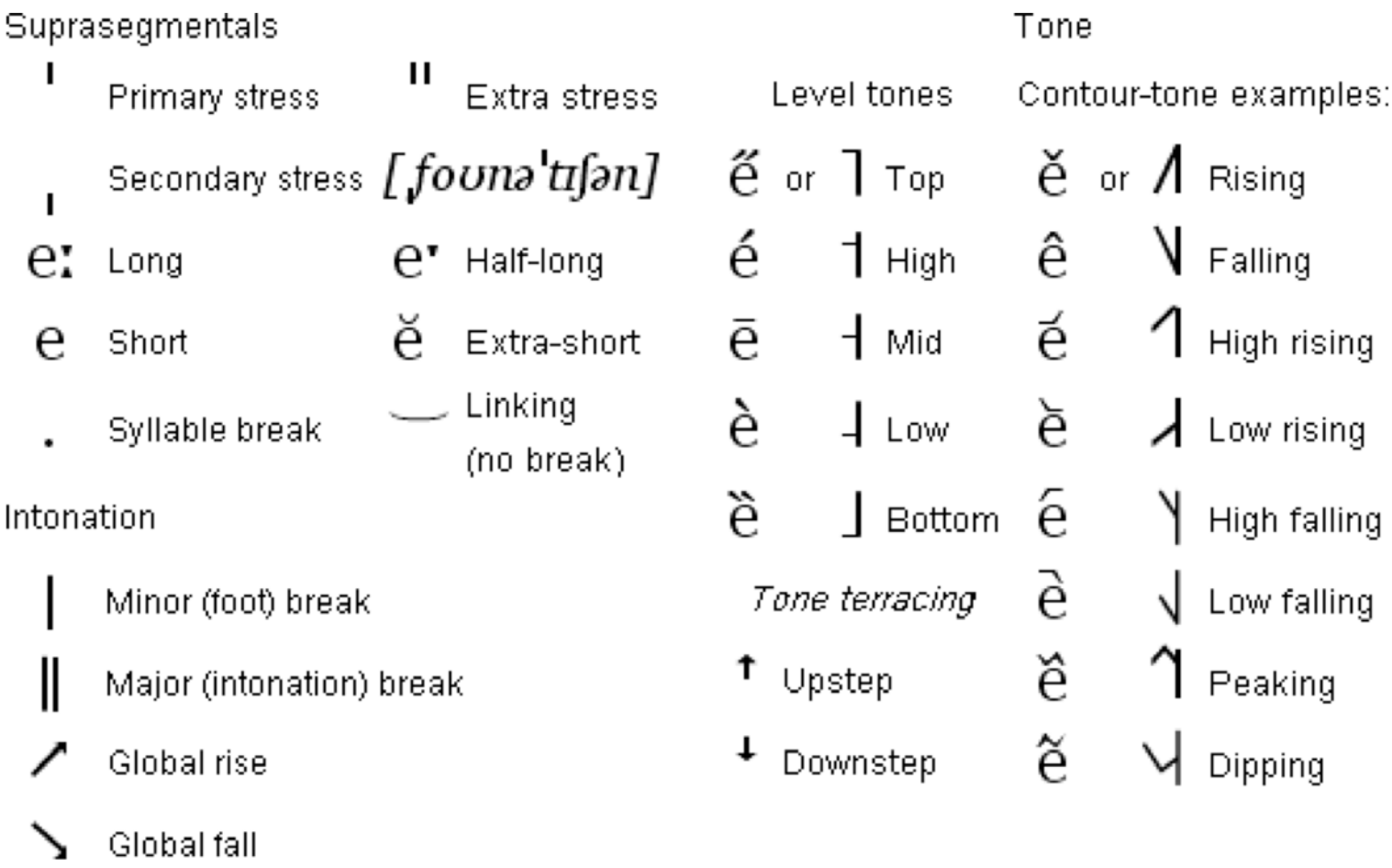
Syllabicity & Releases		Phonation		Primary Articulation		Secondary Articulation			
n̩ ɹ̩	Syllabicity	n̥ d̥	Voiceless *or* Slack voice	t̪ b̪	Voiceless *or* Slack voice	tʷ dʷ	Labialized	ɔ̹ x̹	More rounded
e̞ ɣ̞	Non-syllabic	s̬ d̬	Modal voice *or* Stiff voice	t̺ d̺	Apical	tʲ dʲ	Palatalized	ɔ̜ xʷ̜	Less rounded
tʰ ʰt	(Pre)aspirated	n̤ a̤	Breathy voice	t̻ d̻	Laminal	tˠ dˠ	Velarized	ẽ z̃	Nasalized
d	Nasal release	n̰ a̰	Creaky voice	u̟ t̟	Advanced	tˤ dˤ	Pharyngealized	ɚ˞ ɜ˞	Rhoticity
dˡ	Lateral release			i̠ t̠	Retracted	ɬ ɮ	Velarized or pharyngealized	e̘ o̘	Advanced tongue root
t̚	No audible release	n̼ d̼	Linguolabial	ä j̈	Centralized	ɯ̽ u̽	Mid-centralized	e̙ o̙	Retracted tongue root
e̝ β̝	Lowered	(β̞ is a bilabial approximant)		e̝ ɹ̝	Lowered	(ɻ is a voiced alveolar non-sibilant fricative			

IPA: vowels



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

IPA: suprasegmentals



IPA: English consonants

	⇓	⇓	⇓	
p	pie	pea		lower-case *p*
t	tie	tea		lower-case *t*
k	kye	key		lower-case *k*
b	by	bee		lower-case *b*
d	dye	D		lower-case *d*
g	guy			lower-case *g*
m	my	me	ra*m*	lower-case *m*
n	nigh	knee	ra*n*	lower-case *n*
ŋ			ra*ng*	eng (or angma)
f	fie	fee		lower-case *f*
v	vie	V		lower-case *v*
θ	thigh			theta
ð	thy	thee		eth
s	sigh	sea	listen	lower-case *s*
z		Z	mizzen	lower-case *z*
ʃ (š)	shy	she	mi*ss*ion	esh (or long *s*)
ʒ (ž)			vi*s*ion	long *z* (or yogh)
l	lie	lee		lower-case *l*
w	why	we		lower-case *w*
r (r)	rye			lower-case *r*
j (y)		ye		lower-case *j*
h	high	he		lower-case *h v*
Note also the following:				
tʃ (tš)	chi(me)	chea(p)		
dʒ (dž)	ji(ve)	G		

IPA: English vowels

1	⇓	⇓	⇓	⇓	⇓	
i	heed	he	bead	heat	keyed	lower-case *i*
ɪ	hid		bid	hit	kid	small capital *I*
eɪ	hayed	hay	bayed	hate	Cade	lower-case *e*
ɛ	head		bed			epsilon
æ	had		bad	hat	cad	ash
ɑ	hard		bard	heart	card	script *a*
ɑ	hod		bod	hot	cod	(2) turned script *a*
ɔ	hawed	haw	bawd		cawed	open *o*
ʊ	hood				could	upsilon
oʊ	hoed	hoe	bode		code	lower-case *o*
u	who 'd	who	booed	hoot	cooed	lower-case *u*
ʌ	Hudd		bud	hut	cud	turned *v*
ɜ	herd	her	bird	hurt	curd	reversed epsilon
aɪ	hide	high	bide	height		lower case a (+ ɪ)
aʊ		how	bowed		cowed	(as noted above)
ɔɪ		(a)hoy	Boyd			(as noted above)
ɪ r		here	beard			(as noted above)
ɛr		hair	bared		cared	(as noted above)
aɪr	hired	hire				(as noted above)
ju	hued	hue	Bude		cued	(as noted above)

Phonetic transcription: ARPAbet

- ARPAbet uses only ASCII characters.
- It is widely used in the speech technology society.
- Online pronunciation dictionaries:

	phoneset derived from:	number of wordforms	English variety
LDC PRONLEX	ARPAbet	90,694	American
CMUdict	ARPAbet	100,000	American
CELEX	IPA	160,595	British

ARPAbet-IPA chart

ARPABET	IPA	ARPABET	IPA
p	p^h, p	l	l
b	b	r	ɹ
t	t^h, t	w	w
d	d	y	j
k	k^h, k	er	ɚ
g	g	iy	i
f	f	ih	ɪ
v	v	ey	eɪ
th	θ	eh	ɛ
dh	ð	ae	æ
s	s	aa	ɑ
z	z	ah	ʌ
sh	ʃ	ax	ə
zh	ʒ	ao	ɔ
hh	h	ow	oʊ
ch	tʃ	uh	ʊ
jh	dʒ	uw	u
m	m	ay	aɪ
n	n	aw	aʊ
ng	ŋ	oy	ɔɪ

Unicode and IPA

- In old days, fonts contain 256 glyphs, with code points numbered 0 to 255. In most fonts, code point 65 was the glyph **A**. in a particular IPA font, however, code point 65 might be the glyph **ɐ**.
- Unicode encoding uses 32 bits. This is enough that each distinct glyph can have a unique number. For example, **A** is number 65 and **ɐ** is number 336.
- Unicode IPA fonts: Lucida Grande, Arial Unicode MS, Lucida Sans Unicode, Doulos SIL, Charis SIL, Gentium.

- How to use unicode IPA fonts:

1. Handel, "unicode and IPA"

http://courses.washington.edu/chin342/342guide_to_unicode_ipa.pdf

2. Hayes: Phonetic Fonts Page

http://www.linguistics.ucla.edu/people/hayes/Fonts/