

2. Phonetics

What is phonetics?

- ▶ The study of the minimal units that make up language, i.e., the sounds of speech—the consonants, vowels, melodies, and rhythms
- ▶ Articulatory phonetics: the study of the production of speech sounds
- ▶ Acoustic phonetics: the study of the transmission and the physical properties of speech sounds
- ▶ Auditory phonetics: the study of the perception of speech sounds
- ▶ Which sounds are possible in speech?

Representing speech sounds

2.1.1 studying pronunciation

Spelling	Gershwin	Webster's	Amer. Heritage
tomato	tomato	tə'mātō	təmə'tō
tomato	tomahto	tə'måtō	təmə'tō

Let's call the whole thing off

<https://www.youtube.com/watch?v=017DOCS2p8>

Phonetic transcription system

- ▶ The same sound is spelled using different letters
 - [i] sea, see, scene, receive, thief, amoeba, machine
- ▶ The same letters can stand for different sounds
 - sing, pleasure, resign; charter, character; father, all, about, apple, any, age
- ▶ A single sound is spelled by a combination of letters
 - lock, that, book, boast, mountain, shop, apple, special
- ▶ A single letter represents a combination of sounds: exit, use
- ▶ Letters stand for no sound at all
 - know, doubt, thought, island, rhubarb, moose

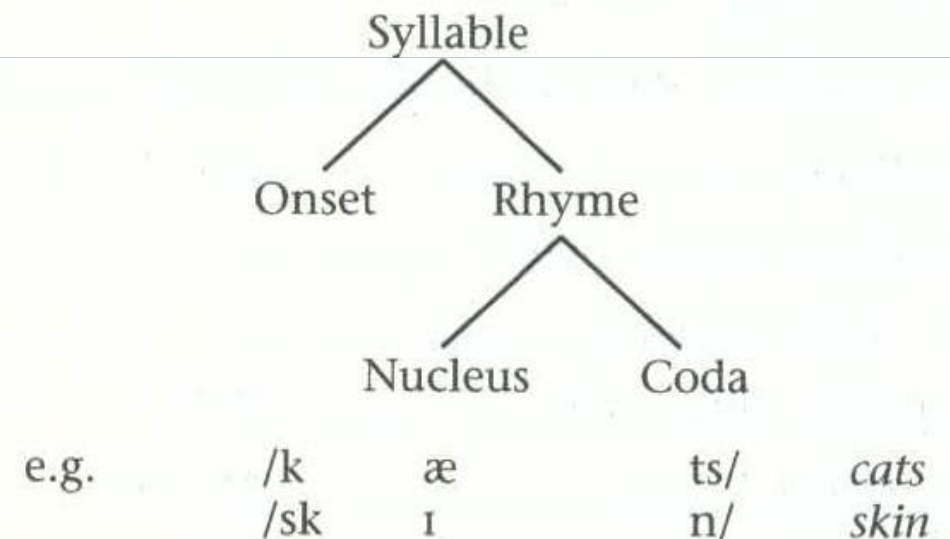
Types of speech sounds

► Segments: consonants, vowels

- Consonants are produced with a constriction somewhere in the vocal tract that impedes airflow.
- Vowels have at most only a slight narrowing and allow air to flow freely through the oral cavity.
- Vowels can function as nucleus (heart) of the syllable, carrying suprasegmental information such as stress, volume, and pitch.
- Vowels: monothong, diphthong
- *knives* vs *naive*

► Suprasegments: stress, tone, intonation

(1) Syllable structure



Phonetic Symbols for English (IPA)

IPA (International Phonetic Alphabet)
Phonetic symbols in []

Symbol	Sample Words	Name of Symbol
Consonants:		
[p]	<u>p</u> it, ti <u>p</u> , sp <u>i</u> t, hiccough <u>h</u> , app <u>e</u> ar	
[b]	<u>b</u> all, gl <u>o</u> b <u>e</u> , am <u>b</u> le, <u>b</u> rick, <u>b</u> ubb <u>l</u> e	
[t]	<u>t</u> ag, pa <u>t</u> , st <u>i</u> ck, p <u>t</u> erodactyl, st <u>u</u> ff <u>e</u> d	
[d]	<u>d</u> ip, car <u>d</u> , <u>d</u> rop, lov <u>e</u> d, batt <u>e</u> d	(cont.)

Symbol	Sample Words	Name of Symbol
[k]	<u>k</u> it, <u>s</u> c <u>oo</u> t, <u>ch</u> ar <u>a</u> cter, <u>cr</u> it <u>iq</u> ue, <u>ex</u> ceed ¹	glottal stop
[g]	<u>g</u> uard, ba <u>g</u> , fi <u>n</u> ger, designate, Pittsb <u>urgh</u>	
[ʔ]	uh- <u>o</u> h, ha <u>t</u> r <u>a</u> ck, Ba <u>t</u> man	
[f]	<u>f</u> oot, lau <u>gh</u> , <u>ph</u> ilosoph <u>y</u> , coff <u>e</u> e, caraf <u>e</u>	
[v]	<u>v</u> est, do <u>v</u> e, grav <u>e</u> l, anv <u>i</u> l, averag <u>e</u>	theta eth, [ɛð]
[θ]	<u>th</u> rough, wr <u>ath</u> , <u>th</u> istle, <u>eth</u> er, te <u>eth</u>	
[ð]	<u>th</u> e, <u>th</u> eir, mo <u>th</u> er, <u>eth</u> er, te <u>eth</u> e	
[s]	<u>s</u> oap, ps <u>y</u> chology, pack <u>s</u> , desc <u>en</u> t, peac <u>e</u> , ex <u>cr</u> uciating ¹	esh, [ɛʃ] yogh, [jouɡ] or ezh, [ɛʒ]
[z]	<u>z</u> ip, road <u>s</u> , kiss <u>e</u> s, <u>X</u> erox, design	
[ʃ]	<u>sh</u> y, miss <u>i</u> on, nati <u>o</u> n, glaci <u>a</u> l, <u>s</u> ure	
[ʒ]	meas <u>ur</u> e, visi <u>o</u> n, az <u>u</u> re, cas <u>ual</u> ty, decis <u>i</u> on	
[h]	<u>wh</u> o, <u>h</u> at, reh <u>a</u> sh, <u>h</u> ole, <u>wh</u> ole	engma or eng
[tʃ]	<u>ch</u> oke, mat <u>ch</u> , featur <u>e</u> , constit <u>u</u> ent	
[dʒ]	<u>j</u> udge, <u>G</u> eorge, <u>J</u> ell-O, regi <u>o</u> n, resid <u>u</u> al	
[m]	<u>m</u> oose, lam <u>b</u> , sm <u>a</u> ck, amn <u>e</u> sty, am <u>p</u> le	
[n]	<u>n</u> ap, design <u>n</u> , sn <u>o</u> w, kn <u>o</u> w, mn <u>e</u> monic	flap
[ŋ]	lung, thin <u>k</u> , fin <u>g</u> er, sing <u>e</u> r, an <u>k</u> le	
[l]	leaf, feel, <u>L</u> loyd, mild, appl <u>a</u> ud	
[ɹ]	<u>r</u> ee <u>f</u> , fear, <u>H</u> arris, pr <u>u</u> ne, car <u>p</u>	
[w]	writ <u>e</u> r, butt <u>e</u> r, udd <u>e</u> r, clutt <u>e</u> r, cut <u>e</u> r	voiceless 'w'
[w]	<u>w</u> ith, <u>sw</u> im, mow <u>i</u> ng, <u>qu</u> een, twiligh <u>t</u>	
[w̥]	<u>wh</u> ich, <u>wh</u> ere, <u>wh</u> at, <u>wh</u> ale, <u>wh</u> y (for those dialects in which <i>witch</i> and <i>which</i> do not sound the same)	
[j]	<u>y</u> ou, <u>b</u> eautif <u>u</u> l, <u>f</u> eud, <u>u</u> se, <u>y</u> ell	lower-case 'j'

Syllabic Consonants:

[m̩]	pos <u>u</u> m, chas <u>m</u> , Ada <u>m</u> , bott <u>o</u> mless	syllabic 'm'
[n̩]	butt <u>o</u> n, chick <u>e</u> n, less <u>o</u> n, kitt <u>e</u> nish	syllabic 'n'
[l̩]	litt <u>l</u> e, singl <u>e</u> , simpl <u>e</u> , stabil <u>i</u> ze	syllabic 'l'
[ɹ̩]	ladd <u>e</u> r, sing <u>e</u> r, bur <u>p</u> , perc <u>e</u> nt	syllabic 'r'

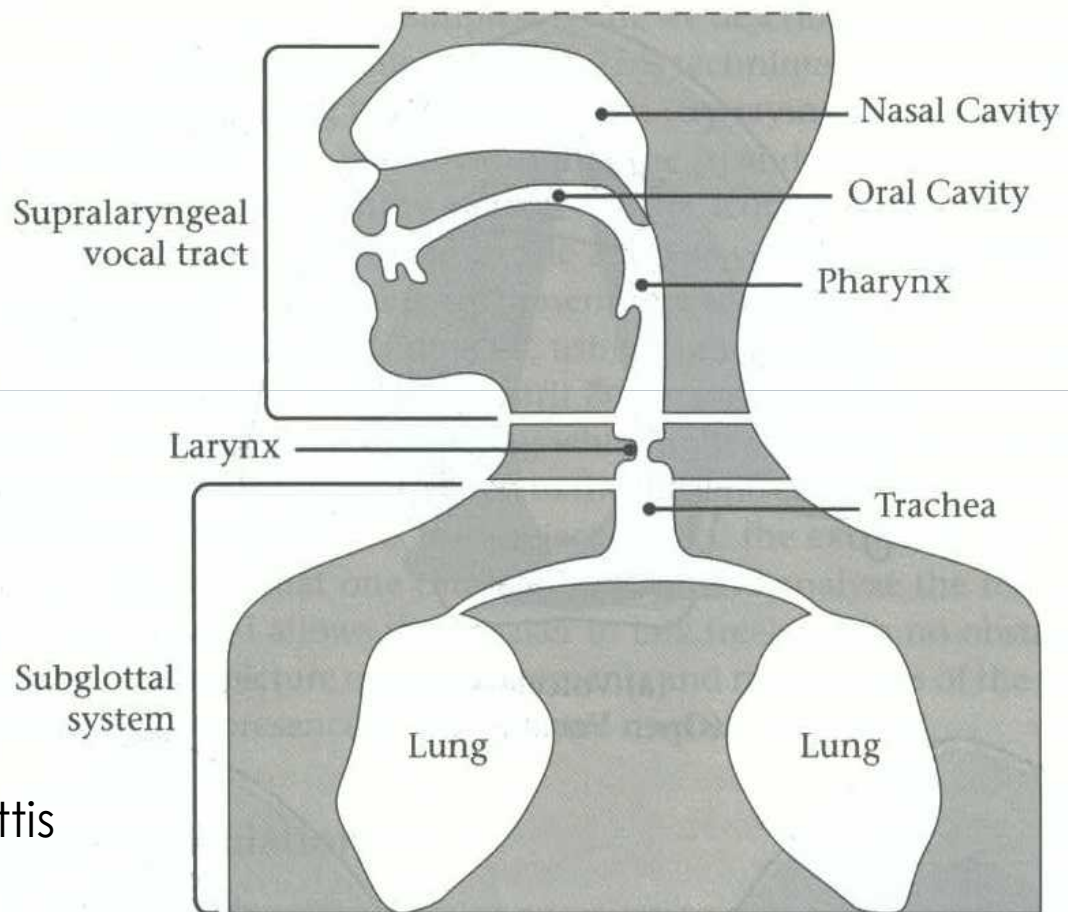
Symbol	Sample Words	Name of Symbol
Vowels:		
i. Monophthongs (Simple Vowels)		
[i]	beat, we, believe, people, money, dean	
[ɪ]	bit, consist, injury, malignant, business, gym	small capital 'i'
[ɛ]	bet, reception, says, guest, bend	epsilon
[æ]	bat, laugh, anger, comrade, rally, hand	ash
[u]	boot, who, sewer, duty, through, dune	
[ʊ]	put, foot, butcher, could, boogie-woogie	upsilon
[ɔ]	bought, caught, wrong, stalk, core	open 'o'
[ɑ]	pot, father, sergeant, honor, hospital, bomb	script 'a'
[ʌ]	but, tough, another, oven, fungus	wedge or turned 'v'
[ə]	among, Asia, enough, famous, harmony	schwa
ii. Diphthongs (Complex Vowels)		
[aɪ]	I, bite, Stein, aisle, choir, island, fine	
[aʊ]	bout, brown, doubt, flower, loud	
[ɔɪ]	boy, doily, rejoice, perestroika, annoy	
[oʊ]	oh, boat, beau, grow, though, over	
[eɪ]	bait, reign, great, they, gauge, age	

Articulation: English Consonants

- Voiced or voiceless?
- Place of articulation: where the airstream constricted
- Manner of articulation: how the airstream constricted

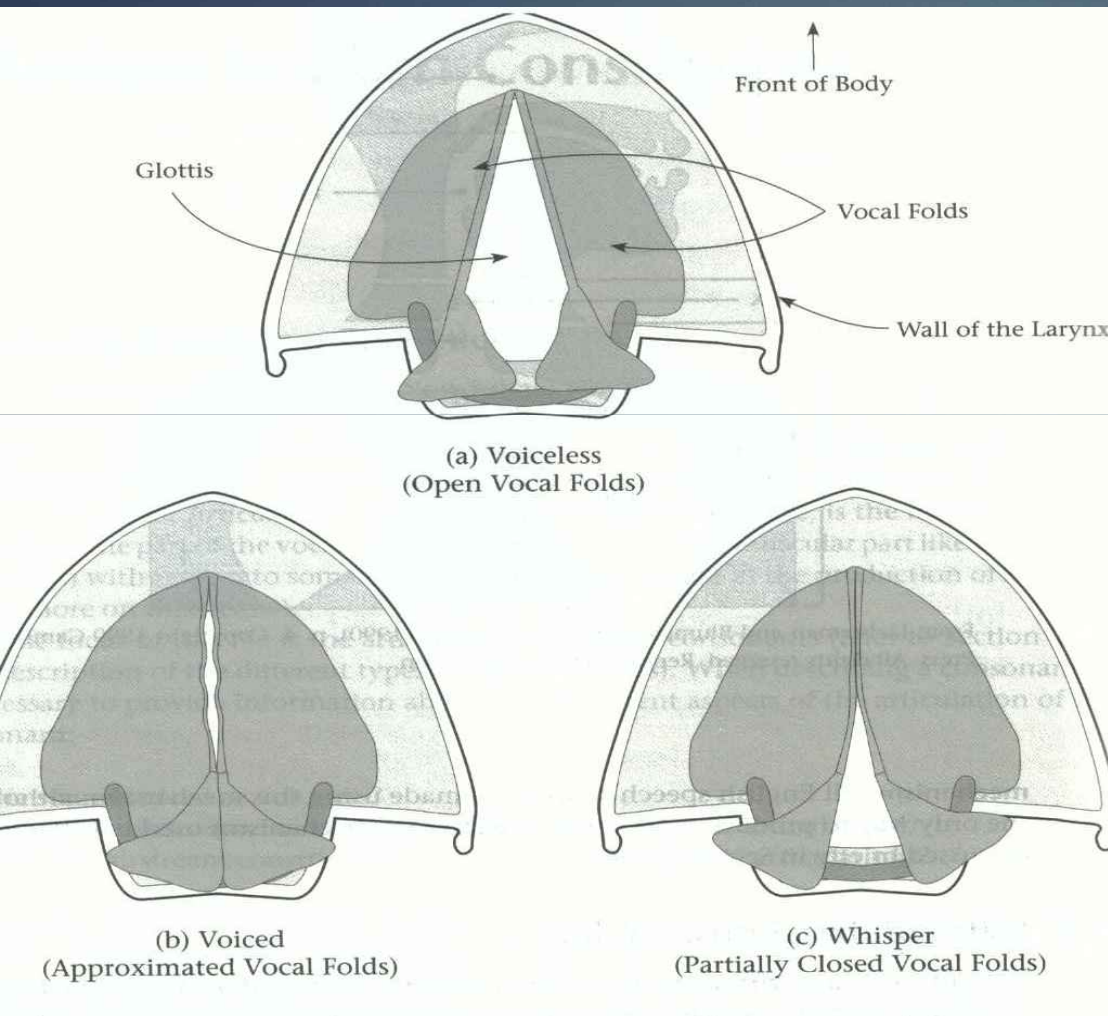
Anatomy of Human Speech Production

- Larynx (voice box): vocal folds, glottis
- Vocal tract: oral and nasal cavities
- Subglottal system



From Lieberman and Blumstein, *Speech Physiology* (1990), p. 4. Copyright 1990 Cambridge University Press. All rights reserved. Reprinted with permission.

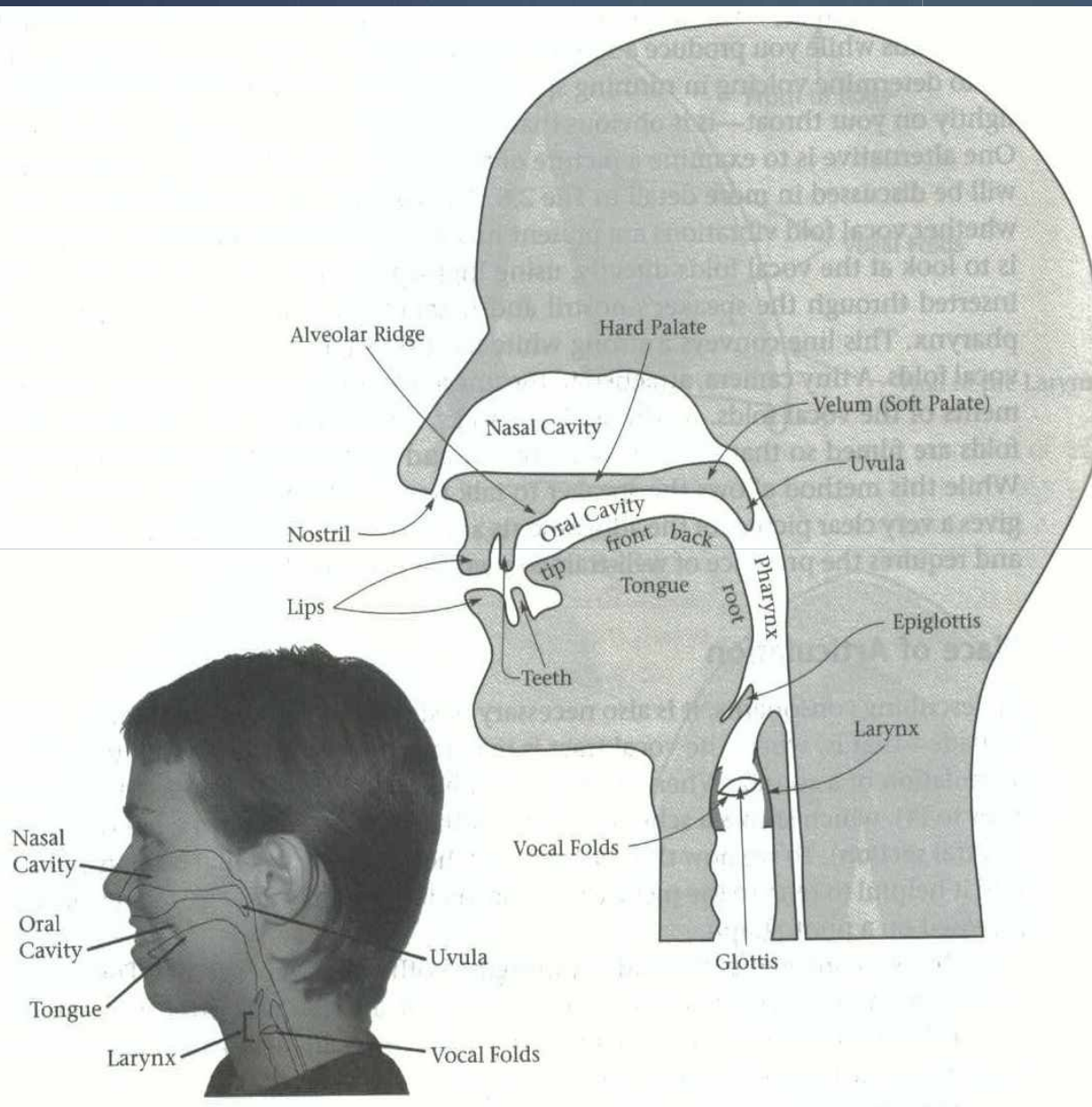
States of the Glottis: Voicing



(3) Voiced versus voiceless sounds

a. [f] <u>f</u> at	c. [θ] <u>th</u> igh	e. [s] <u>s</u> ip	g. [ʃ] <u>sh</u> ip
[v] <u>v</u> at	[ð] <u>th</u> y	[z] <u>z</u> ip	[ʒ] <u>zh</u> ip
b. [tʃ] <u>ch</u> rich	d. [p] <u>p</u> at	f. [t] <u>t</u> ab	h. [k] <u>k</u> ill
[dʒ] <u>ch</u> ridge	[b] <u>b</u> at	[d] <u>d</u> ab	[g] <u>g</u> ill

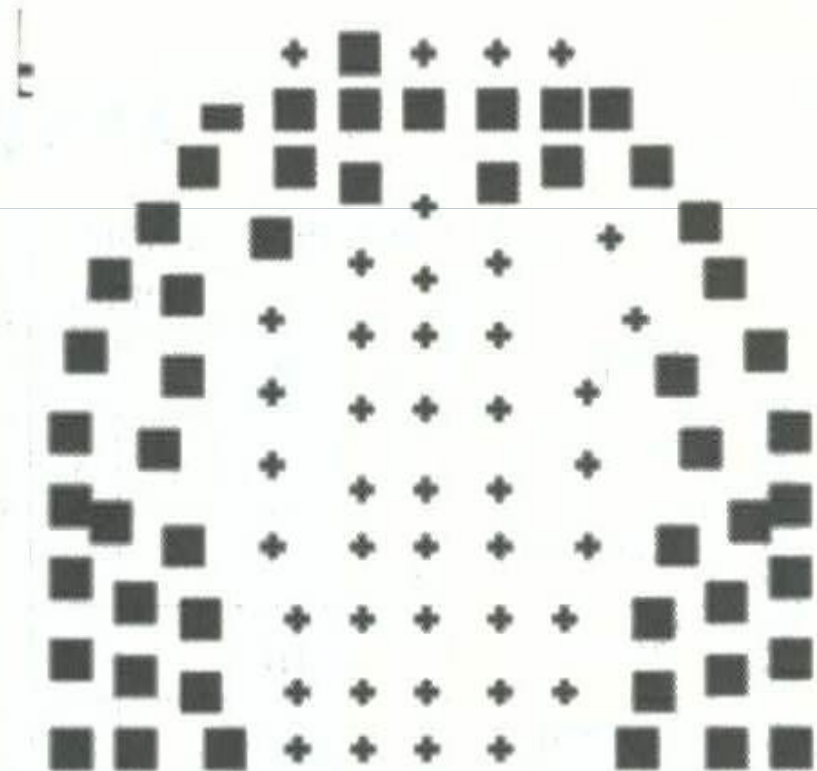
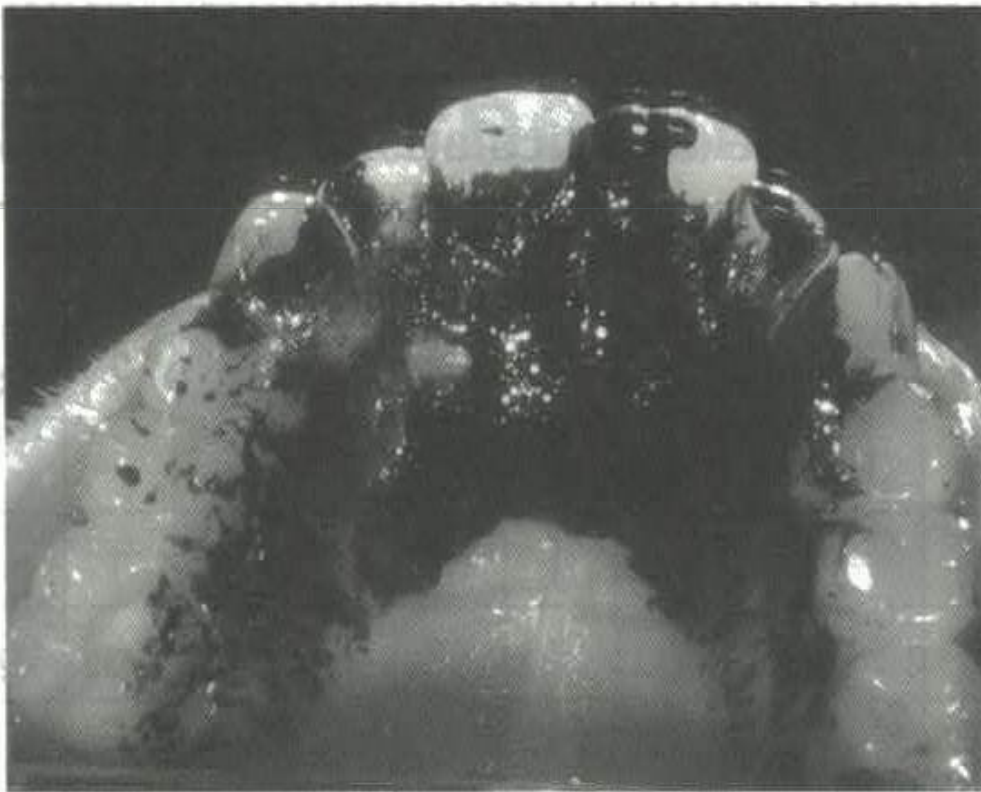
Place of Articulation Manner of Articulation



- Stops
- Fricatives
- Affricates
- Nasals
- Liquids: lateral, retroflex
- Glides
- Flap

Investigating Place and Manner of Articulation: Palatography

(5) Comparing images from static and dynamic palatography for the production of [d]



The Consonant Chart

(6) English consonant chart

		Place of Articulation															
		Bilabial		Labio-dental		Inter-dental		Alveolar		Post-Alveolar		Palatal		Velar		Glottal	
Manner of Articulation	Stop	p	b					t	d					k	g	ʔ	
	Fricative			f	v	θ	ð	s	z	ʃ	ʒ					h	
	Affricate									tʃ	dʒ						
	Nasal		m						n						ŋ		
	Lateral Liquid								l								
	Retroflex Liquid								ɭ								
	Glide	ɰ	w										j				

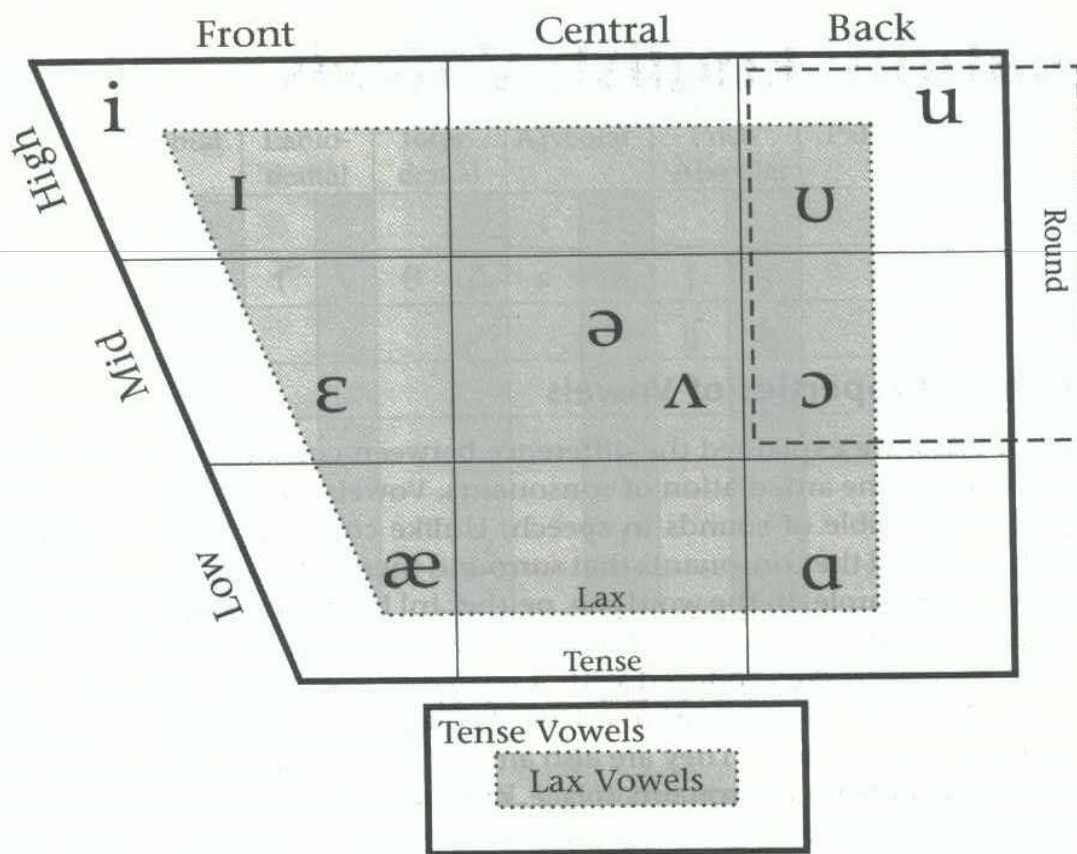
State of the Glottis: Voiceless Voiced

Articulation: English Vowels

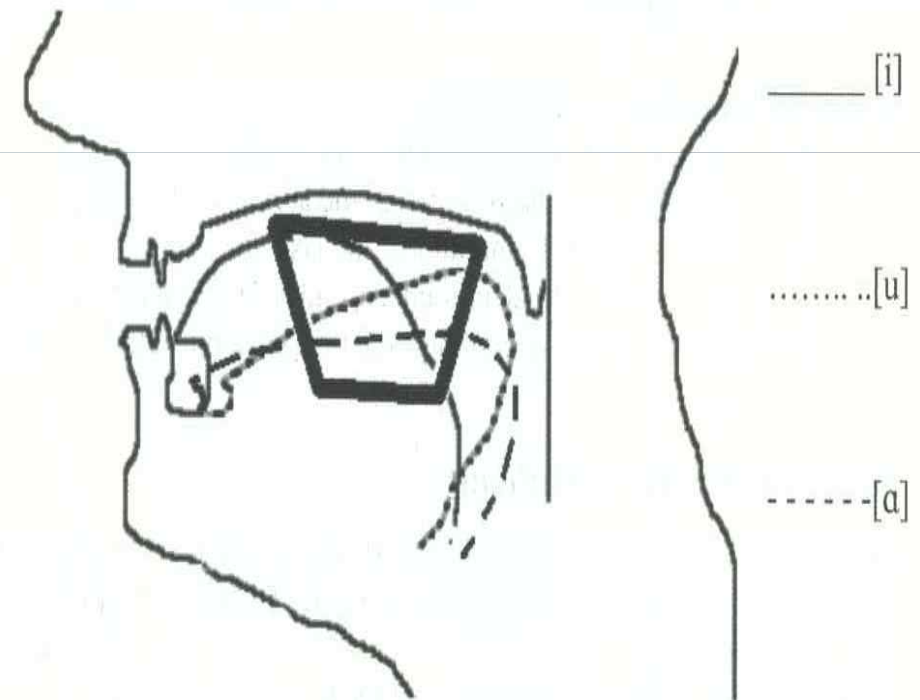
- ▶ Vowels are the most sonorant, or intense, and the most audible of sounds in speech,
- ▶ Unlike consonants, they usually function as syllable nuclei, and the consonants that surround them often depend on the vowel for their audibility.
- ▶ Vowels are voiced: vocal fold vibration is the sound source for vowels
- ▶ Tongue Height: high, mid, low
- ▶ Tongue Advancement: front, central, back
- ▶ Lip Rounding: rounded, unrounded
- ▶ Tenseness: tense, lax

English Vowels

(1) The vowels (monophthongs) of English



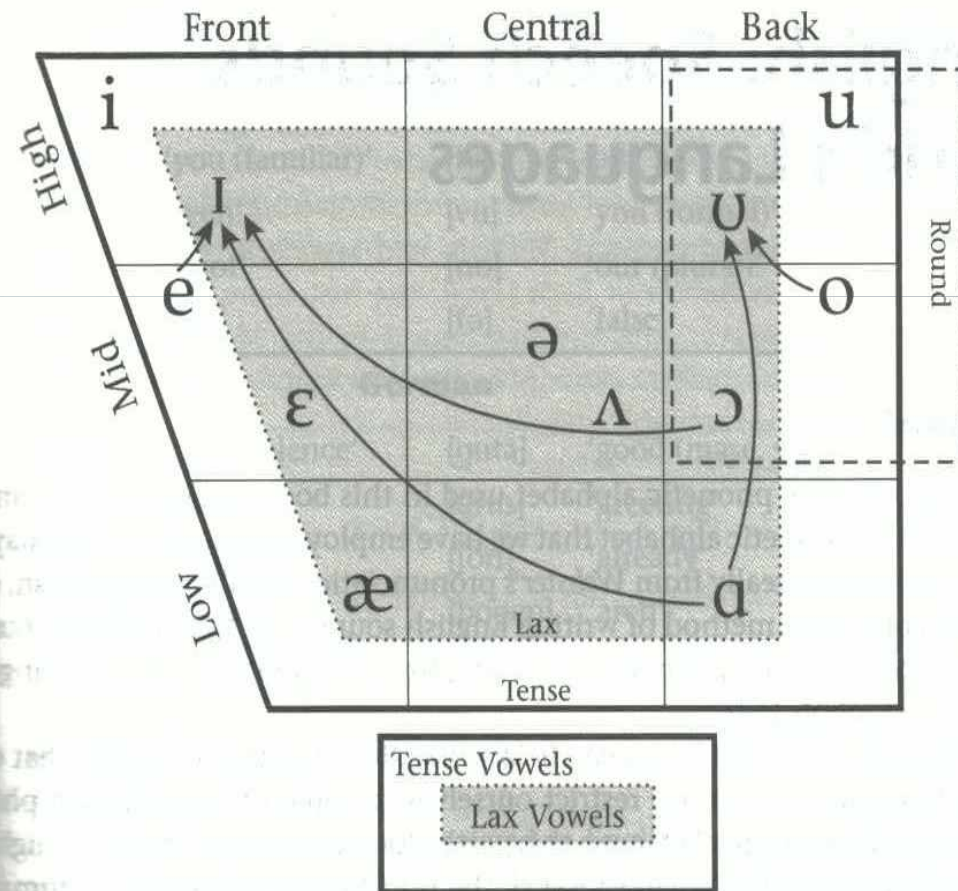
(2) The vowel chart in a sagittal section of the vocal tract, for the articulation of [i], [u], and [ɑ].



Diphthongs

- ▶ Diphthongs: complex vowel sounds
- ▶ Transition from one vowel to the other in the same syllable

(4) Two-part articulations of the diphthongs of English (the arrows indicate the transition)



Beyond English: Speech Sounds of the World's Languages

- ▶ Languages have different sets of consonants and vowels.
- ▶ A distinctive feature in one language may not be one in another language.
 - Voicing in Korean is not a distinctive feature
 - Great Kanto Earthquake in Japan (1923), tested nationality with pronunciations of 十円, 五十円 cf. shibboleth in Hebrew

Vowels

(1) Examples of the contrast between front and back rounded vowels

Front		Back	
French			
[ty]	‘you (familiar)’	[tu]	‘all’
[vy]	‘seen’	[vu]	‘you (formal)’
[nø]	‘knot’	[no]	‘our (plural)’
[fø]	‘fire’	[fo]	‘false’
German			
[gytə]	‘benevolence’	[gutə]	‘good (masc. sg.)’
[grys]	‘greet’	[grus]	‘greeting’
[føn]	‘beautiful’	[fon]	‘already’
[bøgen]	‘arches’	[bogen]	‘arch’

• Korean u (우)

(2) Examples of the contrast between oral and nasal vowels in French

Oral		Nasalized	
[mɛ]	'but'	[mɛ̃]	'hand'
[ʃas]	'hunt'	[ʃãs]	'luck'
[bo]	'beautiful' (masc.)	[bõ]	'good' (masc.)

Fricatives

Examples of fricatives

Description	Symbol	Example	Gloss	Language
voiceless bilabial fricative	[ɸ]	[éɸá]	'he polished'	Ewe
voiced bilabial fricative	[β]	[èβè]	'Ewe'	Ewe
voiceless palatal fricative	[ç]	[çeri]	'hand'	Modern Greek
voiced palatal fricative	[j]	[jut]	'good'	Dutch
voiceless velar fricative	[x]	[xɔma]	'soil'	Modern Greek
voiced velar fricative	[ɣ]	[ɣɔma]	'eraser'	Modern Greek
voiced glottal fricative	[ɦ]	[pluɦ]	'plough'	Ukrainian

Spanish *Cuba*

German *Buch*
Yiddish [xutspɔ]
Mandarin
Chinese [xau]

Spanish *amigo*

Filling in Other Blanks in the Consonant Chart

(4) Examples of affricates and palatals

Description	Symbol	Example	Gloss	Language
voiceless alveolar affricate	[tʰ]	[abutʰi]	'ended'	Canadian French
voiceless labial affricate	[pf]	[pfɛnɪk]	'penny'	German
voiceless palatal stop	[c]	[ceri]	'candle'	Modern Greek
voiceless palatal nasal stop	[ɲ]	[kaɲa]	'pipe'	Spanish

Ingressive Sounds

- “huh”, “헉”
- Scandinavian
- <https://www.youtube.com/watch?v=URgdIAz4QNg>
- ▶ clicks
- Khoisan
- <https://www.youtube.com/watch?v=W6WO5XabD-s>
- Xhosa clicks
- <https://www.youtube.com/watch?v=31zzMb3U0iY>



Places of Articulation Not Used in English

(5) Examples of places of articulation not used in English

Description	Symbol	Example	Gloss	Language
voiceless uvular stop	[q]	[qædri]	'little bit'	Farsi
voiceless pharyngeal fricative	[ħ]	[ʃħab]	'clouds'	Maltese
voiced uvular stop	[g]	[ihipgeoqteq]	'explore'	Inuktitut
voiced pharyngeal fricative	[ʕ]	[ʃor]	'skin'	Yemenite Hebrew

Manners of Articulation Not Used in English

Examples of manners of articulation not used in English

Description	Symbol	Example	Gloss	Language
Voiced alveolar trill	[r]	[pero]	'dog'	Spanish
Palatalized consonants	[pʲ] etc.	[pʲatʲ]	'five'	Russian
Palatalized alveolar lateral liquid	[ɭ]	[beɭa]	'white'	Macedonian
Glottalized (ejective) stops	[pʔ] etc.	[pʔo]	'foggy'	Lakhota

Suprasegmental Features

Length

I. (1) Examples of using length to contrast word meaning in Finnish

I. [muta] 'mud'

II. [mu : ta] 'some other'

III. [mut : a] 'but'

IV. [tapan] 'I kill'

V. [tapa : n] 'I meet'

VI. [tule] 'come!'

VII. [tule :] 'comes'

VIII. [tu : le :] 'is windy'

- Korean: 말:(language)/말(horse), 밤:(chestnut)/밤(night), 굴:(cave)/굴(oyster)

Intonation

- (2) a. You got an A on the test
b. Yes

- (3) a. Speaker1: Who kissed Peter?
b. Speaker2: MARY kissed Peter.

[pitch accent]

- a. Speaker1: Who did Mary kiss?
b. Speaker2: Mary kissed PETER.

- a. Speaker1: What did Mary do to Peter?
b. Speaker2: Mary KISSED Peter.

- (4) a. You got an A on the test.
b. You got an A on the test?
c. You got an A on the test, a C on the homework, and B on the quiz.

[edge tone]

Tone

Thai, Chinese, Vietnamese

Languages in New Guinea such as Skou

Bantu languages of Africa such as Zulu, other African languages such as Yoruba, Igbo

North and South American Indian languages such as Apache, Navajo, Kiowa, Mazotec, Bora

(5) Examples from Mandarin Chinese: different tones, different meanings

Segments	Tone Numbers ²	Tone Pattern	Gloss
[ma]	55	high level	'mother'
[ma]	35	high rising	'hemp'
[ma]	214	low falling rising	'horse'
[ma]	51	high falling	'scold'

- Chinese: *ma*

<https://www.youtube.com/watch?v=9XRXYaHOlpo>

- Korean Gyeongsang dialect: 2 vs e

https://www.youtube.com/watch?v=6M8jbW_jzMg

(6) Examples of level and contour tones in Kikerewe

Word	Tone Pattern	Gloss
[kùsàlà]	low-low-low	'to be insane'
[kùsálà]	low-high-low	'to cut off meat'
[kùfǐ:ngà]	low-rise-low	'to defeat, win'
[kùsì:ngà]	low-low-low	'to rub, apply ointment'
[kùzúmà]	low-high-low	'to insult, scold'
[kùzùmà]	low-low-low	'to rumble, be startled'
[kùkālâ:ngà]	low-mid-fall-low	'to fry'

Stress

- ▶ A stressed syllable is more prominent, longer, louder, and contains full vowels.
- ▶ English: primary, secondary, tertiary stress
 - photograph, photography
- ▶ Placement of stress
 - Czech: first syllable
 - Welsh: next to last syllable
 - French: last syllable
 - Russian, English: unpredictable
 - record, perfect, subject, blackboard