24.901

Sept. 13, 2010 **Distinctive Features-1 (vowels)**

[1] lexical item

- string of speech sounds (phonemes); two items distinct if they differ in length or position
- each phoneme is composed of a matrix of feature specifications
- features are typically binary: [±Feature]
- features have articulatory and acoustic correlates representing the grammatically controlled aspects of the sound implemented in the phonetic component
- features also have a classificatory function: they define the alphabet of sounds that encodes the vocabulary of the language in the lexicon; they characterize the natural classes for the rules and constraints that describe the distribution and change of sounds
- feature theory developed at MIT in 1950-52 by Roman Jakobson, Gunnar Fant, Morris Halle (*Preliminaries to Speech Analysis*) based on earlier insights of Nikolai Trubetzkoy in the 1930's.

[2] some features for Vowels

	i	ɪ	e	ɛ	æ	a	ɔ	o	u	ʊ
high	+	+	–	–	–	–	–	–	+	+
low	–	–	–	–	+	+	–	–	–	–
back	–	–	–	–	–	+	+	+	+	+
ATR	+	–	+	–	–	–	–	+	+	–

(key words: [i] beat, [ɪ] bit, [e] bait, [ɛ] bet, [æ] bat, [ɔ] bought, [o] boat, [u] boot, [ʊ] foot

- articulatory neutral point for vowels: [ɛ]
- [+high] vowel raise tongue body from neutral point; [–high] do not; [+low] vowels lower tongue body below neutral point; [–high] do not; [+back] vowels retract tongue body from neutral point; [–back] do not
- tense-lax distinction described here as [±Advanced Tongue Root]; no consensus on this point
- IPA symbols are abbreviations for feature matrixes
- each sound is represented as plus, minus, or zero for each feature
- every phoneme must be representable as some plus/minus vector for features
- feature system is component of Universal Grammar that allows a child to distinguish speech from noise and begin learning vocabulary of the language of environment
- some believe that different part of brain activated for sounds of language as opposed to noise in general

[3] Chamarro (Guam) fronting of back vowels

- vowel system in stressed syllables

	front	back
high	i	u
mid	e	o
low	æ	a

gumə	house	i gimə	the house
tomʊ	knee	i temʊ	the knee
lahɪ	male	i læhɪ	the male
gwihən	fish	i gwihən	the fish
pecʊ	chest	i pecʊ	the chest

- informal statement of changes:
  - u > i after definite article
  - o > e
  - a > æ
- but same change occurs in other contexts:

tunʊʔ	to know	en tinʊʔ	you know
hulʊʔ	up	sæn hilʊ?	upward
otdʊt	ant	mi etdʊt	lots of ants
oksʊ?	hill	gi eksʊ?	at the hill
lagʊ	north	sæn lægʊ	toward north

[4] statement of rules with IPA symbols

u > i after i, e, æ
o > e after i, e, æ
a > æ after i, e, æ

- this description fails to express the fact that the changes are related:
  all occur in the same context
  changing sounds [u,o,a] share something in common (back vowels)
  same change in each pair: back vowel changes to corresponding front one

[5] But if sounds represented with features then only certain classes of sounds can be expressed simply:
[i,e,æ] and [u,o,a] are **natural classes** while [i,e,a] or [u,æ,a] are not

sounds that undergo rule: [+back] vowels
sounds that trigger rule: [– back] vowels
sound change: [+back] -> [–back]

[6] rules can now be defined to express sound changes: to change a sound is to alter its feature specification

– cons –> [– back] / – cons C_o ___ (C_o = zero or more consonants)
+back – back

«a back vowel changes to the corresponding front vowel when vowel of preceding syllable is a front vowel» a rule of assimilation

rule terminology
focus: matrix to be changed by rule
/ = "in the context of"
___environmental dash locates focus relative to context: before or after
structural change: matrix to right of arrow

[7] neutralization of height/ATR contrasts before [r]

Irish English	General American			
i weary	ɪ		cf.	wean
ɪ spirit	ɪ			wicked
e fairy	ɛ	Mary		crazy
ɛ ferry	ɛ	merry		sexy
æ marry	ɛ	marry		taxi

– cons -> – ATR / ___ r
– back – low

[8] [±round]
[+round] sounds produced with a compression/pursing of the lips; [–round] with lips spread

	i	y	e	ø	ɛ	œ	æ	a/ɑ	ɒ	ɔ	ʌ	o	ɤ	u	ɯ
high	+	+	–	–	–	–	–	–	–	–	–	–	–	+	+
low	–	–	–	–	–	–	+	+	+	–	–	–	–	–	–
back	–	–	–	–	–	–	–	+	+	+	+	+	+	+	+
ATR	+	+	+	+	–	–	–	–	–	–	–	+	+	+	+
round	–	+	–	+	–	+	–	–	+	+	–	+	–	+	–

French:	[i] ligne		[y] lune	[u]	loup
	[e] blé		[ø] peu	[o]	eau
	[ɛ] père		[œ] peur	[ɔ]	mort
Russian:	[i]	bitʲ	[ɯ] bɯtʲ	[u]	budʲ
		'to beat'	'to be'		'be' imper.
Korean:	[e]	enuri	[ɤ] ɤdi	[o]	onɨl
		'discount'	'where'		'today'

[8] Turkish vowel harmony

	front		back	
high	i	y	ɯ	u
mid/low	ɛ	œ	a	ɔ

noun	pl.	his N.	
dal	dal-lar	dal-ɯ	'branch'
kɔl	kɔl-lar	kɔl-u	'arm'
kɯz	kɯz-lar	kɯz-ɯ	'daughter'
kul	kul-lar	kul-u	'slave'
yɛl	yɛl-lɛr	yɛl-i	'wind'
gœl	gœl-lɛr	gœl-y	'sea'
diʃ	diʃ-lɛr	diʃ-i	'tooth'
gyl	gyl-lɛr	gyl-y	'rose'

- roots contrast for eight possible vowels
- most suffixes contrast for just [±high]; values for [back] and [round] determined by harmony

[– cons] -> [α back] / [α back] Co __ (palatal harmony)

– cons -> [α round] / [α round] Co __ (labial harmony)
+high

- what does grammar predict for ‘his slaves’?

[9] Tamil (Christdas 1988)

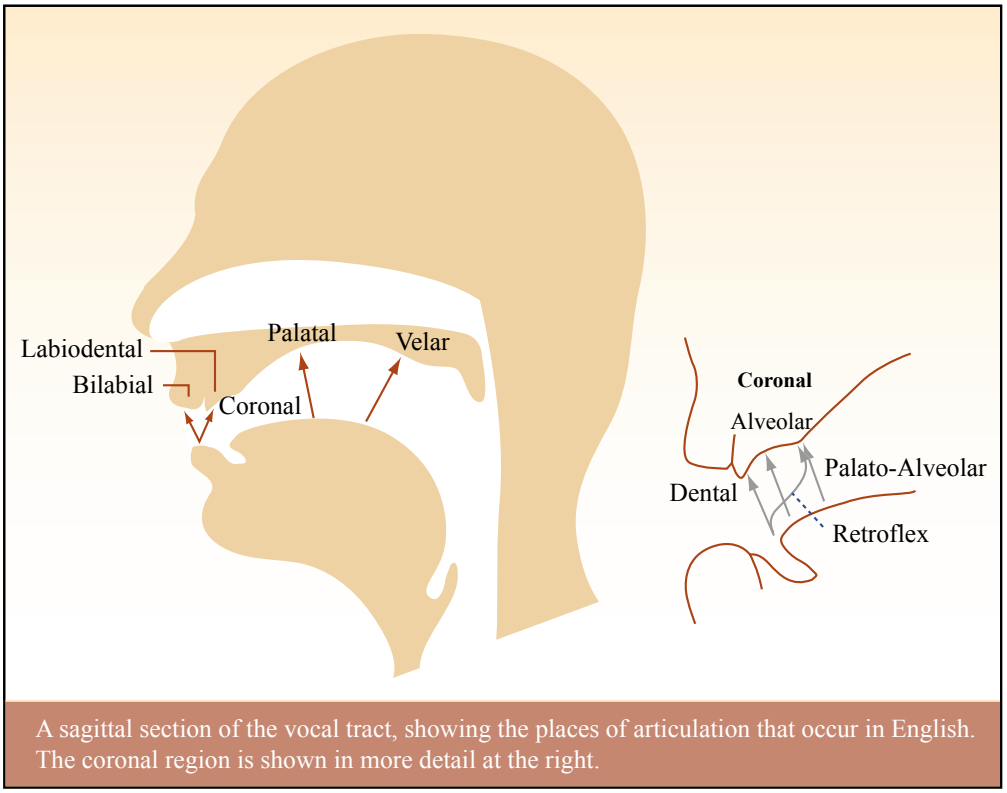
i	u	*ji, *je, ja, jo, ju	wi, we, wa, *wo, *wu
e	o		
	a	(asterisked sequences are ungrammatical)	
j	w		

Consonants

- produced with constriction or obstruction in supralaryngeal vocal tract
- traditionally described by place and manner of articulation
- up to eleven places distinguished

[1] places of articulation according to the IPA

Place	stop	fricative
bilabial	p, b	ɸ, β
labiodental		f, v
dental	t̪, d̪	θ, ð
alveolar	t, d	s, z
postalveolar		ʃ, ʒ
retroflex	ʈ, ɖ	ʂ, ʐ
palatal	c, ɟ	ç, ʝ
velar	k, g	x, ɣ
uvular	q, G	χ, ʁ
pharyngeal		ħ, ʕ
laryngeal	ʔ	h, ɦ



A sagittal section of the vocal tract, showing the places of articulation that occur in English. The coronal region is shown in more detail at the right.

[2] manner of articulation

- degree and type of stricture
- **stop** (plosive): complete closure and blockage of airflow; sudden release (acoustic spike) [d]
- **nasal**: oral closure with lowered velum so air flows into nasal cavity [n]
- **fricative**: narrow constriction creating turbulence [z]
- **affricate**: stop with delayed release creating turbulence [d^z]
- **approximant**: one articulator approaches the other but no turbulence produced

glide (semi-vowel): w, ɥ, j	French: Louis [wi], lui [ɥi], lié [je]
lateral: l, ɭ , ʎ	Italian: fili [l] vs. figli [ʎ]
rhotic: ɹ, (r = trilled, ɾ tap/flap)	English: red [ɹ], Spanish: perro [r] vs. pero [ɾ]

[3] features for consonants: place and manner of articulation

active oral articulators: [± labial], [± coronal], [± dorsal]
other active articulators: velum ([± nasal]), tongue root ([± constricted pharynx]), glottis ([± spread glottis], [± constricted glottis])

nasal: [± nasal]; [+ nasal] sounds are produced with the velum lowered while [–nasal] (oral) sounds have the velum raised; most languages contrast oral and nasal plosives (i.e. [n] vs. [t]) and some contrast oral and nasal vowels such as French beau [bo] vs. bon [bɔ̃];
nasals are found at the same places as stops: m, ɱ, n, ɳ, ɲ, ŋ, N

stricture: [± continuant]
[–continuant]: stops and affricates
[+ continuant]: all others

[± delayed release]
[+ delayed release]: affricates
[–delayed release]: all others

[± strident] (bound to coronal articulator)
[+ strident]: sibilants (s, t^s, ʃ, tʃ,): high turbulence
[–strident]: interdentals θ

[± lateral] (bound to coronal articulator)
[+ lateral]: side of tongue is lowered
[–lateral]: all others

[4] major place distinctions

labials: [± labial]: lower (and upper) lip

[–labiodental]	[+ labio-dental]		
[m, p, b, ɸ, β]	[ɱ, f, v]	Spanish: la [β]aca	English: la[v]a

coronals: [± coronal] front portion of tongue

dental/alveolar vs. alveopalatal: [± anterior]

	[+ anterior]	[–anterior]	
stop	t, d	c,ɟ	Hungarian: kutya [c] Magyar [ɟ]
fricative	s, z	ʃ, ʒ	English: press [s] pressure [ʃ] (cf. coif, coifure)
affricate	t^s, d^z,	tʃ, dʒ	Mandarin: below
nasal	n	ɲ	Spanish: cana [n] caña [ɲ]

Mandarin sibilants

dental	tsai 51	'again'	sai	51	'compete'
postalveolar (retroflex)	tʂaŋ 51	'rise'	ʂaŋ	51	'above'
alveolo-palatal	tɕi 55	'chicken'	ɕi 55		'west'

high vs. lower turbulence: [± strident]

[+ strident]	[–strident]	
[s, t^s, ʃ, $t^ʃ$]	[θ, ð]	English: sin vs. thin [θ]

tip vs. blade (apical vs. laminal): [± distributed]

[–distributed]	[+ distributed]	
retroflex [ʈ]	interdental [θ]	
dental [t̪]	alveolar [t]	Australian Aboriginal

dorsal: [± dorsal]: tongue body is articulator;
subsidiary features [high], [back], ([low])

[k'] of *keep* vs. [k] of *coop*: [–back] vs. [+ back]

velar vs. uvular:		[+high]	[–high]
	stop	k	q
		g	G
	fricative	x	χ
		ɣ	ʁ

pharyngeal: [±constricted pharynx] tongue root is articulator

	fricative	ħ	ʕ

stops not found; difficult to make a closure

laryngeal: [±constricted glottis] vocal folds are the active articulators

		[constricted gl]	[spread gl]
stop	ʔ	+	–
fricative	h	–	+

examples:

Arabic gutturals:		[dorsal]	[constr ph]	[high]	[back]	[voice]	[spread gl]	[constr gl]
xaali	'my uncle'	+	–	+	+	–	–	–
ɣaali	'expensive'	+	–	+	+	+	–	–
qaal	'he said'	+	–	–	+	–	–	–
ħaali	'my condition'	–	+	–	–	–	–	–
ʕaali	'high'	–	+	–	–	+	–	–
haal	'mirage'	–	–	–	–	–	+	–
ʔaal	'family, kin'	–	–	–	–	–	–	+

[4] Sudanese Arabic (PGG ex. 1.12)

kitaab	'book'	bit 'daughter'	samak 'fish'
kitaa[f]	Fathi	bi[t] Fathi	sama[k] Fathi
kitaa[p]	Samiir	bi[s] Samiir	sama[k] Samiir
kitaa[p]	ʃariif	bi[ʃ] ʃariif	sama[k] ʃariif
kitaa[p]	Xaalid	bi[t] Xaalid	sama[x] Xaalid
kitaa[p]	Hasan	bi[t] Hasan	sama[k] Hasan

[5] major class features

[±syllabic]

[+syllabic] denotes vowel, carries nucleus of syllable

[–syllabic] sounds at margin of syllable or nonsyllabic

[±consonantal]

[+cons] oral constriction greater than a glide/semi-vowel

[–cons] oral constriction less than a glide/semi-vowel

[±sonorant]

[+sonorant] oral constriction not sufficient to cause air pressure to build up to prevent voicing of vocal folds

[–sonorant] oral constriction impedes spontaneous voicing and requires some adjustment to maintain voicing

	syllabic	consonantal	sonorant
vowel	+	–	+
glide	–	–	+
liquid	–	+	+
nasal	–	+	+
fricative	–	+	–
stop	–	+	–
affricate	–	+	–

Examples

French high vowel devocalization

il loue	[lu]	lou-er	[lwe]	il lie	[li]	li-er	[lje]
'he rents'		'to rent'		'he binds'		'to bind'	

Palestinian Arabic glide vocalization

dalw-ak	dalu	dʒalj-ak	dʒali	cf.	ʔabu	'father'
'your pail'	'pail'	'your dish'	'dish'		ʔabu:k	'your father'

Popular English lateral vocalization

feeling	[l]	feel	[fiw]

Argentinian Spanish glide "hardening"

le[j] le[ʒ]es
'law' 'laws'

sonorant consonants allow a preceding voicing contrast while obstruents often trigger neutralization (assimilation)

Russian voicing assimilation:

bjez mamɯ	bjes papɯ	bjez brata
ot mamɯ	ot papɯ	od brata

[6] laryngeal features

[±voice]: [+voice] sounds have vibration of the vocal folds; [–voice] sounds lack it

[±spread glottis]: [+spread gl] is feature for aspirated sounds;

[±constricted gl]: [+constricted gl] is the feature for glottalized consonants

		[voice]	[spread gl]	[constricted gl]
voiceless unaspirated:	p,t,k	–	–	–
voiced unaspirated:	b,d,g	+	–	–
voiceless aspirated:	p^h,t^h,k^h	–	+	–
voiced aspirated:	b^h,d^h,g^h	+	–	–
voiceless glottalized:	pʼ,tʼ,kʼ	–	–	+
voiced glottalized:	ɓ,ɗ,ɠ	+	–	+

- no contrast: Finnish p, t, k (cf. voiceless unaspirated stops of English s**p**in, s**t**em, s**k**in
- binary contrasts
  - Spanish: p vs. b — voiceless vs. voiced — paso 'step' vs. basa 'base' ± stiff
  - Mandarin: p vs. p^h — voiceless vs. aspirated — pai 'white' vs. p^hai 'row'
  - Nootka: p vs. pʼ — voiceless vs. glottalized — pa:- 'go' vs. pʔa 'give away'
- ternary contrasts
  - Thai: p vs. p^h vs. b — pàa 'forest' vs. p^hàa 'to split' vs. bàa 'shoulder'
  - Korean: p vs. p^h vs. pʼ — tal 'moon' vs. t'al 'daughter' vs. thal 'burn'
- quaternary
  - Hindi: p vs. p^h and b vs. b^h — pal 'take care of' vs. p^hal 'edge of knife' vs. bal 'hair' vs. b^hal 'forehand'
- vocal fold vibration is influenced by a variety of factors; Halle & Stevens (1971) propose adding features of glottal tension [±stiff] and [±slack] see PGG pp. 40-1

[6] secondary articulations: superimposition of vocalic lip and tongue-body articulations in combination with the primary oral constriction

labialization:	[+round]	sa vs. $s^{w}a$	cf. whale [h^{w}] vs. wail [w] vs. hail [h]
palatalization:	[+high, –back]	sa vs. $s^{j}a$	Russian papa vs. $p^{j}at^{j}$ 'five'
velarization:	[+high, +back]	sa vs. $s^{ɣ}a$	leaf vs. feel [l] vs. [ɬ]
pharyngealization:	[+back, +low]	sa vs. $s^{ʕ}a$	Arabic saif 'sword' vs. $s^{ʕ}$aif 'summer'

[7] prosodic features

- quantity/length: [±long] duration of articulation
  - short vs. long vowels: ta vs. ta: (ta vs. taa; tă vs. tā) Czech, Latin
  - short vs. long (geminate) consonants: tata vs. tatta (tata vs. tat:a) Italian
  - both consonants and vowels: Japanese, Finnish, Hungarian
    - Japanese length contrasts
      - kite 'coming' ki:te 'listening'
      - site 'doing' sitte 'knowing'
- tone: F_0 rate of vibration of vocal folds
  - level: [±hi], [±lo]
    - high vs. nonhigh/low: Moore tá vs. tà Kinande tá vs. ta
    - high vs. mid vs. low: Yoruba tá vs. ta vs. tà
  - contour:
    - rise vs. fall: tă vs. tâ (Thai)
- stress: phonetic correlates vary among duration, pitch change, energy

stressed vs. unstressed:	Russian	ˈpapa
primary vs. secondary:	English	ˌAlaˈbama

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further examples

Korean compounds

ap	'front'	nat	'sickle'	kuk	'nation'
ni	'tooth'	nal	'edge'	min	'person'
a**m**-ni	'front tooth'	na**n**-nal	'edge of sickle'	ku**ŋ**-min	'people'

Spanish article + noun

kasa	goma	doña	tatʃa	boka	peka
la-kasa	la-**ɣ**oma	la-**ð**oña	la-tatʃa	la-**β**oka	la-peka
'house'	'gum'	'lady'	'blemish'	'mouth'	'freckle'

Japanese verb inflection

negative	kak-anai	tob-anai	mat-anai	das-anai
conditional	kak-eba	tob-eba	mat-eba	das-eba
tentative	kak-oo	tob-oo	mat-oo	das-oo
continuative	kak-imasu	tob-imasu	matʲ-imasu	daʃ-imasu
basic	kak-u	tob-u	matˢ-u	das-u

Russian voicing contrasts and assimilation

Ivan	mam-a	Ljud-a	pap-a	Dim-a	vod-a
ot Ivan-a	ot-mam-ɯ	ot-Ljud-ɯ	ot-pap-ɯ	od-Dim-ɯ	vot-k-a
bjez Ivan-a	bjez-mam-ɯ	bjez-Ljud-ɯ	bjes-pap-ɯ	bjez-Dim-ɯ	

Spanish indefinite + noun

un aro 'an earring' um beso 'a kiss' un dado 'a die' uŋ kwerpo 'a body'

Greenlandic Eskimo (high and mid vowels in complementary distribution)

ugsik	‘cow’	nanoq	‘bear’
iga	‘pot’	seʁmeq	‘glacier’
nuna	‘land’	neʁdloq	‘goose’
imaq	‘sea’	ipeʁaq	‘harpoon strap’
ikusik	‘elbow’	oʁpik	‘tree’

Kikuyu infinitive prefix

ɣo-tɛŋɛra	to run	ɣo-kuua	‘to carry’
ɣo-koora	‘to root out’	ko-ruya	‘to cook’
ko-oria	‘to ask’	ko-mɛɲa	‘to know’
ko-hɔta	‘to be able’	ko-ina	‘to dance’
ko-niina	‘to finish’	ɣo-kaya	‘to cut’
ɣo-tʃuuka	‘to slander’	ko-ɣaya	‘to divide’

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