24.961 Lecture 2

Early Generative Model (Chomsky & Halle 1968, aka SPE)

[1] basic properties

- unpredictable features of lexical item stored in permanent linguistic memory (lexicon); predictable features assigned by phonological rules
- phonological rules convert surface syntactic structures to phonetic representations
- lexical and grammatical formatives represented as strings of distinctive feature matrixes at both the underlying, phonological level and the surface, phonetic level
- phonological rules are context-sensitive rewrite rules that alter feature structure (A -> B /X_Y) or delete, insert, reorder entire segments
- the rules apply in a linear sequence and form a partially ordered set
- some rules apply at the level of the word (e.g. Vowel Shift) and others at level of the phrase (e.g. Nuclear Stress Rule)
- some rules may apply in a cycle
- focus on alternations to discover the rules (if alternations are regular then speaker/learner posits a single underlying form from which the different phonetic variants can be derived by context-sensitive rules)
- concern with explicitness and formal statement
- tremendous success; many languages analyzed by MIT's first generation of graduate students: French (Schane), Spanish (Harris), Russian (Lightner), Japanese (McCawley), Sanskrit (Zwicky), Latin (Foley), Turkish (Lees), Menomini (Bever), Mandarin (Woo); new generalizations discovered or old ones viewed in a different light. [MIT Dissertations: http://libguides.mit.edu/diss
- rules do not aim at particular structures; functional explanations viewed with suspicion
- principles of morpheme and word-shape (phonotactics) of limited interest (but see Stanley 1967); no concern for variation or frequency; focus on "deeper" morphophonemics rather than "lower-level" phonetic processes.

Illustration from SPE's analysis of English segmental phonology (SPE Chapter 4)

[1] vowel reduction: when unstressed, short vowels appear as [ə] (or [ɨ] if high)

t**é**l**e**gr**à**ph t**e**l**é**gr**a**phy	[ɛ] ≈ [ə], [ə] ≈ [ɛ], [æ] ≈ [ə]
át**o**m, **a**t**ó**mic	[æ] ≈ [ə], [ə] ≈ [a]
ar**ó**m**a**, **à**r**o**m**á**tic	[ə] ≈ [æ], [o] ≈ [ə], [ə] ≈ [æ]
ór**i**gin, **o**r**í**ginal	[ɔ] ≈ [ə, ɨ], [ə, ɨ] ≈ [ɪ]

- schwa is predictable variant of full vowel in unstressed syllable: if we start with schwa we cannot predict which vowel will occur under stress (source of many spelling errors)

- problem for Autonomous (Structural) Phonemics: violates the invariance[1] condition and yet schwa presumed not to be phonemic

[2] Flapping and vowel length: two famous sound alternations (Chomsky 1964)

- American Structuralists concerned with contrast; intuition that while aspirated [p^h] of English *pool* and Korean *p^hul* 'grass' are phonetically equivalent, they have distinct linguistic status; in Korean aspiration is contrastive while in English it is not
- contrast is to be represented as a level of the grammar (the phonemic level) where only contrastive sounds (distinctive features) are represented; noncontrastive sounds (features) are allophones restricted to the phonetic level: English /pul/ -> [p^hul] vs. Korean /p^hul/ -> [p^hul]
- procedures of analysis proposed to discover the phonemes; complementary distribution and minimal pairs (see Zellig Harris 1951)
- English flapping:

  a[ɾ]om, a[t^h]omic be[d], be[ɾ]-ing (cf. Spanish where /d/ and /ɾ/ contrast)

  [t,d] -> [+sonor] / 'V _ V ('V = stressed vowel)

- vowel length:

  vowels shorter before [-voice] consonants: *hĭt* [ɪ] vs. *hid [ɪ:]*; *bĕt* [ɛ] vs. *bed* [ɛ:]

- Canadian raising

	tie	*tight*	*tide*	*cow*	*out*	*crowd*	*type*	*bike*
RP, GA	aj	ăj	aj	aw	ăw	aw	ăj	ăj
Canadian	aj	ʌ̆j	aj	aw	ʌ̆w	aw	ʌ̆j	ʌ̆j

  V -> [-long] / __ ([-syll])[-voice]

  ă -> [-low] / __ [+high]

- conclusion: flap [ɾ] and mid-vowel diphthongs [ʌ̆j] and [ʌ̆w] are not phonemes given their limited and predictable distribution
- *writer* [ʌ̆j] vs. *rider* [ʌ̆w] (Bloch 1942)
  minimal pair: [ɹʌ̆jɾəɹ] vs. [ɹajɾəɹ]; seems to indicate that the [aj] vs. [ʌ̆j] difference is contrastive (phonemic) despite its limited and otherwise predictable distribution
  but the difference is completely predictable if phonological processes apply sequentially to modify an underlying representation composed of unpredictable information

/ɹajt/	/ɹajt-əɹ/	/ɹajd/	/ɹajd-əɹ/	
ɹăjt	ɹăjtəɹ	-----	----------	vowel shortening before [-voice]
rʌ̆jt	rʌ̆jtər	----	---------	Canadian Raising
----	rʌ̆jɾər	----	rajɾər	Flapping

[1] 'invariance' was the hypothesis that each phoneme is distinguished by a core of properties that appears in every phonetic realization of the sound.

- Chomsky concludes that there is no autonomous phonemic level between the Underlying Representation and the Phonetic Representation
- Focus of analysis shifts to alternations

[3] Vowel Shift:	divīne	divínity	rigid	rigídity
	serēne	serénity	prosper	prospérity
	profāne	profánity	final	finálity
	[aj]	[ɪ]	[ɪ]	[ɪ]
	[ij]	[ɛ]	[ɛ]	[ɛ]
	[ej]	[æ]	[æ]	[æ]

analysis:

- a quantitative alternation (long diphthong ≈ short lax vowel) as well as a difference in vowel quality
- suffixed form reveals the underlying quality of vowel; but to distinguish from stable short vowels in *rigid*, *rigidity*, etc. the alternating vowels must be underlyingly long; hence div/i:/ne, ser/e:/ne, prof/æ:/e; their quality is changed by shifting the nucleus of the diphthong (a change that is recurrent in the history of English[2])

V: -> Vj	long vowel diphthongizes	
[-low, αhigh] -> [-αhigh] / ___ j	ij and ej interchange nuclei	
[-high, αlow] -> [-αlow] / ___ j	ej and aj interchange nuclei	

- some rule must shorten the root vowel when certain affixes are added: Trisyllabic Laxing: V -> [-long] / ___ $C_oVC_oVC_o$#
- the analysis entails that the underlying vowel never surfaces as such: it is always changed either in quantity or else in quality. But this is exactly what is expected if rules apply mechanically in sequence (without regard to their consequences).

Order: TSL precedes Vowel Shift, which itself is composed of three ordered sub-rules

/ divīne/	/ divīn-iti/	
-------	diviniti	Trisyllabic Laxing
divijn	--------	diphthong formation
divejn	--------	Vowel Shift I
divæjn	--------	Vowel Shift II

[2] See SPE (Chapter 6) and Labov (1994).

- while one might postulate rules that directly relate the surface vowels (e.g. [aj] -> [ɪ] / __ CoVCoVCo#), there is independent evidence that [aj] derives from /i:/.

[4] Velar Softening (velar palatalization before front vowels is a common sound change: cf. Slavic, Mandarin)

criti**c**	criti**c**-al	criti**c**-ism	criti**c**-ize
medi**c**	medi**c**-al	medi**c**-ine	medi**c**-ate
alle**g**e	alle**g**-ation		
ri**g**id	ri**g**or		
re**g**-al	re**g**icide		
analo**g**-ous	analo**g**-y	analo**g**-ize	

[k, g] -> [s, dʒ ~ ʒ] / ___ [-cons, -low, -back][3]
precedes Vowel Shift for two reasons:
in *critic-ize* Vowel Shift alters the context to a low vowel ("counterbleeds")
in *medic-ate* Vowel Shift creates a front mid vowel that fails to soften the velar ("counterfeeds")

/kritik-i:z/	/medik-æ:t/	
kritis-i:z	----------	Velar Softening
kritis-ajz	medik-ejt	Vowel Shift

[5] blocking condition on rules

t -> s / _ -ive, -y		permit	permiss-ive
		democrat	democrac-y
	but	digest	digest-ive
		honest	honest-y
s -> ʃ / _ j		regress	regre[ʃ]-on
		rebel	rebel-[j]on
		permit	permi[ʃ]-on
		explode	explo[ʒ]-on
	but	digest	diges[tʃ]-on

[3] The statement of the structural change in features is tricky and requires a special mechanism (p. 224) that changes the input to [+anterior] if [-voice], somewhat analogous to OT's *tʃ > *s.

- t -> s rule is blocked after s
- avoid sequence of spirants: *s s
- cf. plural zebra-[z], dog-[z], ram-z] , bed-[z], rat-[s], bush-[ɨz], bus-[ɨz]
- is this the same grammatical phenomenon? Not obvious how *s s can both block rules like t -> s and trigger insertion of schwa; a basic motivation for the OT model

[6] s-voicing: at prefix stem boundary /s/ is voiced between vowels

con = **s**ume [s]	re = **s**ume [z]
in = **s**ist, per = **s**ist	re = **s**ist
con = **s**ign	de = **s**ign, re = **s**ign
con = **s**erve	re = **s**erve, de = **s**erve

s -> [+voice] / V = ___ V

apparent exceptions explained by rule ordering: (counterfeeding)

con = **c**ede [s]	re = **c**ede [s]
in = **c**ite	re = **c**ite

/re = ki:t/	
--------	s-voicing
re = si:t	Velar-Softening
re = sajt	Vowel Shift

[7] ks-voicing:

e**x** = amine [gz]	vs.	e**x**-ceed [ks]
e**x** = alt		e**x** = cite
e**x** = ist		

/eks = ke:d/	/eks = ist/	
---------	egz = ist	ks-voicing
eks = se:d	---------	Velar Softening
eks = sijd	---------	Vowel Shift
eksijd	---------	Degemination

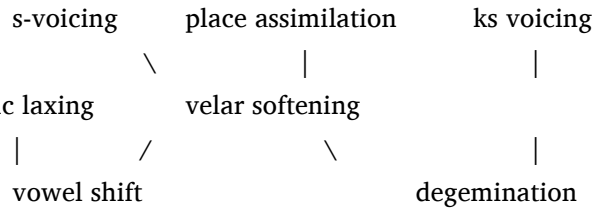
[8] more prefixes: C -> C* / ___ = C* (a subset of prefixes completely assimilate to the following consonant)

ad = here	sub = due
ad = mire	sub = sist
at = test	sup = port
as = sist	suf = fice
an = noy	sub = merge
ac = cuse	suc = cumb

ac = **c**ede [s] suc = **c**eed [s] sug = **g**est [dʒ]

/sub = ke:d/
suk = ke:d assimilation
suk = se:d Velar Softening
suk = sijd Vowel Shift

rule ordering:



[9] the cycle: Chomsky, Halle & Lukoff (1956) show that the stress contours of English compounds and phrases can be computed by simple rules that track the syntactic constituent structure, working from the inside out.

Compound Stress vs. phrasal stress (Nuclear Stress Rule)

Whíte Hòuse	the whìte hórse
bláckbòard	a blàck dréss

Compound Stress: make the stress of the first constituent primary [1] and reduce the other by one degree

[[[black] [board]] [eraser]]

1	1	1	Word Stress
1	2	------	Compound Stress: first cycle
1	3	2	Compound Stress: second cycle

bláck-boărd eràser

[10] SPE suggests applying cyclic stress to word-internal structure

[[[theater] ic + al] ity] (cf. orìgin-álity vs. àbracadábra, Wìnnepesáukee

_1__	theater	cycle 1
2 1_____	theatric	cycle 2
3 2 1	thèàtricálity	cycle 3

[11] some subtle vowel contrasts explained in words that have the same surface stress contours:

rel**a**xátion [æ]	dev**a**státion [ə]
em**e**ndátion [ɛ]	cont**e**mplation [ə]
dom**e**stícity [ɛ]	opp**o**rtunity [ə]

tórm**e**nt [ɛ]	tórr**e**nt [ə]
cónv**i**ct [ɪ]	verd**i**ct [ə]
prógr**e**ss [ɛ]	tigr**e**ss [ə]

[relax] ation [devastate] ion

2 1	1 0 2	Word Stress: cycle-1
3 2 1	2 0 1	Word Stress: cycle-2
----------	dev**ə**státion	Vowel Reduction
2 1	----------	Stress Clash: remove medial stress

[[torment]$_v$]$_n$ [torrent]$_n$

2 1	1 0	Word-Stress: cycle-1
1 2	----------	Word-Stress: cycle-2
---------	ə	

[12] stress in English bases

verbs and adjectives

astónish	maintáin	lamént
imágine	eráse	usúrp
devélop	cajóle	cavórt
sólid	supréme	robúst

cómmon	secúre	diréct
vúlgar	ináne	ovért

nouns

América	aréna	ásterisk
metrópolis	horízon	lábyrinth
vénison	aróma	appéndix

- in nouns, words ending in consonant clusters are treated as “extrametrical”

complex verbs	derived nouns	
per = mít	pér = mit	(cf. fórfeit, hermit)
trans = fér	tráns = fer	
com = pél	pró = tèst	(cf. déntist with flap

- in verbs with latinate [prefix = root] structure, the prefix is unstressible (extrametrical). But on the noun cycle this internal structure is no longer visible (subjacency) and so per = mit (0 1) > (1 2). The surface 1 0 contour derives from another rule of stress clash reduction on weak syllables.

Bloch, Bernard. 1941. Phonemic overlapping. American Speech 16, 278-84.
Chomsky, Noam. 1964. Current Issues in Linguistic Theory. Mouton.
Chomsky, Noam, Morris Halle, and Fred Lukoff. 1956. On accent and juncture in English. For Roman Jakobson. Mouton, p. 65-80.
Chomsky, Noam and Morris Halle. 1968. The Sound Pattern of English. Harper and Row.
Harris, Zellig. 1951. Methods in Structural Linguistics. University of Chicago Press.
Labov, William. 1994. Principles of Linguistic Change. Blackwell.

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