Language and its Applications LT5903

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Lecture 3: Phonology

Lecture plan

- Phonetics v.s phonology
- Phonotactic constraints
  - Borrwoing words
  - Foreign accents
- Phonemes and allophones
  - Distributions of speech sounds
- Phonological rules
- Short break (15 mins)
- Group discussion on HW3

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Phonetics review

The study of the physical properties of the sounds

Articulatory phonetics

segments: consonants, vowels
suprasegmentals: length, stress, tone, intonation
syllable structure: onset, nucleus, coda
IPA: consonants: place, manner, voicing
vowels: tongue advancement, tongue height, lip rounding, tenseness

Acoustic phonetics

fundamental frequency (f0/pitch)
vowel formants: F1,F2,F3
spectrogram

Auditory phonetics

general auditory approach
motor theory of speech perception

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What is phonology?

The study of how sounds are organized within a language and how they interact with each other.

Questions phonology tries to answer:

- Which sounds are possible in a language?

- Do certain types of sounds occur together?

- Is it possible to borrow sounds from other languages in this language?

- How do speakers correct the words/phrases they borrowed?

- Which sounds are predictable/unpredictable?

- Is it possible to determine what the rules are for combinations of sounds?

Phonotactic constraints

The restrictions on possible combinations of sounds.

English:

- [ʒ] or [ŋ] do not occur in the beginning of words, except for borrowing words like *Jaques* and *Nguyen*

- Typical onset clusters:
  - stop/fricative + liquid/glide: [bɹ, θɹ, gl, fl, kw, sw] *bring, three, glean, fly, quick, sweet*
  - [s] + voiceless stop: [sp, st, sk] *spin, stop, school*
  - [s] + nasal: [sm, sn] *smoke, snail*

Phonotactic constraints

Possible syllable structures in English:

V	*a*	CV	*no*	CCV	*flew*	CCCV	*spree*
VC	*at*	CVC	*not*	CCVC	*flute*	CCCVC	*spleen*
VCC	*ask*	CVCC	*ramp*	CCVCC	*flutes*	CCCVCC	*strength*
VCCC	*asked*	CVCCC	*ramps*	CCVCCC	*crafts*	CCCVCCC	*strengths*

Possible syllable structures in some other languages:

Hawaiian	Indonesian	Hebrew
CV	CV	CV
V	V	CCV
	VC	CCVC
	CVC	CVC
		CVCC

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Borrowing words

English:

Ptolemy [ptaləmi]: The 14ᵗʰ century astronomer

Gnosticism [gnastɪsizm]: a collection of religious ideas and systems which coalesced in the late 1st century AD among Jewish and early Christian sects.

→ **deletion:** [taləmi], [nastɪsizm]

Gdansk [gdansk]: a city in Poland

knish [kniʃ]: a traditional Ashkenazi Jewish snack food

→ **schwa insertion:** [gədansk], [kəniʃ]

Japanese:

birth [bɹɵ], **control** [kəntɹɔl]

→ **vowel insertion:** [bɑːsɯ] [kontoroːrɯ]

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Foreign accents

Spanish → English:

student [student] → [estudent]:

[st],[sk],[sp] clusters are not permitted at word onset without being preceded by a vowel in Spanish → **vowel insertion**

French → English:

this [ðɪs] → [zis], *thin* [θɪn] → [sin]:

[ð],[θ] and [ɪ] are not in the phonetic inventory of French → **sound substitution**

English → German:

Bach [bɑx] → [bɑk]/[bɑh]

[x] not in the phonetic inventory of English → **sound substitution**

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Phonemes and allophones

s**t**op	[s**t**ap]
top	[**tʰ**ap]
li**tt**le	[lɪ**ɾ**l]
ki**tt**en	[kʰɪ**ʔ**n̩]
ki**t**	[ki**t̚**]

Phoneme   /t/

Allophones   [t] [tʰ] [ɾ] [ʔ] [t̚]
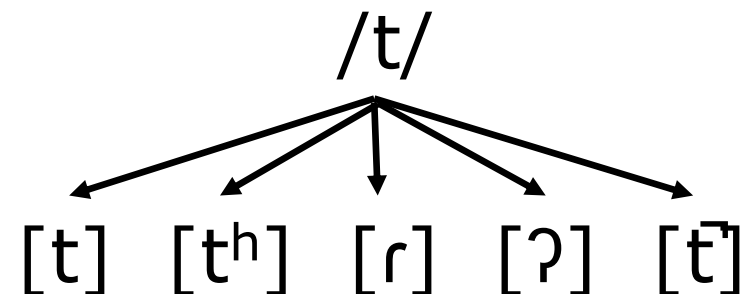
Phonemes and allophones

English
Kate [keɪt]
gate [geɪt]

Kikamba
katala [katala] 'to count.'
ŋkatala [ŋgatala] 'if I count'

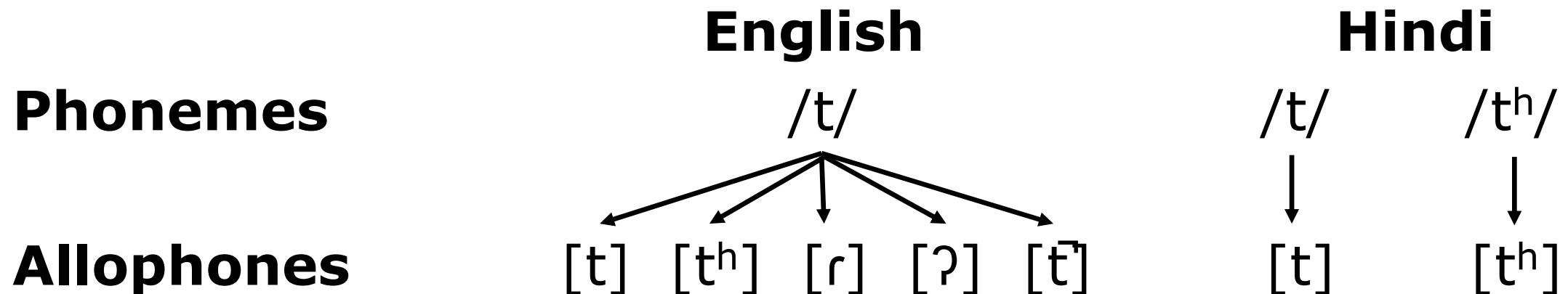|	**English**		**Kikamba**
Phonemes	/k/	/g/	/k/
	↓	↓	⋀
Allophones	[k]	[g]	[k] [g]

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Contrastive and non-contrastive sounds

Non-contrastive: two (or more) ways of producing the same phone that do not produce a change in meaning.

Contrastive: two (or more) ways of producing the same phone that produce a change in meaning.

English [tʰɑp] 'top' v.s [tɑp] 'top'

Hindi   [tʰal] 'plate' v.s [tal] 'beat' → **minimal pairs**

	English	**Hindi**
Phonemes	/t/	/t/ /tʰ/
Allophones	[t] [tʰ] [ɾ] [ʔ] [t̚]	[t] [tʰ]

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The distributions of speech sounds

contrastive	complementary	free variation
• Sounds occur in the same environments; interchanging the phones gives two different words	• Sounds occur in different environments; interchanging the phones does not change the meaning of the words	• Sounds occur in different environments; interchanging the phones does not change the meaning of the words
• Distribution cannot be predicted	• Distribution can be predicted based on the specific phonetic context	• Distribution cannot be predicted
• Allophones of **different** phonemes	• Allophones of the **same** phoneme	• Allophones of the **same** phoneme
'pat' [pæt] v.s 'bat' [bæt]	'spat' [spæt] v.s 'pat' [pʰæt]	'pat' [pæt] v.s 'pat' [pæt̚]

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Quiz

- What is the difference between a phone and a phoneme?

- What is an allophone?

- What is a contrastive sound?

- What are the three types of sound distributions?

Phonological rules

- **Underlying representation:** the phonemic form of a word, part of speakers' linguistic competence about sounds in a language

- **Surface form:** the phonetic form of the word after the phonological rules have been applied

Underlying   /phonemic/

$\downarrow$

Rule Application

$\downarrow$

Surface   [phonetic]

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Evidence from children

Wug Test by Jean Berko Gleason

Determined that young children (5-6) <u>already knew how to correctly pluralize</u> phonological forms.

- **Underlying form:** /wʌg/
- **Rule:** plurals in English: /s/, /z/ or /ɨz/
- **Surface form:** ?

Children correctly said: /wʌgz/

This is a Wug.

Now there is another one.
There are two of them.
There are two _____. ©

Photo courtesy of Jean Berko Gleason

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Plural marking in English

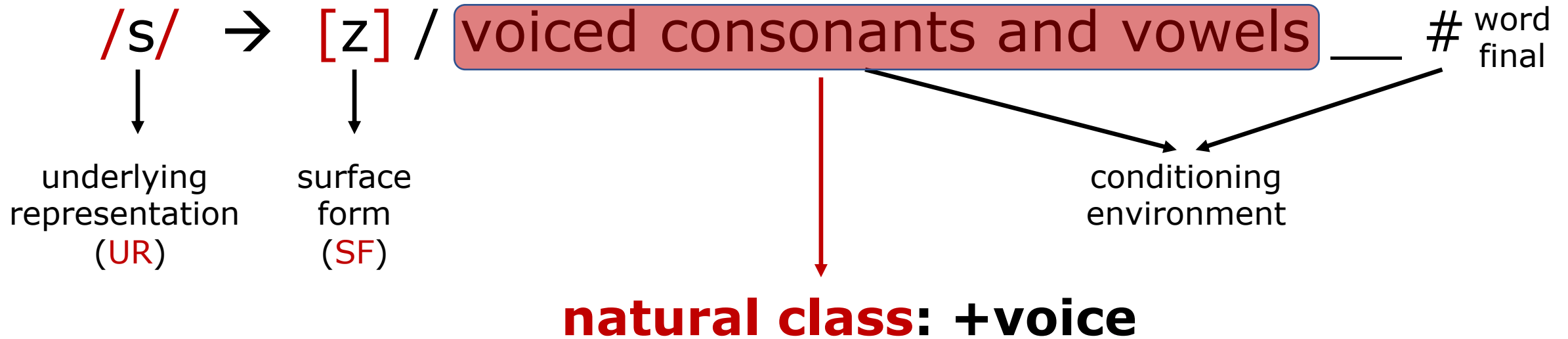What is the distribution for the suffixes [s], [z] and [ɨz]?

Observation:

- [s] after voiceless consonants except for [s], [z], [ʃ], [ʒ], [tʃ], [dʒ]: e.g., caps [kæps], cats [kæts];

- [z] after vowels and voiced consonants except for [s], [z], [ʃ], [ʒ], [tʃ], [dʒ]: e.g., keys [kiz], cabs [kæbz];

- [ɨz] after [s], [z], [ʃ], [ʒ], [tʃ], [dʒ]: e.g., buses [bʌsɨz], bushes [bʊʃɨz], watches [wɒtʃɨz].

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Plural marking in English

Writing the phonological rule:

/s/ → [z] / voiced consonants and vowels ___ # word final

underlying representation (UR)

surface form (SF)

conditioning environment

natural class: +voice

Natural class: a group of sounds in a language that share articulatory or auditory properties, to the exclusion of all other sounds in that language.

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Examples of natural classes:

phonological features

- sibilants: [s z ʃ ʒ tʃ dʒ] → C[+strident]

- non-low front vowels: [i ɪ ɛ] → V[+front,-low]

- coronal (dental/alveolar/post-alveolar/retroflex/palatal) consonants:

  [f v θ ð t d s z n ɹ l ɾ ʃ ʒ tʃ dʒ j] → C[+coronal]

- voiceless consonants: [p, t, k, ʔ, f, s, ʃ, θ, h, tʃ] → C[-voice]

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Plural marking in English

Writing the phonological rule using features:

$$/s/ \rightarrow [+voice] \: / \: [+voice] \: \underline{\quad} \: \#$$

How about [ɨz]?

$$\emptyset \rightarrow [ɨ] \: / \: \boxed{[s, z, ʃ, ʒ, tʃ, dʒ]} \: \underline{\quad} \: s \: \#$$

sibilants

↓

$$\emptyset \rightarrow [ɨ] \: / \: C[+strident] \: \underline{\quad} \: s \: \#$$

Plural marking in English

Multiple rule application

(1) /s/ → [+voice] / [+voice] __ #

(2) Ø → [ɨ] / C[+strident] __ s #

Does the order of rule application matter?

UR	/bʌs-s/
/s/ → [+voice] / [+voice] __ #	bʌss
Ø → [ɨ] / C[+strident] __ s #	bʌsɨs
SF	*[bʌsɨs]

UR	/bʌs-s/
Ø → [ɨ] / C[+strident] __ s #	bʌsɨs
/s/ → [+voice] / [+voice] __ #	bʌsɨz
SF	[bʌsɨz]

correct order!

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Plural marking in English

/z/ as the UR?

(1) /z/ → [-voice] / [-voice] __ #

(2) Ø → [ɨ] / C[+strident] __ z #

UR	/bʌs-z/
/z/ → [-voice] / [-voice] __ #	bʌss
Ø → [ɨ] / C[+strident] __ z #	bʌsɨs
SF	*[bʌsɨs]

UR	/bʌs-z/
Ø → [ɨ] / C[+strident] __ z #	bʌsɨz
/z/ → [-voice] / [-voice] __ #	-----
SF	[bʌsɨz]

correct order!

Plural marking in English

/ɨz/ as the UR?

(1) /z/ → [-voice] / [-voice] __ #

(2) [ɨ] → Ø / C[-strident] __ z #

UR	/bʌs-ɨz/
/z/ → [-voice] / [-voice] __ #	-----
[ɨ] → Ø / C[-strident] __ z #	-----
SF	[bʌsɨz]

UR	/bʌs-ɨz/
[ɨ] → Ø / C[-strident] __ z #	-----
/z/ → [-voice] / [-voice] __ #	-----
SF	[bʌsɨz]

UR	/kæp-ɨz/
/z/ → [-voice] / [-voice] __ #	-----
[ɨ] → Ø / C[-strident] __ z #	kæpz
SF	*[kæpz]

UR	/kæp-ɨz/
[ɨ] → Ø / C[-strident] __ z #	kæpz
/z/ → [-voice] / [-voice] __ #	kæps
SF	[kæps]

correct order!

Plural marking in English

Which one is the UR: /s/, /z/ or /ɨz/?

/s/: (1) Ø → [ɨ] / C[+strident] ___ s #
      (2) /s/ → [+voice] / [+voice] ___ #

voiced consonants and vowels

/z/: (1) Ø → [ɨ] / C[+strident] ___ z #
      (2) /z/ → [-voice] / [-voice] ___ #

→ Correct UR!

voiceless consonants

non-sibilants

/ɨz/: (1) [ɨ] → Ø / C[-strident] ___ z #
      (2) /z/ → [-voice] / [-voice] ___ #

Past tense marking in English

Consider these words:

missed [mɪst], laughed [læft]

glue [glud], planned [plænd], rubbed [rʌbd]

needed [nidəd], seated [sitəd], deleted [dɪlitəd]

Observation:

- **[t]** after voiceless consonants except the voiceless coronal stop [t]: e.g., missed [mɪst], laughed [læft];

- **[d]** after vowels and voiced consonants except the voiced coronal stop [d]: e.g., glue [glud], planned [plænd], rubbed [rʌbd];

- **[əd]** after the coronal stops [d] and [t]: e.g., needed [nidəd], seated [sitəd], deleted [dɪlitəd].

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Past tense marking in English

Write the phonological rule:

voiced consonants and vowels

/t/: /t/ → [+voice] / [+voice] ___ #
Ø → [ə] / C[-continuant, +coronal] _ t #

coronal stops [t,d]

voiceless consonants

/d/: /d/ → [-voice] / [-voice] ___ #   **→ Correct UR!**
Ø → [ə] / C[-continuant, +coronal] _ d #

coronal stops [t,d]

/əd/: /d/ → [-voice] / [-voice] ___ #
[ə] → Ø / C[+continuant, -coronal] _ d #

non-coronal stops

Past tense marking in English

Rule ordering

	needed	missed	seated
UR	/nid-d/	/mɪs-d/	/sit-d/
/d/ → [-voice] / [-voice] __ #	-----	mɪst	sitt
Ø → [ə] / C[-continuant, +coronal] _ d #	nidəd	-----	sitət
SF	[nidəd]	[mɪst]	*[sitət]

	needed	missed	seated
UR	/nid-d/	/mɪs-d/	/sit-d/
Ø → [ə] / C[-continuant, +coronal] _ d #	nidəd	-----	sitəd
/d/ → [-voice] / [-voice] __ #	-----	mɪst	-----
SF	[nidəd]	[mɪst]	[sitəd]

correct order!

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Past tense marking in English

More observation:

needed [nirəd], seated[sirəd], looted [lurəd]

Yet another rule:

C[-continuant, +coronal] → [ɾ] / V[+stress] __ V[-stress]

	needed	looted	seated
UR	/nid-d/	/lut-d/	/sit-d/
Ø → [ə] / C[-continuant, +coronal] __ d #	nidəd	lutəd	sitəd
/d/ → [-voice] / [-voice] __ #	-----	-----	-----
C[-continuant, +coronal] → [ɾ] / V[+stress] __ V[-stress]	nirəd	lurəd	sirəd
SF	[nirəd]	[lurəd]	[sirəd]

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Types of phonological rules

Seven major processes:

- Assimilation
- Dissimilation
- Insertion
- Deletion
- Metathesis
- Strengthening/Fortition
- Weakening/ Lenition

Assimilation

One sound becomes more like a neighboring sound (or gesture) with respect to some phonetic property.

Nasal place assimilation in English: the alveolar nasal /n/ assimilates to the place of articulation of the following consonant

- unbelievable → [ʌmbəlivəbl̩]
- unstable → [ʌnsteibl̩]
- unclear → [ʌŋkliɹ]

Vowel harmony in Finnish: a back vowel becomes front when preceded by a front vowel in the same word:

- [talo] 'house' → [talossɑ] 'in the house'
- [metsæ] 'forest' → [metsæssæ] 'in the forest'

Dissimilation

Two close or adjacent sounds become less similar with respect to some property

Manner dissimilation in Greek: A stop becomes a fricative when followed by another stop

- /epta/ 'seven' → [efta]
- /ktizma/ 'building' → [xtizma]

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Insertion

Segments not present at the phonemic level become inserted into the phonetic forms of the words

Voiceless stop insertion in English: Between a nasal consonant and a voiceless fricative, a voiceless stop with the same place of articulation as the nasal is inserted

- hamster → [hæmpstɹ̩]
- strength → [stɹɛŋkθ]
- dance → [dænts]

Deletion

Rules eliminate sounds present at the phonemic level, usually in unstressed syllables in causal speech

/h/- Deletion in unstressed syllables in English:

* '*He handed her his hat*' → [hi hændəd ɹ̩ ɪz hæt]

Metathesis

Changing the order of sounds to make words easier for hearers to understand or for speakers to say

CV metathesis in Leti: When three consecutive consonants occur, the first consonants trade places with the preceding vowel.

- /danat + kviali/ 'millipede' → [dantakviali]
- /ukar + ppalu/ 'index finger' → [ukrappalu]

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Strengthening/Fortition

Making sounds stronger

Aspiration in English: Voiceless stops become aspirated when they occur at the beginning of a stressed syllable. Aspirated stops are considered stronger because the duration of voicelessness is much longer than unaspirated stops.

- pat → [pʰæt]
- top → [tʰɑp]

Weakening/Lenition

Making sounds weaker

Flapping in English: An alveolar (oral) stop stop is realized as [ɾ] when it occurs after a stressed vowel and before an unstressed vowel. The flap [ɾ] is considered weaker than [t,d] because it is shorter and obstructs the airflow less.

- /t,d/ → [ɾ] / V[+stress] ___ V[-stress]

Practice: Solving phonology problems

Greek

Modern Greek is an Indo-European language spoken in Greece. Examine the sounds [x], [k], [ç], and [c] in the following data. [k] represents a voiceless velar stop, [x] a voiceless velar fricative, [ç] a voiceless palatal fricative, and [c] a voiceless palatal stop. Which of these sounds are in contrastive distribution, and which are in complementary distribution? State the distributions of the allophones.

a. [çiɾos]   'widower'
b. [sxolio]   'school'
c. [scini]   'stage'
d. [cipos]   'garden'
e. [kaɾta]   'card'
f. [xɾoma]   'color'

g. [cefali]   'head'
h. [maçeɾi]   'knife'
i. [xoɾafi]   'field'
j. [xaɾti]   'paper'
k. [çelona]   'tortoise'
l. [kozmos]   'world'

m. [kɾeas]   'meat'
n. [tɾexumenos] 'current'
o. [skoni]   'dust'
p. [facelos]   'envelope'
q. [sçini]   'rope'
r. [ksekuɾasi]   'rest'

Practice: Solving phonology problems

Contrastive:

[k] v.s [x]: [kano] 'do' v.s [xano] 'lose'

[ç] v.s [c]: [çino] 'pour' v.s [cino] 'move'

Complementary distribution:

[k] v.s [c]: [c] before non-low front vowels ([i,e]), [k] elsewhere

[x] v.s [ç]: [ç] before non-low front vowels ([i,e]), [x] elsewhere

C[+velar,-voice] → [+palatal] / ___ V[-low,+front]

Practice: Solving phonology problems

Ebira

Examine the sounds [e] and [a] in the following data from Ebira, a Niger-Congo language of the Nupoid family, spoken in Nigeria. Do they appear to be allophones of separate phonemes or allophones of the same phoneme? If the two sounds are in complementary distribution, state the conditioning environments for the allophones. If they are in contrastive distribution, provide evidence for your claim.

a. [mezi] 'I expect'

b. [meze] 'I am well'

c. [meto] 'I arrange'

d. [metu] 'I beat'

e. [mazɪ] 'I am in pain'

f. [mazɛ] 'I agree'

g. [matɔ] 'I pick'

h. [matʊ] 'I send'

Practice: Solving phonology problems

Complementary distribution:

[e] v.s [a]: [e] before tense vowels, [a] before lax vowels

[a] → [e] / ___ V[+tense]

Practice: Solving phonology problems

Ukrainian

Ukrainian is an Indo-European language of the Slavic family, spoken in Ukraine. Compare the masculine nominative singular forms of nouns with the vocative forms (nominative is used for the subject of a sentence, and vocative is used when calling to or addressing someone, as in "Hey, Robin."). There is a phonological change between the nominative and the vocative, which adds the ending [-e] to the nominative form. Three pairs of sounds are in allophonic variation. What are these pairs of sounds? What sort of phonological process is at work here? (There is a special name for it; see File 3.3.) What do you think is conditioning this alternation? *Note:* [ɦ] and [x] are the voiced glottal fricative and the voiceless velar fricative, respectively.

	Nominative	*Vocative*	*Gloss*
a.	[rak]	[ratʃe]	'lobster'
b.	[junak]	[junatʃe]	'young man'
c.	[ʒuk]	[ʒutʃe]	'beetle'
d.	[pastux]	[pastuʃe]	'shepherd'
e.	[ptax]	[ptaʃe]	'bird'
f.	[boɦ]	[boʒe]	'God'
g.	[pluɦ]	[pluʒe]	'plow'

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Practice: Solving phonology problems

Complementary distribution:
- [k] v.s [tʃ]: [tʃ] before the mid front vowel [e], [k] elsewhere
- [x] v.s [ʃ]: [ʃ] before the mid front vowel [e], [x] elsewhere
- [ħ] v.s [ʒ]: [ʒ] before the mid front vowel [e], [ħ] elsewhere

C[-coronal,-labial,+obstruent] → [+palatal] / ___ V[+mid,+front]

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To do

Assign yourself to the correct group under A3!

Do HW3

Read:

This lecture: **File** Ch3

Next lecture: **File** Ch4