

Where am I?

- **HUL242: Fundamentals of Language Sciences**
- **Phonology (Lecture-3)**
- **Monday, Feb 3rd**

Today

- Practice

- Identifying Phonological processes
- Formulating Phonological Rules

- Rule Ordering

- Syllable and its structure

Practice: Mokilese (Micronesian) vowel voicing

- Your task: Give a phonological analysis of when Mokilese vowels are voiced, and when they're voiceless. (Note: The dot symbol below a vowel such as [ṵ] indicates that the vowel is voiceless).

[p̰isan]	'full of leaves'	[uduk]	'flesh'
[t̰up̰uk̰ta]	'bought'	[kaskas]	'to throw'
[p̰uko]	'basket'	[poki]	'to strike something'
[kisa]	'we two'	[pil]	'water'
[s̰up̰wo]	'firewood'	[apid]	'outrigger support'
[kamw̰ok̰iti]	'to move'	[lud̰ʒuk]	'to tackle'

Practice: Mokilese (Micronesian) vowel voicing

[pisan]	'full of leaves'	[uduk]	'flesh'
[tupukta]	'bought'	[kaskas]	'to throw'
[puko]	'basket'	[poki]	'to strike something'
[kisa]	'we two'	[pil]	'water'
[supwo]	'firewood'	[apid]	'outrigger support'
[kamwɔkiti]	'to move'	[ludʒuk]	'to tackle'

- Hint:

- Start by making a list of the contexts in which voiced vowels occur and the contexts in which voiceless vowels occur.
- Use this list to devise a phonological rule that predicts exactly the distribution of voiceless/voiced vowels.

- Rule: $V[+High +voice] \rightarrow V[-voice] / C[-voice] _ C[-voice]$

Practice: Southern Kongo

- Consider the following data from Southern Kongo. Use it to answer the questions below

[tobola]	'to bore a hole'	[tʃina]	'to cut'
[tanu]	'five'	[tʃiba]	'banana'
[kesoka]	'to be cut'	[ŋokʃi]	'lion'
[kasu]	'emaciation'	[nsele]	'termite'
[kunezulu]	'heaven'	[azimola]	'alms'
[nzwetu]	'out'	[lolonzi]	'to wash house'
[zevo]	'then'	[zenɡa]	'to cut'
[zima]	'to stretch'	[tenisu]	'tennis'

- The sounds [t] and [tʃ] aren't contrastive in Southern Kongo. How do we know this?
- Which of [t] and [tʃ] is the underlying form? How do you know?
- Write a rule characterizing the distribution of [t] and [tʃ].

Practice: Southern Kongo

- Consider the following data from Southern Kongo. Use it to answer the questions below

[tobola]	'to bore a hole'	[tʃina]	'to cut'
[tanu]	'five'	[tʃiba]	'banana'
[kesoka]	'to be cut'	[ɲokʃi]	'lion'
[kasu]	'emaciation'	[nsele]	'termite'
[kunezulu]	'heaven'	[azimola]	'alms'
[nzwetu]	'out'	[lolonzi]	'to wash house'
[zevo]	'then'	[zenɡa]	'to cut'
[zima]	'to stretch'	[tenisu]	'tennis'

- No minimal pairs: [tʃ] only shows up before [i], and [t] shows up everywhere else.
- [t] is the underlying form since its distribution is much less restricted.
- [t] → [tʃ] / #___[i]

Practice: Southern Kongo

[tobola] 'to bore a hole'

[tanu] 'five'

[kesoka] 'to be cut'

[kasu] 'emaciation'

[kunezulu] 'heaven'

[nzwetu] 'out'

[zevo] 'then'

[ɟima] 'to stretch'

[tʃina] 'to cut'

[tʃiba] 'banana'

[ŋokʃi] 'lion'

[nsele] 'termite'

[azimola] 'alms'

[lolonɟi] 'to wash house'

[zeŋga] 'to cut'

[tenisu] 'tennis'

- Is there evidence that a similar process dictates what we see when we see [s] vs. [ʃ], and [z] vs. [ɟ]? Explain.

➤ [ʃ] and [ɟ] also only occur before [i]. This suggests that [s] and [ʃ] are underlying /s/, and that [z] and [ɟ] are underlying /z/

Rule ordering

Rule ordering: Order sometimes matters

- When two rules are operative in a language's phonology, there is **sometimes** reason to assume that one rule applies **before** the other!
- Consider our slow and quick speech pronunciations of the word English word 'Pared'.

Slow speech

[p^hə. 'ɪe:d]

Rapid speech

['pɪe:d]

- Two rules are relevant here :

Aspiration: $C \left[\begin{array}{c} +\text{stop} \\ -\text{voice} \end{array} \right] \rightarrow [+ \text{ aspirated}] \quad / \quad \# \quad _ \quad V$

Schwa deletion: $[\text{ə}] \rightarrow \emptyset \quad / \quad _ \quad [\text{stressed syllable}]$

(**Note:** Another rule, 'vowel lengthening', is also active. However, we will ignore it for now)

- Which order should apply first in rapid speech?

Rule ordering: Rapid speech

- Aspiration, then deletion

Note: Underlying forms/representations are composed of phonemes.

Underlying form

/pə.'ɪed/

Step 1: Aspiration

[p^hə.'ɪe:d]

Step 2: Deletion

['p^hɪe:d]

‘Wrong output’

- Deletion, then aspiration

Underlying form

/pə.'ɪed/

Step 1: Deletion

['pɪe:d]

Step 2: Aspiration

['pɪe:d]

‘Correct output’

(aspiration applies but the condition is not met.)

- **Schwa deletion** applies **first**! If aspiration was applied first, we’d incorrectly end up with the impossible form *['p^hɪe:d].

Sometimes order do not matter

- Rules *can* be unordered, though. For example:

Slow speech

[p^hə.ˈɪe:d]

- Rules:

Aspiration: $C \left[\begin{array}{c} +\text{stop} \\ -\text{voice} \end{array} \right] \rightarrow [+aspirated] / \# _ V$

Vowel lengthening: $V \rightarrow V:/ _ C[+Voice]$

- It doesn't matter which order you apply these rules.

No ordering: slow speech

- It doesn't matter which order you apply these rules in:

Aspiration, then lengthening

Underlying form

/pə.'ɪed/

Step 1.

[p^hə.'ɪed]

Step 2.

[p^hə.'ɪe:d] 'Correct output'

Lengthening, then aspiration

Underlying form

/pə.'ɪed/

Step 1.

[pə.'ɪe:d]

Step 2.

[p^hə.'ɪe:d] 'Correct output'

Another phonological process: English flapping

- Consider the following data (V: is an extra-long vowel):

Word	Pronunciation
writer	[ˌaɪrəɪ]
rider	[ˌaɪrəɪ]
traitor	[ˌtreɪrəɪ]
trader	[ˌtreɪrəɪ]
doted	[ˌdoʊrəd]
toted	[ˌtoʊrəd]
toaded	[ˌtoʊrəd]

How to pronounce the flap [ɾ]

<https://www.youtube.com/watch?v=Y7FUneS1mBs>

- Are [t] and [d] in complementary distribution? **No**
- Are [t] and the flap [ɾ] in complementary distribution? **Yes**
- Are [d] and flap [ɾ] in complementary distribution? **Yes**

English flapping: phonological rule

- Since [t] and [ɾ] are in complementary distribution, we need a rule that tells us which shows up where. What does it look like?

$$[t] \rightarrow [\textcolor{brown}{r}] / \textcolor{brown}{V} _ \textcolor{brown}{V}$$

- Since [d] and [ɾ] are in complementary distribution, we need a rule that tells us which shows up where. What does it look like?

$$[d] \rightarrow [\textcolor{brown}{r}] / \textcolor{brown}{V} _ \textcolor{brown}{V}$$

- Can we unify these two rules into one general rule?

Yes: Using natural class

$$\textcolor{brown}{C} \left[\begin{array}{c} +\text{stop} \\ +\text{alveolar} \end{array} \right] \rightarrow [\textcolor{brown}{r}] / \textcolor{brown}{V} _ \textcolor{brown}{V}$$

The interaction of flapping and vowel lengthening

- Two rules here: flapping and vowel lengthening (we already saw).

$$C \left[\begin{array}{c} +\text{stop} \\ +\text{alveolar} \end{array} \right] \rightarrow [r] / V _ V$$

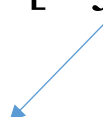

$$V \rightarrow V:/ _ C[+\text{Voice}]$$

- Are these rules ordered?

Word	Pronunciation
writer	[ˌaɪrɪt̬ər]
rider	[ˌaɪd̪ɪːrɪt̬ər]
traitor	[ˌtreɪt̬ər]
trader	[ˌtreɪd̪ɪːrɪt̬ər]
doted	[ˈdɒt̬əd]
toted	[ˈtɒt̪ɪːəd]
toaded	[ˈtɒd̪ɪːrɪt̬əd]

Evidence for order

- Consider the following derivation for *writer*:

	VL before F	F before VL
Underlying form	/ɹajtəɪ/	/ɹajtəɪ/
Step 1.	[ɹajtəɪ]	[ɹajrəɪ]
Step 2.	[ɹajrəɪ]	[ɹaj:rəɪ]
		
	‘Correct output’	‘Wrong output’

- Vowel lengthening (VL) must happen before flapping (F).

Syllable

Syllable

- A syllable is a unit of organization for a sequence of speech sounds.
- The English word 'Telegraph' could be broken into three phonological parts. These phonological units are called syllables.

[tɛ.lə.ɡɹæf]

- Syllables are often considered the phonological "building blocks" of words.

Syllable

- Sonority (singability) plays an important role in forming syllables.

(Sonorant sounds are produced with a continuous airflow with vocal fold vibrating as vowels, glides, liquids, and nasals. **Sonorants** are more **resonant** sounds.)

- Since vowels are the most sonorous sounds, syllables usually have a vowel nucleus at their core. Less sonorous sounds may appear on either side of a nucleus.

Sonority scale:

vowels → glides → liquids → nasals

- Thus, the word **telegraph** has three syllables [tɛ.lə.ɡɹæf] because it has three vowels that serve as syllable nuclei.

Syllable

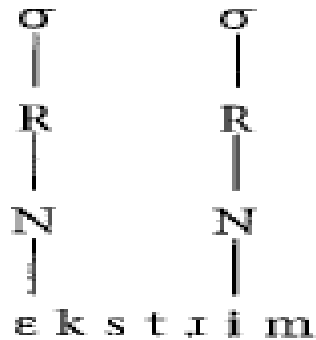
- Speakers know that syllables have internal syllabic structures as well.
 - Onset
 - Nucleus
 - Coda

Syllable

- All languages have syllables. The shapes of syllables are governed by various kinds of constraints, but there are certain universal tendencies:
 - syllable **nuclei** usually consist of one vowel (V);
 - syllables usually begin with **onsets**;
 - syllables often end with **codas**;
 - onsets and codas usually consist of one consonant (C).
- The most common types of syllables found in languages throughout the world take the shapes **CV** and **CVC**.
- Languages may **violate the universal tendencies**.

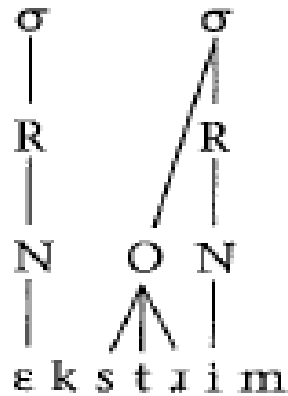
Syllable structure: Step 1, Nucleus formation

- The nucleus is the only obligatory constituent of a syllable, it is constructed first.
- Each vowel segment in a word makes up a syllabic nucleus. In the word '**extreme**', there are two vowels. So, there are two nuclei.
- The nucleus is a part of Rhyme (R). Thus, above each nucleus symbol, an R symbol is placed above which there is a syllable symbol (all linked with association lines)



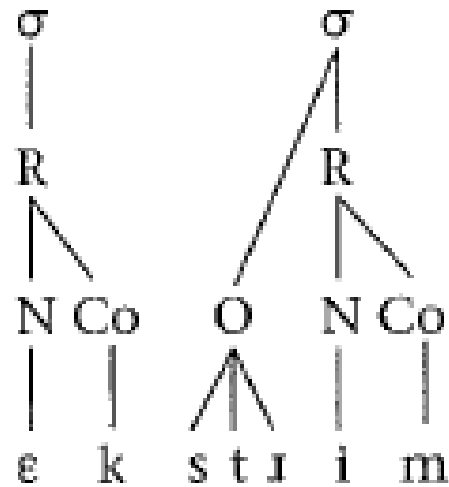
Sept 2: Onset-formation

- The longest sequence of consonants to the left of each nucleus that does not violate the phonotactic constraints of the language in question is the onset (O) of the syllable.



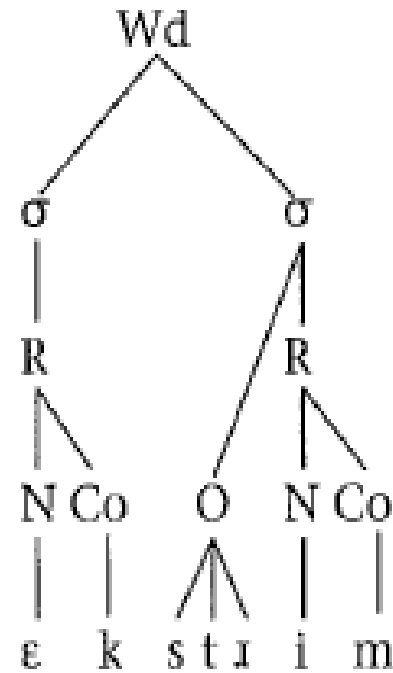
Step-3: Coda-formation

- Any remaining unassociated consonants to the right of each nucleus form the coda (Co).
- A syllable with a coda is called a **closed syllable**; a syllable without a coda is called an **open syllable**.



Step 4: Word-level representation

- Syllables that make up a single form branch out from the word-level representation W_d .

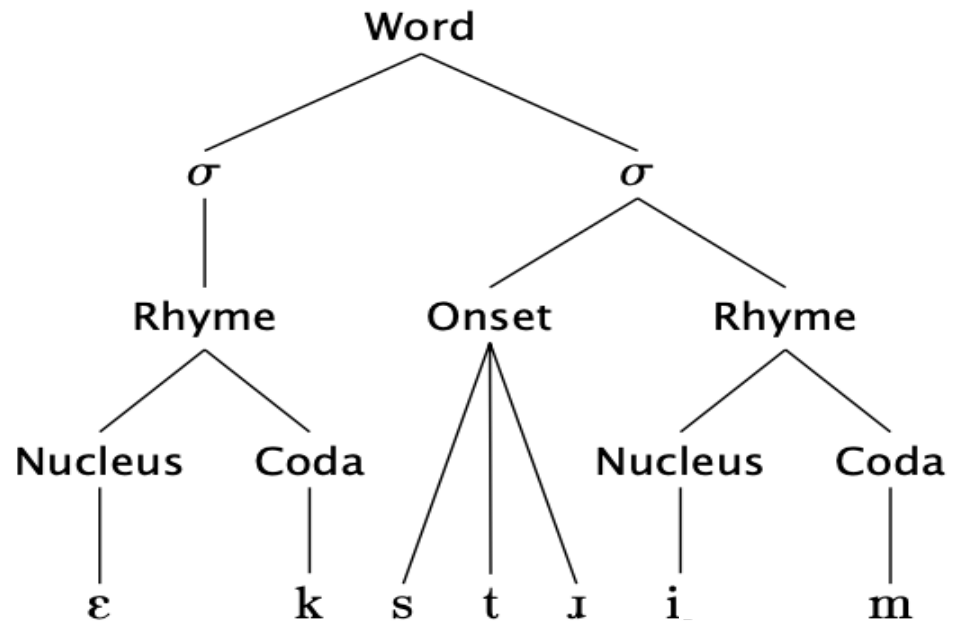


Syllables: The underlying rules

- Sounds are phonologically grouped within words.
- Word and syllable structure can be described with a set of rules:
 - Word $\rightarrow \sigma(+)$
A word must have at least one syllable (and possibly more)
 - $\sigma \rightarrow (\text{Onset}) \text{ Rhyme}$
A syllable must have a rhyme (and may have an onset)
 - Rhyme $\rightarrow \text{Nucleus (Coda)}$
A rhyme must have a nucleus (and may have a coda)
 - Onset $\rightarrow C(+)$
The onset may consist of multiple consonants
 - Nucleus $\rightarrow V$
The nucleus can be filled by exactly one vowel
 - Coda $\rightarrow C(+)$
The coda may consist of multiple consonants

Syllables: Structural representation

- The syllable structure of the word “extreme”



Word $\rightarrow \sigma +$

σ \rightarrow (Onset) Rhyme

Rhyme \rightarrow Nucleus Coda

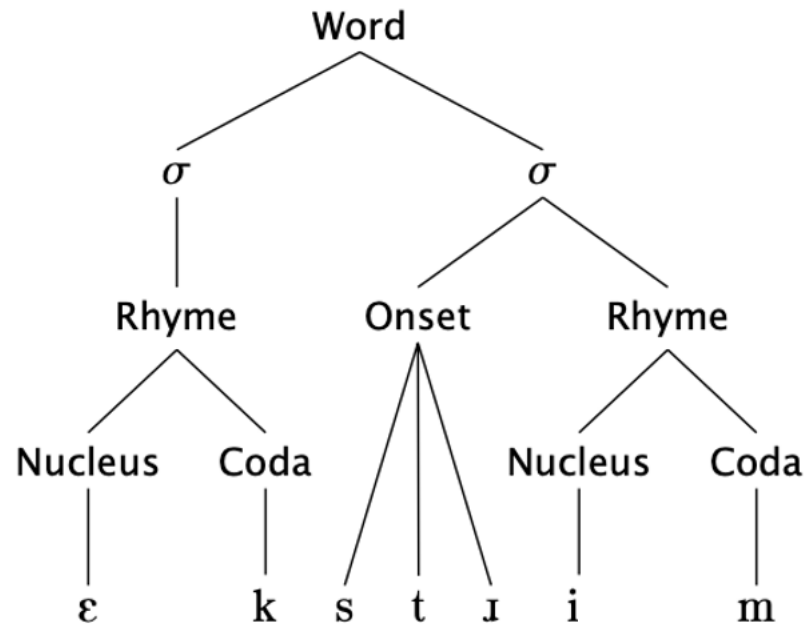
Onset $\rightarrow C +$

Nucleus $\rightarrow V$

Coda $\rightarrow C$

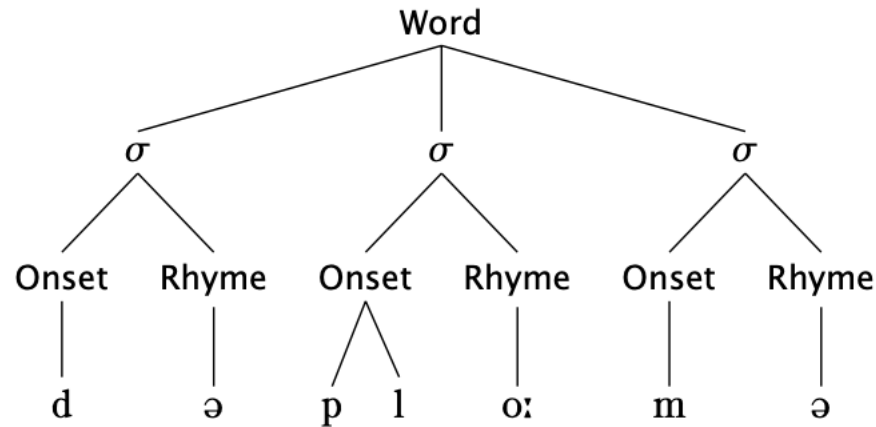
Syllables: Rules and Trees

- These rules can be used to generate the tree we just saw:



Syllables: Maximizing onsets

- Syllabification of “diploma”



- Why do we parse it [də.plo:mə]? Why not (e.g.) [dəp.lo:m.ə]

- Human languages have something called the **Maximal Onset Principle**: in general, we like to pack as many consonants as possible into the beginnings of syllables.

Syllabic Phonology: Coming Back to Aspiration

- The distribution of aspiration in English can be stated generally by referring to syllable Structure.

Table 3.23 English aspiration

A		B		C	
[p ^h æ̃n]	pan	[spæ̃n]	span	[slæ̃p]	slap
[p ^h é̃n]	pain	[spé̃j̃n]	Spain	[slát̃]	slot
[p ^h ó̃wk]	poke	[spó̃wk]	spoke	[blák̃]	block
[t ^h ó̃wn]	tone	[stó̃wn]	stone		
[k ^h ín]	kin	[skín]	skin		
[p ^h ɪ̃spáj̃ɪ]	perspire	[splæt̃]	splat		
[t ^h ə̃mé̃ɹow]	tomato	[ʌpsét̃]	upset		
[k ^h ə̃nó̃]	canoe				
[əp ^h ɔ̃n]	upon				
[ət ^h æk̃]	attack				
[t ^h ək ^h í̃lə̃]	tequila				

- English voiceless stops are aspirated syllable-initially.

Syllabic Phonology: Phonetic Length in English Vowels

- English vowels are **long** when followed by a voiced obstruent in the coda position of the same syllable units.

Table 3.25 Phonetic length in English: long vowels before voiced coda consonants

A		B	
bad	[bæɹd]	bat	[bæt]
Abe	[eɹjb]	ape	[eɹp]
phase	[feɹz]	face	[fejs]
leave	[liɹv]	leaf	[lif]
tag	[tʰæɹg]	tack	[tʰæk]
brogue	[bɹo:wɹg]	broke	[bɹowk]
		tame	[tʰējm]
		meal	[mil]
		soar	[sɔɹ]
		show	[ʃow]

Table 3.26 Short vowels before voiced onset consonants in English

obey	[ow.bej]	/obe/
redo	[ɹi.du]	/ɹidu/
regard	[ɹi.gɑɹd]	/ɹigɑɹd/

Syllabic Phonology: Phonotactics (Onset Constraints)

- Initial consonant clusters in onset position in English containing a voiceless stop

<i>Labial + sonorant</i>		<i>Coronal + sonorant</i>		<i>Velar + sonorant</i>	
[pl]	please	[tl]	—	[kl]	clean
[pɪ]	proud	[tɪ]	trade	[kɪ]	cream
[pw]	—	[tw]	twin	[kw]	queen
[pj]	pure	[tj]	tune (British)	[kj]	cute
[spl]	splat	[stl]	—	[skl]	sclerosis
[spɪ]	spring	[stɪ]	strip	[skɪ]	scrap
[spw]	—	[stw]	—	[skw]	squeak
[spj]	spew	[stj]	stew (British)	[skj]	skewer

- Generalization:

$$\sigma [s] \left\{ \begin{array}{c} p \\ t \\ k \end{array} \right\} \left\{ \begin{array}{c} (l) \\ \text{ɪ} \\ (w) \\ j \end{array} \right\}$$

Syllabic Phonology: Phonotactics

- Magahi language does not allow consonant clusters in the onset position.
- Thus, any borrowed words that have consonant clusters in the onset position are syllabified differently, such as by inserting a vowel sound as below.
 - Prem [prem] → [pə.rem]
 - School [skul] → [is.kul] (do not allow consonant clusters in the onset position)
- Punjabi phonotactics
 - School [skul] → [sə.kul] (do not allow consonant clusters in the onset position)

Park [paɹk] → [pa.rək]

- What do you notice?
- The consonant cluster in the coda position is simplified.

Syllabic Phonology: Korean [l] and [r]

- [l] and [r] are not contrastive in Korean. ([.] indicates a syllable boundary).

[mul] ‘water’

[mal] ‘horse’

[mul.kama] ‘place for water’

[mal.kama] ‘place for horse’

[mu.re] ‘at the water’

[ma.re] ‘at the horse’

[pal] ‘foot’

[pa.ri] ‘of the foot’

[səul] ‘Seoul’

[ru.pi] ‘ruby’

[il.kop] ‘seven’

[ra.tio] ‘radio’

- State the distribution of [l] and [r] in Korean
 - [l] appears at the ends of syllables as the *coda* and
 - [r] appears at the beginnings of syllables as the *onset*.

Practical Applications of Phonology

- Language Teaching and Learning
 - Helps language learners understand sound patterns and improve their accents.
 - Aids learners in recognizing distinct sounds in a new language.
 - Simplifies complex rules like stress, intonation, and rhythm that can help in teaching phonetics.
- Language Technology
 - Developing a Speech Recognition System like Siri or Alexa and improving accuracy in identifying sounds.
 - Developing Text-to-Speech Systems
 - Developing Language Translation Tools

Practical Applications of Phonology

- Speech Therapy
 - Diagnoses and treats phonological disorders like stuttering or misarticulation.
 - Helps children with delayed speech development or specific sound difficulties.
- Forensic Linguistics
 - Analyzes phonological features in voice recordings for legal cases.
 - Determines regional or social origins of speakers by analyzing accents.
- Audiology
 - Assists in designing hearing aids and cochlear implants by understanding how humans perceive and process sounds.
- Media and Entertainment
 - Dubbing and Voiceover: Ensures accurate phonological matches in different languages.

Practical Applications of Phonology

- Language Documentation
 - Documents endangered languages by analyzing sound patterns.
 - Studies relationships between languages through phonological similarities.
- Language and Brain/mind
 - Explores how the brain processes sounds and patterns during language comprehension and production.

Next class

- Morphology
- Readings:
 - Language-files_Ch-4_Morphology
 - Sections 4.1 and 4.2