

# Where am I?

- HUL242: Fundamentals of Language Sciences
- **Phonology (Lecture-1)**
- Monday, Jan 20

# **Practical Applications of Phonetics**

# Practical Application of Phonetics

- The study of speech sounds has several practical applications across different fields.
  - ❖ Language Learning and Teaching
    - Helps learners produce accurate sounds in a foreign language by understanding articulation and sound patterns.
    - IPA helps in learning precise pronunciation.
  - ❖ Speech Therapy/Articulation Disorders/Clinical Research
    - Hearing Impairment: Designing better hearing tools.
    - Speech Disorders: Understanding conditions like stuttering or dysarthria for treatment development.
    - Identifying and correcting speech sound errors in children or adults.

# Practical Application of Phonetics

- ❖ Technology
  - Speech Recognition Systems: Phonetics is essential in designing applications like virtual assistants (e.g., Siri, Alexa) and voice-activated systems.
  - Text-to-Speech Synthesis: Creating natural-sounding artificial voices in applications like audiobooks or navigation systems.
  - Language Processing: Enhancing automatic translation tools like Google Translate.
  
- ❖ Linguistic Research
  - Dialect Studies: Analyzing regional and social variations in speech patterns.
  - Historical Linguistics: Understanding the evolution of sounds in languages over time.

# Phonology

# Phonology

- Phonology deals with sounds in a language.
- In this module, we talk about the *mental representation of sounds* in the human mind and learn about the kinds of *rules that languages use for putting the sounds together* and *how these rules underlie certain interesting regularities* in the sound systems of different languages.

# Distinctive sounds: Minimal Pair

- [p] and [b] are **distinct sounds** phonetically in English. So are [p] and [p<sup>h</sup>]!
- Are these sound distinct in English the same way?

# Minimal Pair

- We know that [p] and [b] are distinct sounds in English because we can think of two words that differ *only in those two sounds*:

[pæt] ‘pat’

[bæt] ‘bat’

- These are different words with different meanings. And they differ *only* in their choice of [p] or [b]. In other words, [pæt] and [bæt] form a **minimal pair**.
- Two words are a **minimal pair** if they differ in **exactly one sound**.
- **Note:** A minimal pair is established based on sounds and not spelling.

## No minimal pair

- Can you think of minimal pairs for [p] and [p<sup>h</sup>]?
- No, there is no minimal pair for these sounds. These are phonetically conditioned.

# Minimal Pair

- Are [t] and [d] **distinct** sounds in English?

➤ **Yes!** Here's a minimal pair:

[rud] ‘rude’  
[rut] ‘root’

- Are [k] and [g] distinct sounds in English?

➤ **Yes!** Here's a minimal pair:

[pæg] ‘peg’  
[pæk] ‘pack’

## No minimal pair

- Can you think of minimal pairs for
  - [t] and [t<sup>h</sup>]?
  - [k] and [k<sup>h</sup>]?
- No, there is no minimal pair for these sounds. These are phonetically conditioned.

# Minimal Pair: Contrastive Distribution

- When replacing one sound with the other in the same *phonological environment* results in a change in meaning, the two sounds are said to be in **contrastive distribution**.

Phonological environment for

[p] and [b] = [\_æt]

[t] and [d] = [ru\_]

[g] and [k] = [pæ\_]

- If a sound is in contrastive distribution, it is considered a **phoneme** in that language.

# Phoneme

- Phonemes are **contrastive** phonological units in a particular language and native speakers of the language perceive them as different and distinctive sounds.
- Sounds are the physical realization of phonemes.
  - Sounds/phones come out of your mouth; **phonemes are in your head.**
- Phonemes are represented using slanted brackets / /

/p/ phoneme



[p] sound

# Minimal Pairs: Contrastive Distribution for English Consonants

**Table 3.1** Contrasts among consonants in English

	<i>Labial</i>	<i>Interdental</i>	<i>Alveolar</i>	<i>Alveopalatal</i>	<i>Palatal</i>	<i>Velar</i>	<i>Glottal</i>
Stops and Affricates	tap [p] tab [b]		pat [t] pad [d]	batch [tʃ] badge [dʒ]		pick [k] pig [g]	
Fricatives	leaf [f] leave [v]	thigh [θ] thy [ð]	sip [s] zip [z]	mesher [ʃ] measure [ʒ]			hip [h]
Nasals	sum [m]		sun [n]			sung [ŋ]	
Liquids and Glides			leer [l] rear [ɹ]		yet [j]	wet [w]	

# Minimal Pairs: Contrastive Distribution for English Vowels

**Table 3.2** Vowel contrasts in American English

beet	[bit]	[i]
bit	[bit]	[ɪ]
bait	[bejt]	[eɪ]
bet	[bɛt]	[ɛ]
bat	[bæt]	[æ]
cooed	[kʰud]	[u]
could	[kʰʊd]	[ʊ]
code	[kʰəwd]	[ow]
cawed	[kʰɔd]	[ɔ] (for some dialects)
cod	[kʰəd]	[ɑ]
cud	[kʰʌd]	[ʌ]
lewd	[lud]	[u]
loud	[lawd]	[aw]
lied	[laɪd]	[aj]
Lloyd	[lɔɪd]	[ɔj]

# Coming back to aspirated and non-aspirated stop sounds?

- Can you think of minimal pairs for
  - [t] and [t<sup>h</sup>]?
  - [p] and [p<sup>h</sup>]?
  - [k] and [k<sup>h</sup>]?
- No, there is no minimal pair for these sounds. These are phonetically conditioned.

# Another example of phonetic variation

- Another pronunciation of “*p*-sound”: unreleased *p*

[p<sup>h</sup>ɪt] ‘pit’

[spit] ‘spit’

[mæp̚] ‘map’

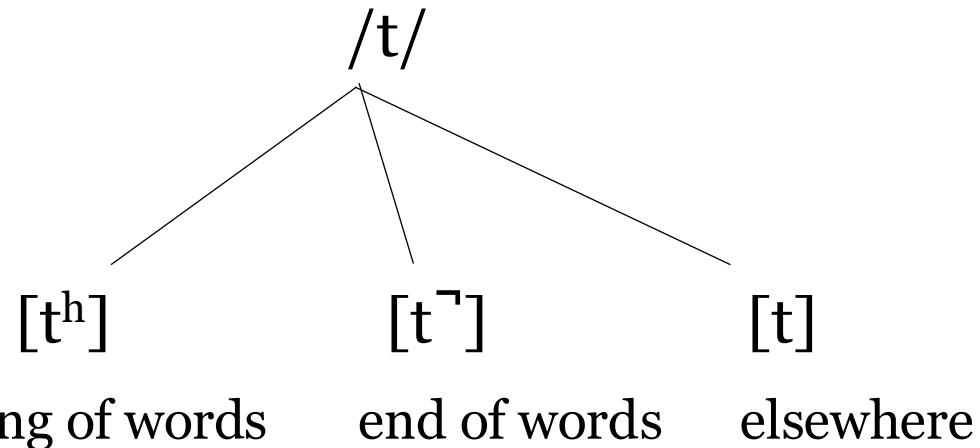
- The  $\checkmark$  symbols means “unreleased”. That is, when English speakers say *map*, they don’t let air pass after the last consonant.
- A similar pattern is observed with the “*t*-sound” and the “*k*-sound”:

[t<sup>h</sup>im stʌk sæt̚] ‘team, stuck, sat’

[k<sup>h</sup>ip skin flæk̚] ‘keep, skin, flack’

# Phonetic Variation: Complementary distribution

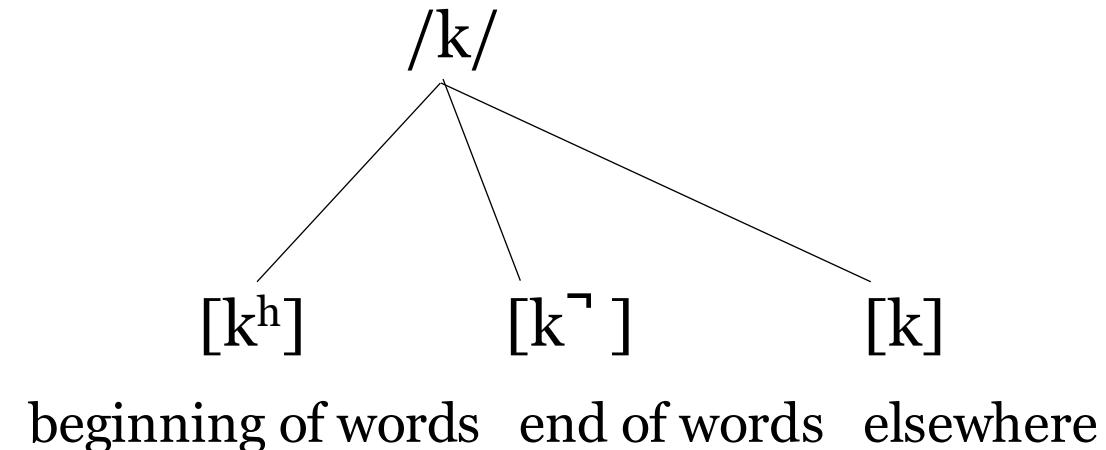
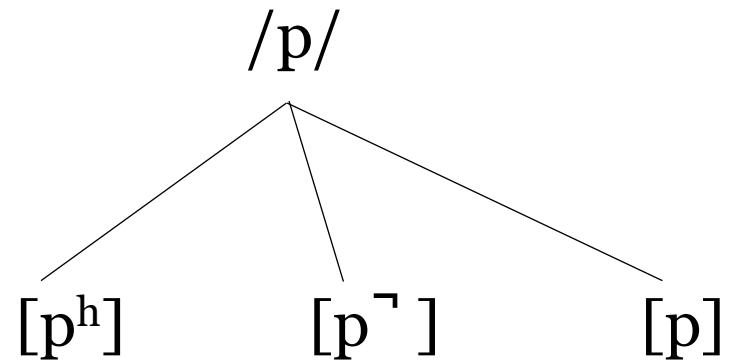
- There are **no minimal pairs** for [t], [t<sup>h</sup>] and [t̚]. In other words, these sounds are in **complementary distribution**.



- /t/ the **underlying mental representation**, called **Phoneme**
- [t<sup>h</sup>], [t̚], [t] its **realization** in speech, called **Allophones**
- [t<sup>h</sup>] and [t̚] are phonetically conditioned.

# Complementary distribution

- And the **same thing** holds for the bilabial and velar voiceless stops!
- All of these sounds are realized in slightly different ways, depending on their phonetic environment!



- /p/ or /k/ the **underlying** sound called **Phoneme**
- [p<sup>h</sup>]/[k<sup>h</sup>], [p̚]/[k̚] , [p]/[k] its **realization** in speech, called **Allophones**
- [p<sup>h</sup>]/[k<sup>h</sup>] and [p̚]/[k̚] are phonetically conditioned.

# Similarity among distinct sounds: Natural Class

- Aspiration and unreleased in English target all three oral voiceless stops.
  - Oral voiceless stops become aspirated at the beginning of words.<sup>1</sup>
  - Oral voiceless stops become unreleased at the end of words.
- Phonological processes target **similar** sounds in general.
- What does it mean for two distinct sounds to be similar?
- We talk about how distinct sounds can be similar to each other in terms of the notion of a **natural class**.

**Note:** [1] to be revised

# For reference: IPA chart for English

Place of Articulation															
	Bilabial		Labio-dental		Inter-dental		Alveolar		Alveo-palatal		Palatal		Velar		Glottal
Manner of Articulation	p	b					t	d					k	g	?
Manner of Articulation	Stop	p	b				t	d					k	g	?
	Fricative			f	v	θ	ð	s	z	ʃ	ʒ				h
	Affricative								tʃ	dʒ					
	Nasal		m					n						ŋ	
	Flap							r							
	Lateral							l							
	Approximant							r							
	Retroflex							r							
	Approximant														
Glide		w									j				

State of the Glottis	
Voiceless	Voiced

# Phonology and similarity: Natural Class

- What is common among [p t k]?
  - Oral voiceless stop sounds
- These are the only oral voiceless stop sounds in English.
- A group of sounds is a **natural class** when there's a description that separates out those sounds from other sounds.
- In other words, when there is a parameter or a set of parameters that **uniquely** characterizes a group of sounds **to the exclusion of all others**.

# Phonology and similarity: Natural Class

- How would you characterize the sounds [p t k ?] ?
  - They're the **voiceless stops**.
- How would you characterize the sounds [b d g] ?
  - They're the **voiced stops**.
- How would you characterize the sounds [d n r z ɹ l] ?
  - They're the **voiced alveolars**.

# Phonology and similarity: Natural Class

- These all form a **natural class**
  - The oral voiceless stops are exactly [p t k]
  - The voiceless stops are *exactly* [p t k ?]
  - The voiced stops are *exactly* [b d g]
  - The voiced alveolars are *exactly* [d n ɾ z ɹ l]

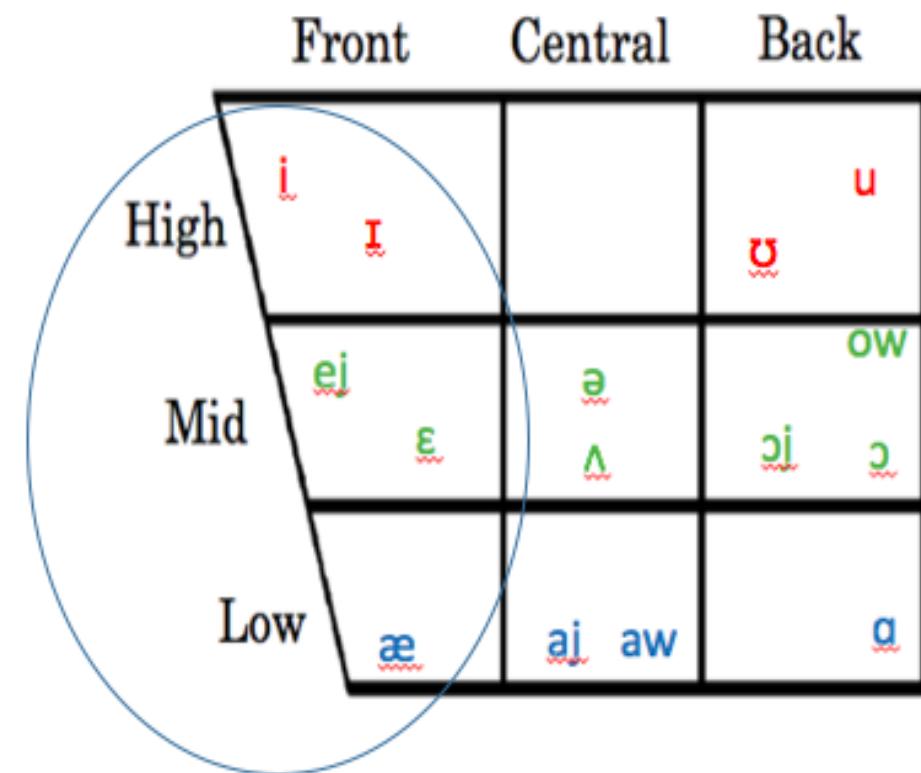
# Phonology and similarity: Natural Class

- Is [i ɪ ε æ, ej] a natural class in English?

**Yes.** These are the only **front vowels**.

- Is [i ɪ ε ] a natural class in English?

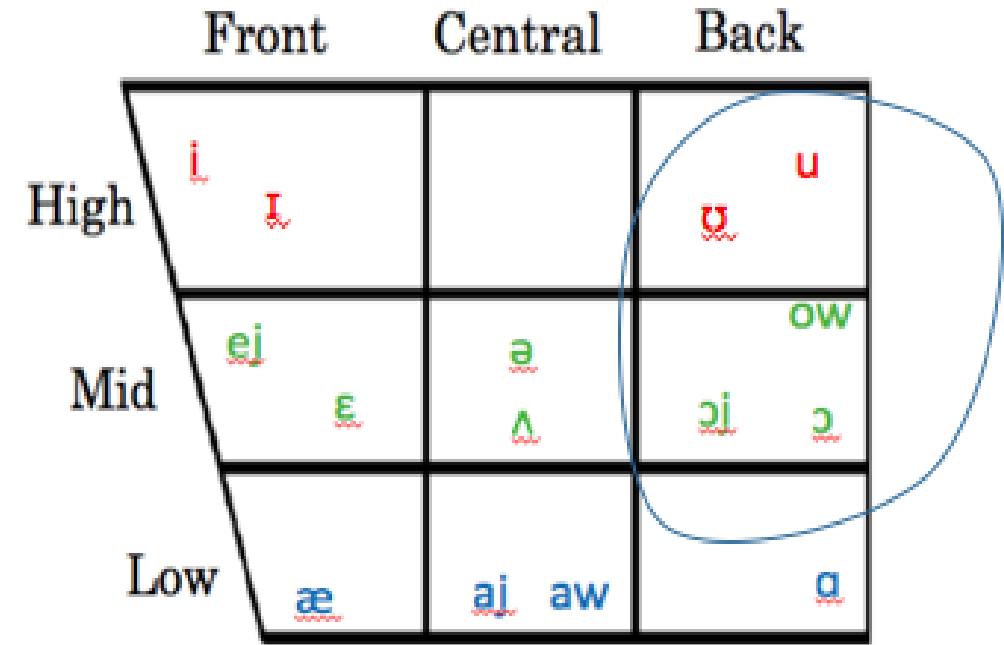
**No.** These are not the only front vowels



# Another example in vowel space

- Is [u ʊ ɔ w ɔ j] a natural class?

**Yes.** These are the **back, rounded vowels**

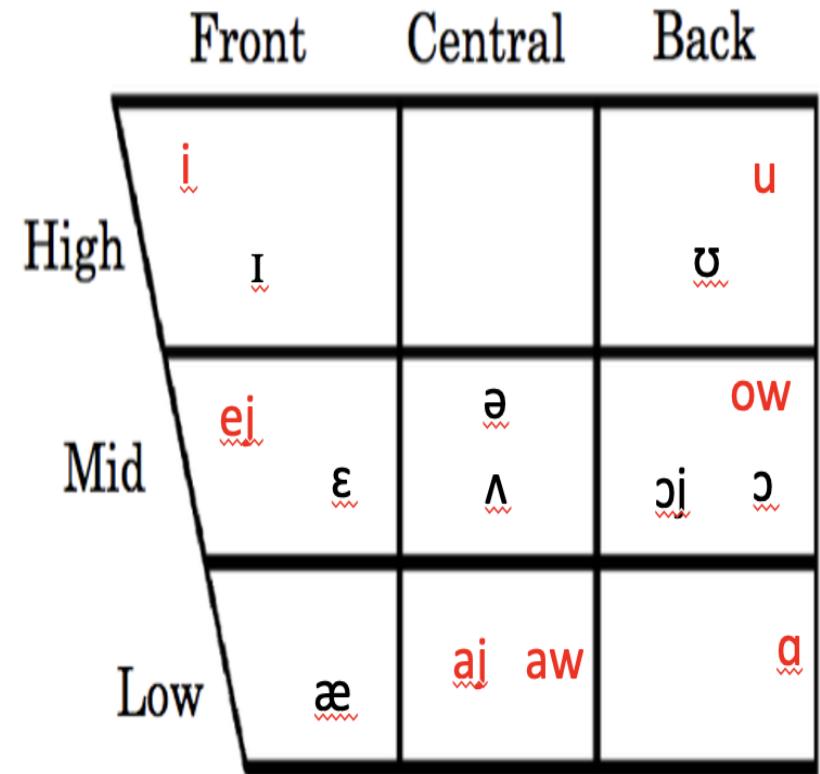


- Could we describe the back-rounded vowels in other ways?
    - Yes! Technically, **rounded** is enough since in English, all rounded vowels are necessarily back vowels.
    - But **back** by itself isn't enough, since there are back vowels that aren't rounded

# One more!

- Is [i ɪ u ʊ ɔ ɔɪ ε æ ə] a natural class?

**Nope!** It's not a natural class.



- No set of parameters describes *exactly these sounds!*
- The set includes front, mid, & back sounds, as well as tense & lax.

# Generalizing the rule

[p<sup>h</sup>it spit mæp̄] ‘pit, spit, map’

[t<sup>h</sup>im stʌk sæt̄] ‘team, stack, sat’

[k<sup>h</sup>ip skin flæk̄] ‘keep, skin, flack’

- Can we come up with a general version of this rule covering /p t k/?
- Do they form a **natural class**?

**Yes!** /p t k/ are precisely the oral voiceless stops! So, the rule is:

- *Oral* voiceless stops are aspirated at the beginning of words.
- *Oral* voiceless stops are unreleased at the end of words.

# Phonological rules and natural classes

- In general, phonological rules **target natural classes**.
- It would be incredibly **unusual** to find a language that had the sounds /p b t d k g/, but where a rule like aspiration targeted only /p d k/.
- /p d k/ doesn't form a natural class!

# **Cross-linguistic variation**

# A question

- Are there minimal pairs for the following sounds, or are they in complementary distribution in Hindi?

[t t<sup>h</sup> d]

[p p<sup>h</sup> b]

[k k<sup>h</sup> g]

- Consider the following data:

[pəl] ‘moment’

[kal] ‘era/period’

[tal] beat

[p<sup>h</sup>əl] ‘fruit’

[k<sup>h</sup>al] ‘skin’

[t<sup>h</sup>al] ‘plate’

[bəl] ‘strength’

[gal] ‘cheek’

[dəl] ‘lentil’

- There are minimal pairs for *each* of these sounds, and so they are **not** in complementary distribution. **Aspiration** for voiceless stops is **distinctive** in Hindi.

## Another question

- Could there be a language in which [t] and [d] **aren't** distinct sounds?  
Yes! **Swampy Cree** (an indigenous language spoken in Canada) is one!

# Some Cree example

- |                    |                          |
|--------------------|--------------------------|
| 1. [kodak] ‘goose’ | 4. [namwat] ‘not at all’ |
| 2. [adim] ‘dog’    | 5. [tahki] ‘often’       |
| 3. [nisto] ‘three’ | 6. [mide] ‘heart’        |

- Do a phonological analysis of [t] and [d].
  - Are there minimal pairs?
  - Or are [t] and [d] in complementary distribution?

	[t]	[d]
1.		o__a
2.	a:_#	
3.		a__i
4.	#_a	
5.	s_o	
6.		i__e

# A distribution chart and the generalization

	[t]	[d]
1.		o_a
2.	a:_#	
3.		a_i
4.	#_a	
5.	s_o	
6.		i_e

- Do you notice anything about when [d] shows up in Swampy Cree?
- **Generalization:**
  - [d] is found between two vowels.

# Yapese (Micronesian) vowel length

[θi:s] ‘a post’

[θis] ‘to topple’

[pu:l] ‘moon’

[pul] ‘to gather’

[?e:r] ‘part of a lagoon’

[?er] ‘near you’

- Is vowel length distinctive in Yapese? How do you know?
- Yes! There are minimal pairs that differ only in the lengths of their respective vowels.

# Vowel length in English

- Is vowel length distinctive in English? How do you know?  
Nope! We have no minimal pairs differing only in vowel length.

[bæk]	[ba:g]
[mɪs]	[miz]
[nɛt]	[ne:d]

- **Generalization:**
  - A vowel is lengthened when followed by a **voiced consonant**.
  - The voicing of the next consonant conditions vowel length.

# Consonant length in Italian

The following data is from Italian:

[fatɔ] ‘fate’ [fatɔ:] ‘fact’

[fanɔ] ‘grove’ [fanɔ:] ‘they do’

[kasa] ‘house’ [kas:a] ‘box’

- Is consonant length distinctive in Italian? How do you know?
- Yes! C and C: (short and long consonants) form minimal pairs.

# Phonetics vs Phonology

Phonetics	Phonology
<ul style="list-style-type: none"><li>Study the sounds of human speech</li></ul>	<ul style="list-style-type: none"><li>Study the speech sounds in a language<ul style="list-style-type: none"><li>➤ English 7 stops vs. Magahi 20 stops</li><li>➤ English 9 fricatives vs Magahi 2 fricatives</li></ul></li><li>Magahi phonology is different from English phonology</li></ul>
<ul style="list-style-type: none"><li>Primarily concerned with the concrete physical properties of language sounds. [p] voiceless, bilabial, stop [b] voiced, bilabial, stop [i] high, front, tense, unrounded vowel [u] high, back, tense, rounded vowel</li></ul>	<ul style="list-style-type: none"><li>Governs the sound patterns and the systematic phonetic variation found in language.</li><li>[k] sounds in the English words cat [kʰæt] vs. skip [skip]</li></ul>

# Next Class

- Phonological Analysis
  - Phonological Processes
  - Phonological Rules