Phonemes and Allophones
Supplementary Readings

The following readings have been posted to the Moodle course site:

- Contemporary Linguistics: Chapter 3 (pp. 59-69)
- Language Files: Chapter 3.1 (pp. 101-108)
Handouts for This Lecture

For this lecture, you should have printed out the following handout, which was posted to the course website:

- “Important Vocabulary Items for Phonology”

(Definitely make sure to have it for next time!)
A Review of Where We Are

The Fundamental Question:
What are the rules and mental representations that underlie our ability to speak and understand a language?

Last Class:

► There are rules that affect the pronunciation of words.
► The study of these rules is phonology.
► There is a phonological rule for breaking down words into syllables (syllabification).
A Review of Where We Are

The Fundamental Question:
What are the **rules** and **mental representations** that underlie our ability to speak and understand a language?

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- There are **rules** that affect the **pronunciation** of words.
- The study of these rules is **phonology**.
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This Class:
There are **phonological rules** that affect the pronunciation of single, individual phones.
A Review of Where We Are

The Fundamental Question:
What are the **rules** and **mental representations** that underlie our ability to speak and understand a language?

Last Class:

- There are **rules** that affect the **pronunciation** of words.
- The study of these rules is **phonology**.
- There is a **phonological rule** for breaking down words into syllables (syllabification).

This Class:
There are **phonological rules** that affect the pronunciation of single, individual phones.

- To show you this, I need to show you how we’ve been oversimplifying IPA until now...
An Oversimplification Revealed

Right now, we’d transcribe these words as follows:

<table>
<thead>
<tr>
<th>‘top’</th>
<th>[tap]</th>
<th>‘cop’</th>
<th>[kap]</th>
<th>‘pop’</th>
<th>[pap]</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘stool’</td>
<td>[stul]</td>
<td>‘school’</td>
<td>[skul]</td>
<td>‘spool’</td>
<td>[spul]</td>
</tr>
<tr>
<td>‘eat’</td>
<td>[it]</td>
<td>‘eke’</td>
<td>[ik]</td>
<td>‘eep’</td>
<td>[ip]</td>
</tr>
</tbody>
</table>

Under this transcription:
- All the words in the 1st column share a sound: [t]
- All the words in the 2nd column share a sound: [k]
- All the words in the 3rd column share a sound: [p]
An Oversimplification Revealed

Right now, we’d transcribe these words as follows:

‘stool’ [stul]  ‘school’ [skul]  ‘spool’ [spul]
‘eat’  [it]  ‘eke’  [ik]  ‘eep’  [ip]

Problem:
The actual ‘t’-sounds in the 1st column are a bit different from each other.

- Put your hand in front of your mouth and say “top”.
- There’s a strong burst of air when you say the “t”.
- This burst isn’t there when you say “stool” and “eat”.

Aspiration in English
The Facts
An Oversimplification Revealed

Right now, we’d transcribe these words as follows:

<table>
<thead>
<tr>
<th>Word</th>
<th>Transcription</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘top’</td>
<td>[tAp]</td>
</tr>
<tr>
<td>‘stool’</td>
<td>[stul]</td>
</tr>
<tr>
<td>‘eat’</td>
<td>[it]</td>
</tr>
<tr>
<td>‘cop’</td>
<td>[kap]</td>
</tr>
<tr>
<td>‘school’</td>
<td>[skul]</td>
</tr>
<tr>
<td>‘eke’</td>
<td>[ik]</td>
</tr>
<tr>
<td>‘pop’</td>
<td>[pap]</td>
</tr>
<tr>
<td>‘spool’</td>
<td>[spul]</td>
</tr>
<tr>
<td>‘eep’</td>
<td>[ip]</td>
</tr>
</tbody>
</table>

Problem:
The actual ‘k’-sounds in the 2\textsuperscript{nd} column are a bit different from each other.

- Put your hand in front of your mouth and say “cop”.
- There’s a strong burst of air when you say the “c”.
- This burst isn’t there with “school” and “eke”.
An Oversimplification Revealed

Right now, we’d transcribe these words as follows:

<table>
<thead>
<tr>
<th>Word</th>
<th>Transcription</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘top’</td>
<td>[tAp]</td>
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<td>[stul]</td>
</tr>
<tr>
<td>‘eat’</td>
<td>[it]</td>
</tr>
<tr>
<td>‘cop’</td>
<td>[kap]</td>
</tr>
<tr>
<td>‘school’</td>
<td>[skul]</td>
</tr>
<tr>
<td>‘eke’</td>
<td>[ik]</td>
</tr>
<tr>
<td>‘pop’</td>
<td>[pAp]</td>
</tr>
<tr>
<td>‘spool’</td>
<td>[spul]</td>
</tr>
<tr>
<td>‘eep’</td>
<td>[ip]</td>
</tr>
</tbody>
</table>

Problem:
The actual ‘p’-sounds in the 3rd column are a bit different from each other.

- Put your hand in front of your mouth and say “pop”.
- There’s a strong burst of air when you say the “p”.
- This burst isn’t there when you say “spool” and “eep”.

▶
Aspiration

Vocabulary:
The strong burst of air when you pronounce \([t]/[k]/[p]\) in “top”/“cop”/“pop” is called **aspiration**.

IPA Representation:
Aspiration on a consonant \(C\) is represented in IPA by a superscripted “h” (\(C^h\)).

Therefore the following is a more accurate transcription of the words we saw before:

- ‘top’ \([th^hAp]\)
- ‘stool’ \([stul]\)
- ‘eat’ \([it]\)
- ‘cop’ \([k^hAp]\)
- ‘school’ \([skul]\)
- ‘ekte’ \([ik]\)
- ‘pop’ \([p^hAp]\)
- ‘spool’ \([spul]\)
- ‘eep’ \([ip]\)
Aspiration and Phonology

Key Observation:
English speakers don’t just aspirate any old consonant they want.

- Normal pronunciation requires aspiration to be on [t] in “top”
- Normal pronunciation requires *no* aspiration on [t] in “stool” and “eat”.

Conclusion:
Part of knowing English is knowing *where aspiration can (and must) go*.

Question:
*How* is this information represented in our brains?
Towards the Aspiration Rule

Wrong Hypothesis:
Maybe we just memorize it on a word-by-word basis?

- When we learn a word like ‘cop’, we learn:
  - The phones that compose it: [kəp]
  - Whether any phones are aspirated: [kʰəp]
Towards the Aspiration Rule

Wrong Hypothesis:
Maybe we just memorize it on a word-by-word basis?

▶ When we learn a word like ‘cop’, we learn:
  ▶ The phones that compose it: [kæp]
  ▶ Whether any phones are aspirated: [kʰæp]

Problem for Wrong Hypothesis:
English speakers know where aspiration must go in words they’ve never heard before.

▶ Read the following words to yourselves silently.

“torble”
“stib”
“ort”

“corble”
“skib”
“ork”

“porble”
“spib”
“orp”
Towards the Aspiration Rule

Wrong Hypothesis:
Maybe we just memorize it on a word-by-word basis?

► When we learn a word like ‘cop’, we learn:
  ► The phones that compose it: [kʌp]
  ► Whether any phones are aspirated: [kʰʌp]

Problem for Wrong Hypothesis:
English speakers know where aspiration must go in words they’ve never heard before.

► Now say them with your hand in front of your mouth

“torble”
“stib”
“ort”

“corble”
“skib”
“ork”

“porble”
“spib”
“orp”
Towards the Aspiration Rule

Wrong Hypothesis:
Maybe we just memorize it on a word-by-word basis?

▶ When we learn a word like ‘cop’, we learn:
  ▶ The phones that compose it: [kap]
  ▶ Whether any phones are aspirated: [kʰap]

Problem for Wrong Hypothesis:
English speakers know where aspiration must go in words they’ve never heard before.

▶ You probably pronounced them as follows:

Conclusion:

- Since you’d never heard those made-up words before...
- Your knowledge of where aspiration goes couldn’t have been memorized...
- So the ‘Wrong Hypothesis’ is wrong...
Towards the Aspiration Rule

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- Since you’d never heard those made-up words before...
- Your knowledge of where aspiration goes couldn’t have been memorized...
- So the ‘Wrong Hypothesis’ is wrong...

Right Hypothesis
Aspiration in English is governed by a **general rule**.
- This rule tells you which consonants aspiration has to go on.
Towards the Aspiration Rule

So, what *is* the rule for where aspiration goes?...
Towards the Aspiration Rule

So, what is the rule for where aspiration goes?...

The following set of English words is representative of the pattern:

<table>
<thead>
<tr>
<th>‘top’</th>
<th>[tʰap]</th>
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<td>[ip]</td>
</tr>
<tr>
<td>‘twitter’</td>
<td>[tʰwi.ɻᵣ]</td>
<td>‘quitter’</td>
<td>[kʰwi.ɻᵣ]</td>
<td>‘please’</td>
<td>[pʰliz]</td>
</tr>
<tr>
<td>‘return’</td>
<td>[ɻᵣ.i.tʰɻᵣn]</td>
<td>‘recoil’</td>
<td>[ɻᵣ.kʰɭɭᵣ]</td>
<td>‘repay’</td>
<td>[ɻᵣ.pʰɭej]</td>
</tr>
<tr>
<td>‘wits’</td>
<td>[wits]</td>
<td>‘licks’</td>
<td>[ɭks]</td>
<td>‘lips’</td>
<td>[ɭps]</td>
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Towards the Aspiration Rule

So, what *is* the rule for where aspiration goes?...

The following set of English words is representative of the pattern:

| ‘top’   | [tʰap]  | ‘cop’   | [kʰap]  | ‘pop’   | [pʰap]  |
| ‘stool’ | [stul]  | ‘school’| [skul]  | ‘spool’ | [spul]  |
| ‘eat’   | [it]    | ‘eke’   | [ik]    | ‘EEP’   | [ip]    |
| ‘return’ | [wi.tʰ.iun] | ‘recoil’ | [ui.kʰɔɪl] | ‘repay’ | [ui.pʰeɪ] |
| ‘wits’  | [wɪts]  | ‘licks’  | [lɪks]  | ‘lips’  | [lɪps]  |

The Pattern:
[t]/[k]/[p] can (and must) be aspirated when they are the first sound in a syllable (onset).
The Aspiration Rule

Interim Summary:

► English has rules for the pronunciation of words (phonology)
► English ‘phonology’ has rules for the pronunciation of individual phones.
► One of those rules states where [t]/[k]/[p] bear aspiration (are ‘aspirated’)

The Aspiration Rule:
[t]/[k]/[p] can (and must) be aspirated when they are the first phone in an onset.
Sounds in Memory vs. Sounds in Speech

Key Fact:
The Aspiration Rule forces us to distinguish between:

- The phones that are actually produced when we talk
- The way those phones are represented in our memories.

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Basic Assumption About Memory:
When we learn a word, we store in memory a representation of how it is pronounced.
Sounds in Memory vs. Sounds in Speech

Key Fact:
The Aspiration Rule forces us to distinguish between:

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- The way those phones are represented in our memories.

Basic Assumption About Memory:
When we learn a word, we store in memory a representation of how it is pronounced.

A Special Notation:

- For the actual spoken phones, I’ll continue to put them in square brackets ([...]).
  - [ænd] = the sound produced when we say “and”
- For the representation of the phones in memory, I’ll put them in angled brackets (/.../)
  - /ænd/ = the representation in our memory of how to say “and”
The Representation in Memory

Question:
When we learn a new word like “torble”, do we store in memory which sounds are aspirated?

- Does the representation put into memory look like this: /tʰɔrbl/ (with aspiration)
- Or, does it look like this: /tɔrbl/ (without aspiration)
The Representation in Memory

Question:
When we learn a new word like “torble”, do we store in memory which sounds are aspirated?

▶ Does the representation put into memory look like this: /tʰɔrbəl/ (with aspiration)
▶ Or, does it look like this: /tɔrbəl/ (without aspiration)

Answer:
The answer appears to be ‘/tɔrbəl/’ (without aspiration).

▶ Some experimental evidence (psycholinguistics unit).
▶ It also makes the most sense, practically speaking...
The Representation in Memory

General Principle of Simplicity in Memory:
If the information already follows from a general rule, we don’t waste time/effort memorizing it.
The Representation in Memory

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If the information already follows from a general rule, we don’t waste time/effort memorizing it.

A Simple Example: Spelling

- When the spelling of a word follows general rules...
  - It’s easier to learn the word.
  - Because, you don’t have to memorize the ‘details’.
    - All that info just follows from the rules...
    - So you don’t have to put it into memory.

- When the spelling of a word is irregular...
  - It’s harder to learn the word.
  - Because, you do have to memorize the ‘details’ (which letters, which order)
    - You do have to put all that info into memory.
    - That takes time and effort.
The Representation in Memory

General Principle of Simplicity in Memory:
If the information already follows from a general rule, don’t waste time/effort memorizing it.

- If something already follows from a rule...
- We don’t waste time/energy also putting that information into memory.
The Representation in Memory

General Principle of Simplicity in Memory:
If the information already follows from a general rule, don’t waste time/effort memorizing it.

- If something already follows from a rule...
- We don’t waste time/energy also putting that information into memory.

The Consequences for Aspiration
Since our Aspiration Rule already says where aspiration can/must go, we don’t also (redundantly) put that information into memory.

- Therefore, although we pronounce the words like this: ‘top’ [tʰAp] ‘cop’ [kʰAp] ‘pop’ [pʰAp]
A Picture of Speech Production

Step 1: Access memorized representation /tejbl/
Step 2: Apply syllabification rule tej.bl
Step 3: Apply aspiration rule thej.bl
Step 4: Pronounce word [thej.bl]
The Crucial Distinction

Important Conclusion:
There is an important distinction between:

★ The sound as **produced** by the speaker.
★ The sound as **represented in memory**.

Illustration:
★ In memory, “table” is represented as ‘/tejbl/’
  ★ No aspiration, No syllabification
★ When pronounced, “table” is produced as ‘[tʰej.b]’
  ★ Aspiration on [t], Syllabification complete
Phonemes and Allophones

Vocabulary

- **Phoneme** = The sound as represented in memory (/.../)
- **Allophone** = The sound as actually produced by a speaker ([...])

Vocabulary:

[X] is an **allophone** of /Y/ if [X] is one way that speakers pronounce /Y/. 
Phonemes and Allophones

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Vocabulary:

[X] is an **allophone** of /Y/ if [X] is one way that speakers pronounce /Y/.

Illustration:

/t/ a phoneme of English
[tʰ] an allophone of /t/ in English
[t] an allophone of /t/ in English

Vocabulary:

We say that [tʰ] and [t] are **allophones of the same phoneme** (namely,/t/).
Allophones Across Languages

KeyFact:
Whether or not two phones are allophones of the same phoneme depends on the language in question.

- In one language, [X] and [Y] are allophones of the same phoneme.
- In another language, [X] and [Y] are allophones of different phonemes.
Different Languages, Different Phonemes

Example: Aspiration in English and Thai

- In English, [t] and [\textsuperscript{th}] are allophones of the same phoneme (/t/).
- In Thai, [t] and [\textsuperscript{th}] are allophones of \textit{two different} phonemes (/t/, /\textsuperscript{th}/).
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How Do We Know?

- In Thai, the following are *two different words*: [tam] ‘to pound’ [tʰam] ‘to do’
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- In Thai, the following are *two different words*: [tam] ‘to pound’ [tʰam] ‘to do’
- These words look exactly the same, except one has [t] where the other has [tʰ].
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- In Thai, the following are two different words: 
  [tam] ‘to pound’  [tʰam] ‘to do’

  These words look exactly the same, except one has [t] where the other has [tʰ].

- This shows that [t] and [tʰ] must be allophones of different phonemes...
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How Do We Know?

- In Thai, the following are *two different words*:
  - [tam] ‘to pound’ [tʰam] ‘to do’
- These words look exactly the same, except one has [t] where the other has [tʰ].
- This shows that [t] and [tʰ] *must* be allophones of different phonemes...
- *Why?*... (here comes the ‘R2’).
The Logic

The Facts: In Thai, these are two different words:

[tam] ‘to pound’      [tʰam] ‘to do’
The Logic

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► If [t] / [tʰ] were allophones of the same phoneme in Thai
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  - There would be a rule stating where you use [t] / [tʰ].
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The Key Reasoning:

▶ If [t] / [tʰ] were allophones of the same phoneme in Thai
  ▶ There would be a rule stating where you use [t] / [tʰ].
  ▶ Since [tʰam] is a word, this rule would entail [tʰ] before [-am].

▶ But, since [tam] is also a word, this rule would entail [t] before [-am].
▶ But, one rule couldn’t require both [tʰ] before [-am] and [t] before [-am].
▶ Therefore, there isn’t actually a rule in Thai stating where you use [t] and [tʰ].
▶ And so, [t] and [tʰ] are allophones of two different phonemes (/t/, /tʰ/).
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  ► But, one rule couldn’t require both [tʰ] before [-am] and [t] before [-am].

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► And so, [t] and [tʰ] are allophones of two different phonemes (/t/, /tʰ/).
Minimal Pairs

Vocabulary
Minimal Pairs = Two words that sound exactly the same, except one has [X] where the other has [Y].

- If two words are minimal pairs differing only in [X] and [Y], then they are minimal pairs for [X] and [Y].

The General Principle:
If there are minimal pairs for [X] and [Y], then [X] and [Y] are allophones of different phonemes.
Some Illustrative Examples

Example 1:
The following are minimal pairs for [l] and [r] in English

‘rap’ [ræp] ‘lap’ [læp]
‘rip’ [rɪp] ‘lip’ [lɪp]
‘peer’ [pʰɪə] ‘peel’ [pʰɪl]
Some Illustrative Examples

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Example 2:
The following are minimal pairs for [s] and [ʃ] in English

‘sip’ [sɪp] ‘ship’ [ʃɪp]
‘mess’ [mɛs] ‘mesh’ [mɛʃ]
‘last’ [læst] ‘lashed’ [læʃt]
Some Illustrative Examples

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The following are minimal pairs for [l] and [ɾ] in English

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‘mess’ [mɛs] ‘mesh’ [mɛʃ]
‘last’ [læst] ‘lashed’ [læʃt]

▶ These pairs show that there’s no rule that states whether you say [ɾ]/[l] or [s]/[ʃ].
▶ Thus, they show that these are all allophones of different phonemes.
Contrast

More Vocabulary:

- If [X] and [Y] are allophones of different phonemes, then they are said to **contrast**.
- If [X] and [Y] are allophones of the same phoneme, then they **don’t contrast**.
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Key Fact 1: Contrast Means Perception
When two phones ([X] and [Y]) **contrast** in a language, this means that:

- There are minimal pairs for [X] and [Y].
- So, [X] and [Y] distinguish words of the language.
- So, **speakers must perceive the difference between [X] and [Y]**.
  - (Like [s] vs. [ʃ] in English)
Contrast

More Vocabulary:

- If [X] and [Y] are allophones of different phonemes, then they are said to **contrast**.
- If [X] and [Y] are allophones of the same phoneme, then they **don’t contrast**.

Key Fact 2: No Contrast Means Maybe No Perception

When two phones ([X] and [Y]) *don’t contrast* in a language, this means that:

- There *aren’t any* minimal pairs for [X] and [Y].
- So, [X] and [Y] *don’t* distinguish any words of the language.
- So, speakers *don’t necessarily* perceive the difference between [X] and [Y].
  - (Like [t] vs. [tʰ] in English)
An Analogy That Might Help

If [X] and [Y] are allophones of the same phoneme, the language views them as ‘the same sound’.

- They are represented the same way in memory (/X/)
- Speakers don’t necessarily hear the difference
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If X and Y are ‘the same person’, then we can never get them both in the same place at the same time.
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If X and Y are two different people, then we can get them both in the same place at the same time.
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If X and Y are two different people, then we can get them both in the same place at the same time.

The Analogy:
Looking for minimal pairs is like trying to get two people in the same place at the same time.

- “place and time” \(\approx\) the surrounding phones
- If [X] and [Y] show up in the same ‘place / time’, they are two different ‘sounds’ (phonemes) in the language.
An Analogy That Might Help

If [X] and [Y] are allophones of the same phoneme, the language views them as ‘the same sound’.

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The Analogy:
Looking for minimal pairs is like trying to get two people in the same place at the same time.

- “place and time” ≈ the surrounding phones
- If [X] and [Y] are never in the same ‘place / time’, they might be the same ‘sound’ (phoneme) in the language.
Complementary Distribution

Vocabulary:
If there aren’t minimal pairs for [X] and [Y], then they are in complementary distribution.

Key Fact:
If two phones are allophones of the same phoneme, then they must be in complementary distribution.

Illustration:
[t] and [tʰ] in English ▶[t] and [tʰ] are allophones of the same phoneme (/t/). ▶So, there’s a rule that states whether you say [t] or [tʰ] ▶So, two English words can’t be exactly the same, except for [t] and [tʰ] ▶If you try to replace [t] with [tʰ], the result is unpronounceable in English.
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- [t] and [tʰ] are allophones of the same phoneme (/t/).
- So, there’s a rule that states whether you say [t] or [tʰ]
- So, two English words can’t be exactly the same, except for [t] and [tʰ]
  - If you try to replace [t] with [tʰ], the result is unpronounceable in English.
    - [tʰap] * [tap]
    - [stap] * [stʰap]
The Logical Picture

In summary:

▶ If you can find minimal pairs for [X] and [Y], then
  ▶ [X] and [Y] are **allophones of different phonemes**.
  ▶ [X] and [Y] **contrast** in the language
  ▶ [X] and [Y] are perceived by speakers as ‘different sounds’

▶ If you can’t find minimal pairs for [X] and [Y], then
  ▶ [X] and [Y] are **in complementary distribution**.
  ▶ [X] and [Y] might be **allophones of the same phoneme**
  ▶ [X] and [Y] might be perceived by speakers as ‘the same sound’.
The Logical Picture

In summary:

- If you can find minimal pairs for [X] and [Y], then
  - [X] and [Y] are allophones of different phonemes.
  - [X] and [Y] contrast in the language.
  - [X] and [Y] are perceived by speakers as ‘different sounds’.

- If you can’t find minimal pairs for [X] and [Y], then
  - [X] and [Y] are in complementary distribution.
  - [X] and [Y] might be allophones of the same phoneme.
  - [X] and [Y] might be perceived by speakers as the ‘same sound’.
One Last Point of Logic:

Fact We Just Saw:
If [X] and [Y] are allophones of the same phoneme, then they are in complementary distribution.
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Fact We Just Saw:
If [X] and [Y] are allophones of the same phoneme, then they are in complementary distribution.

Key Logical Point:
But, [X] and [Y] might be in complementary distribution and still be allophones of different phonemes.
Fact We Just Saw:
If [X] and [Y] are allophones of the same phoneme, then they are in complementary distribution.

Key Logical Point:
But, [X] and [Y] might be in complementary distribution and still be allophones of different phonemes.

Analogy:
Even if two people are never in the same room together, they might still be two different people.

Illustration: [ŋ] and [h] in English
► In English, [ŋ] is never in onsets.
► In English, [h] is never in codas.
► However, we still think they are different phonemes...
(We’ll see why next class)
The phonology of a language includes rules that affect individual phones.

Example:
In English, [t]/[p]/[k] are aspirated at the beginning of onsets.

Given these rules, we must distinguish between:
- **phoneme**: the sound as represented in memory
- **allophone**: the sound as actually produced
Summary

Minimal Pairs and Complementary Distribution

- Languages differ in whether phones are allophones of the same (or different) phonemes.

Example:

In Thai, [t] and [tʰ] are allophones of different phonemes.
Summary

Minimal Pairs and Complementary Distribution

- Languages differ in whether phones are allophones of the same (or different) phonemes.

Example:

In Thai, [t] and [tʰ] are allophones of different phonemes.

- If we can find minimal pairs for two phones, then we know they are allophones of different phonemes.

Example (Thai):

[tam] ‘to pound’ [tʰam] ‘to do’
Summary

Minimal Pairs and Complementary Distribution

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- If we can find minimal pairs for two phones, then we know they are allophones of different phonemes.

  Example (Thai):
  [tam] ‘to pound’  [tʰam] ‘to do’

- If we can’t find minimal pairs for them, then they might be allophones of the same phoneme.

  Example:
  - In English, there are no minimal pairs for [t] and [tʰ]...
  - ...but there also aren’t minimal pairs for [ŋ] and [h]