LING 101 • Lecture outline

• Natural classes
• Stating allophone environments
• Phonological rules

Background reading:
• CL Ch 3, sec 1 and Appendix
0. Course information

• Ways to find help and support:
  - Office of the **Dean of Students**,  
  - **Counseling and Psychological Services**  
    (available 24/7; telehealth appointments: 919-966-3658)  
  - **Student Wellness**
0. Course information

- For our course specifically:
  - Office hours! (Or make an appointment)
  - “Forum” topic on Sakai for each course unit
    - You are welcome to post questions there
    - Questions may be answered in the forum or in class
    - You are welcome to answer questions asked by other students
1. Review: Phonemes, allophones, the mental lexicon, and mental grammar

• The **mental sound categories** of a language are the __________ of the language
  
  - Write __________ using _____ brackets: _i_
1. Review: Phonemes, allophones, the mental lexicon, and mental grammar

• The **mental sound categories** of a language are the **phonemes** of the language
  - Write **phonemes** using **slash** brackets: /i/

• A **physical pronunciation** of a phoneme is an __________ of that phoneme
  - Write __________ using ______ brackets: _i_
1. Review: Phonemes, allophones, the mental lexicon, and mental grammar

- The **mental sound categories** of a language are the **phonemes** of the language
  - Write phonemes using slash brackets: /i/

- A **physical pronunciation of a phoneme** is an **allophone** of that phoneme
  - Write allophones using **square brackets**: [i]

- Every phoneme has at least one allophone
  - Some phonemes have more than one allophone
1. Review: Phonemes, allophones, the mental lexicon, and mental grammar

- Words (morphemes) are stored in the mental lexicon in terms of their **phonemes**
- The phonetic (surface, pronounced) forms of words, containing **allophones**, are produced by the mental grammar, which applies **phonological rules** where needed

\[
/ (\text{stored form of word}) / \quad \quad \quad (\text{with phonemes}) \\
\downarrow \text{Phonological rules} \downarrow \\
[ (\text{pronounced form of word}) ] \quad (\text{with allophones})
\]
1. Review: Phonemes, allophones, the mental lexicon, and mental grammar

- To analyze the phonology (grammar) of a language:
  - Propose **phonological rules** as needed

- How do we know when a rule is needed?
  - Determine whether two sounds belong to the **same phoneme** (as allophones) or to **different phonemes**
  - If one phoneme has **multiple allophones**, we need a **rule** to determine which allophone appears where
Last time, we discussed:

- **How can we tell** if two phonetically different sounds belong to **different phonemes** or to the **same phoneme** in a language we are analyzing?

  → We have to **look at data** from the language we are analyzing and **make a case** for the status of the pair of sounds **in that language**
2. Allophones of a phoneme vs. two phonemes

Review from last time:

• **Step 1.** Look for a *minimal pair*
  → If we find one, ...  
  → If we don’t find one, ...
2. Allophones of a phoneme vs. two phonemes

Review from last time:

• **Step 1.** Look for a **minimal pair**
  → If we find one, we have **separate phonemes**
  → If we don’t find one, we should **go to Step 2**

• **Step 2.** Consider the **environments** where the sounds occur — are they:
  
  **predictable** (non-overlapping)?
  **unpredictable** (overlapping)?
2. Allophones of a phoneme vs. two phonemes

Step 2. Consider the environments where the sounds occur — are they: • **predictable** (non-overlapping)? • **unpredictable** (overlapping)?)

• If two sounds are allophones of the same phoneme, the mental grammar **chooses** which to use based on their surrounding (sound) **environment**
  - Given the environment, we can reliably **predict** which of the sounds we will see there

• So **predictable** environments are **evidence** that the **mental grammar decides** which sound to put where: the sounds are **allophones** of the same phoneme
2. Allophones of a phoneme vs. two phonemes

Step 2. Consider the environments where the sounds occur — are they: • **predictable** (non-overlapping)? • **unpredictable** (overlapping)?

• If two sounds **belong to separate phonemes**, they are **independent** of each other, so both can occur in (at least some of) the **same** environments.
  - Given just the environment, we **can’t predict** which of the sounds will appear there.

• So **unpredictable** environments are **evidence** that the mental grammar does not determine which sound to put where: **separate phonemes**
2. Allophones of a phoneme vs. two phonemes

Step 2. Consider the environments where the sounds occur — are they:  
• **predictable** (non-overlapping)?  
• **unpredictable** (overlapping)?

- Consider this:
  If we have a *minimal pair* for two sounds, are the environments for those two sounds **predictable** or **unpredictable**?
  
  - [ɪ] vs. [ɪ]  
    - [lɪp] *leap*  
    - [lɪp] *lip*  
  
  - [l] __ [p]  
  - [l] __ [p]
2. Allophones of a phoneme vs. two phonemes

• **Step 1.** Look for a **minimal pair** → separate phonemes

• **Step 2.** Consider the **environments** where the sounds occur — are they:
  
  predictable (non-overlapping)? → allophones  
  unpredictable (overlapping)? → separate phonemes

New for today:

• **Step 3.** If you have found that two sounds are **allophones of the same phoneme**, **state the environments** where each allophone occurs

But first, some background on **natural classes**
3. Natural classes

• Which of the sounds of English can be aspirated? [p] [t] [k]

• Why these sounds and no others?
  → These are the sounds of English that are __________________
3. Natural classes

• Which of the sounds of English can be **aspirated**? 
  
  [p]  [t]  [k]

• Why these sounds and no others?
  
  → These are the sounds of English that are **voiceless oral stops**

• This kind of pattern is not unusual!
  
  - In the languages of the world, groups of sounds *with some property or properties in common* tend to **behave as a group** in some way
3. Natural classes

- A set of sounds with some *property or properties in common* is called a **natural class**

- If natural classes often **behave as a group** in native-speaker language behavior, what does that tell us about the mental grammar?
  - Natural classes are defined by sound properties
  - So, the mental grammar **uses sound properties to represent** the sounds of language

→ “Phonetic” properties are **mentally relevant**!
3. Natural classes

• What does it mean to say this?

*The mental grammar uses sound properties to represent the sounds of language*

- The mental grammar doesn’t actually “see” a speech sound like [u] or [t]
- Instead, it “sees” a set of properties that represents each sound

• In the mental grammar...

[u] is represented as: high back round tense vowel
[t] is represented as: voiceless alveolar oral stop
- CL uses “features” to further formalize this concept; we won’t!
3. Natural classes

• Practice: What properties can we use to describe each of these groups of sounds as a single natural class, while excluding other sounds as specified?

(a) [f θ s ʃ h] but not [t z v b]

(b) [p ɡ m d η t] but not [s ej w]

(c) [i ow u a ej] but not [ɪ æ k m]

(d) [i I] but not [æ ow ɛ η ʧ]
3. Natural classes

- Practice: What properties can we use to describe each of these groups of sounds as a single natural class, while excluding other sounds as specified?

(a) [f θ s ʃ h] but not [t z v b]
   voiceless fricatives | it may take >1 property to describe a class

(b) [p ɡ m d ɳ t] but not [s eʃ w]
   stops

(c) [i ow u ɑ eʃ] but not [ɪ æ k m]
   tense

(d) [i ɪ] but not [u ɔ æ əw ɛ ɳ ʧ]
   high unrounded
4. Allophone environments as natural classes

Returning to the topic of allophones:

• **Step 3.** If you have found that two sounds are *allophones of the same phoneme*, **state the environments** where each allophone occurs.

• Since putting the allophones of a phoneme in the right places is the job of the **mental grammar**
  - and the mental grammar **represents sounds** in terms of their **properties**
  → **we always state the environment of an allophone in terms of sound properties**
4. Allophone environments as natural classes

- Back to our Canadian Raising example...

(modified from Table 3.3 in CL, p 74)

<table>
<thead>
<tr>
<th>Allophone</th>
<th>Sound</th>
<th>Allophone</th>
<th>Sound</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ʌjs ]</td>
<td>‘ice’</td>
<td>[ ajz ]</td>
<td>‘eyes’</td>
</tr>
<tr>
<td>[ lʌjs ]</td>
<td>‘lice’</td>
<td>[ lajz ]</td>
<td>‘lies’</td>
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<tr>
<td>[ tʌjt ]</td>
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<td>‘fly’</td>
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<tr>
<td>[ lʌjk ]</td>
<td>‘like’</td>
<td>[ tajm ]</td>
<td>‘time’</td>
</tr>
<tr>
<td>[ nʌjf ]</td>
<td>‘knife’</td>
<td>[ fajv ]</td>
<td>‘five’</td>
</tr>
</tbody>
</table>

Can either environment (or both) be stated as a natural class?
4. Allophone environments as natural classes

Can either environment be stated as a natural class?

<table>
<thead>
<tr>
<th></th>
<th>[ʌj]</th>
<th>[aj]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ # ]</td>
<td>[s]</td>
<td>[ # ]</td>
</tr>
<tr>
<td>[ l ]</td>
<td>[s]</td>
<td>[ l ]</td>
</tr>
<tr>
<td>[ tɹ ]</td>
<td>[t]</td>
<td>[ tɹ ]</td>
</tr>
<tr>
<td>[ tɹp ]</td>
<td>[p]</td>
<td>[ tɹb ]</td>
</tr>
<tr>
<td>[ fl ]</td>
<td>[t]</td>
<td>[ fl ]</td>
</tr>
<tr>
<td>[ l ]</td>
<td>[k]</td>
<td>[ t ]</td>
</tr>
<tr>
<td>[ n ]</td>
<td>[f]</td>
<td>[ f ]</td>
</tr>
</tbody>
</table>

- **[ʌj]** appears before [s, t, p, k, f] in this data set
- These sounds are all **voiceless** | *this is a natural class!*
Can either environment be stated as a natural class?

- [ʌj] appears before [z, d, b, m, v, #] (# = edge of the word)
  - No shared properties (because of #)
  - But this list does **not** include any **voiceless** sounds
4. Allophone environments as natural classes

Can either environment be stated as a natural class?

<table>
<thead>
<tr>
<th>[ʌj]</th>
<th>[aj]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ #]</td>
<td>[ #]</td>
</tr>
<tr>
<td>[ l]</td>
<td>[ l]</td>
</tr>
<tr>
<td>[ t u]</td>
<td>[ t u]</td>
</tr>
<tr>
<td>[ t u]</td>
<td>[ t u]</td>
</tr>
<tr>
<td>[ f l]</td>
<td>[ f l]</td>
</tr>
<tr>
<td>[ l]</td>
<td>[ t]</td>
</tr>
<tr>
<td>[ n]</td>
<td>[ f]</td>
</tr>
<tr>
<td>[ s]</td>
<td>[ z]</td>
</tr>
<tr>
<td>[ s]</td>
<td>[ z]</td>
</tr>
<tr>
<td>[ t]</td>
<td>[ d]</td>
</tr>
<tr>
<td>[ b]</td>
<td>[ #]</td>
</tr>
<tr>
<td>[ k]</td>
<td>[ m]</td>
</tr>
<tr>
<td>[ f]</td>
<td>[ v]</td>
</tr>
</tbody>
</table>

• Our analysis of the environments of these diphthongs:
  - [ʌj] appears before **voiceless** sounds
  - [aj] appears **elsewhere**
Step 3. If you have found that two sounds are allophones of the same phoneme, state the environments where each allophone occurs.

Now we can expand on this:

- At least one of the two allophones should have an environment that is statable as a natural class using properties of sounds.

- If one allophone has an environment that is “wherever the other allophone doesn’t occur”, we can state its environment as elsewhere.
5. Writing a phonological rule

• So far, we have seen:
  - **Phonemes** are mental sound categories
  - One phoneme may have multiple **allophones**
  - In that case, some factor in the **environment**—described in terms of **sound properties**—determines which allophone appears

• Next:
  - How does the **mental grammar** make sure that the correct allophones appear in the correct environments? → **Phonological rules**
5. Writing a phonological rule

• When one phoneme has multiple allophones, we write a **phonological rule** (or rules) to determine where each allophone appears.

• Remember:
  - The phoneme appears in its basic form in the mental lexicon.
  - When it needs to be changed into a *different* allophone, a phonological rule applies to make that adjustment.
  - Phonological rules are part of the **mental grammar** of a native speaker.
5. Writing a phonological rule

• How to write a phonological rule:

(1) Choose one allophone as the **basic** one
   - If one allophone has the environment ‘elsewhere’, pick this one as basic
   - Otherwise, if one allophone has an environment that is a **more general natural class**, pick this one as basic (this is NOT about which allophone appears “more often” in the data set!)
   - If *no* allophone has a more general environment, just pick any one as the basic one (here, more than one analysis is equally insightful)
5. Writing a phonological rule

(1) Choose one allophone as the **basic** one

- For Canadian Raising, which allophone is basic?

<table>
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<tr>
<th>Allophone</th>
<th>Word</th>
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<td>[ʌjs]</td>
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- [ʌj] appears before **voiceless** sounds
- [aj] appears **elsewhere**
5. Writing a phonological rule

(1) Choose one allophone as the **basic** one

- For Canadian Raising, which allophone is basic?

  - [ʌjs] ‘ice’
  - [lʌjs] ‘lice’
  - [tɹʌjt] ‘trite’
  - [tɹʌjp] ‘tripe’
  - [flʌjt] ‘flight’
  - [lʌjk] ‘like’
  - [nʌjf] ‘knife’
  - [ajz] ‘eyes’
  - [lajz] ‘lies’
  - [tuajd] ‘tried’
  - [tuajb] ‘tribe’
  - [flaj] ‘fly’
  - [tajm] ‘time’
  - [fajv] ‘five’

- [ʌj] appears before **voiceless** sounds
- [aj] appears **elsewhere** ← **basic allophone**
(2) The **basic** allophone is the “name” of the phoneme (what to put inside the / /)

- This is the allophone we will get when *no* phonological rule applies — the **default** option
5. Writing a phonological rule

(2) The **basic** allophone is the “name” of the phoneme (what to put inside the / /)

- This is the allophone we will get when *no* phonological rule applies — the **default** option

- For Canadian Raising, we can now say that the phoneme that has allophones [aj] and [ʌj] is /aj/
5. Writing a phonological rule

(3) For each non-basic allophone of the phoneme, write a phonological rule

A phonological rule must state:
- the segment or class of segments it applies to
- the properties that need changing, in order to turn the basic form of the phoneme into the appropriate allophone
- the environment in which it applies
5. Writing a phonological rule

(3) For each non-basic allophone of the phoneme, write a **phonological rule**

- For Canadian Raising, we need the rule to...
  
  • apply to /aj/
  
  • change the *low* part of this diphthong to *mid*
  
  • apply in the environment “before a *voiceless* sound”
5. Writing a phonological rule

• Conceptually, a **phonological rule** says, “When phoneme /P/ appears in the designated context, *change it* into allophone [Q].”

• Reminder: It is **sound properties** like “voiced” or “nasal” that the mental grammar manipulates, **not** entire individual speech sounds like [m]
  - Changing [m] to [b] means *changing* “nasal” to “oral”, **not** replacing one sound with another
  - Therefore: Always write your phonological rule in terms of **sound properties**, even when only one sound is affected!
6. Rule notation

• Here is how we will state phonological rules in our model of mental grammar:

\[ A \rightarrow B / X \_ \_ Y \]

A  The sound(s) affected by the rule
B  The property(ies) that the rule changes
/  ‘In the environment of’
  _  Where the affected sound(s) are located with respect to the context
X  Preceding context, if any
Y  Following context, if any

*** Always state A, B, X, Y in terms of properties ***
6. Rule notation

• For the Canadian Raising example:
  - We haven’t specifically talked about how to represent diphthongs with sound properties, since they have two parts
  - Proposal: Describe a diphthong primarily in terms of its first part (with second part in parentheses)
  - /aj/ is therefore described as:
    low central unrounded (to palatal glide) diphthong
6. Rule notation

- Rule for the Canadian Raising example:

<table>
<thead>
<tr>
<th>Affected sound:</th>
<th>Changed property:</th>
<th>Environment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>low central</td>
<td>mid</td>
<td>/ _ voiceless</td>
</tr>
<tr>
<td>unrounded diphthong</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Describe the affected sound in enough detail to identify it.
- Indicate only the changed property (don’t simply state all the properties of the outcome, [ʌ]—focus on the change).
- Use _ to show where the affected sound is located with respect to the relevant environment.
7. Some key points to remember

Why are we going through all this?

• To analyze the phonology (grammar) of a language:
  - Propose **phonological rules** as needed

• How do we know when a rule is needed?
  - Determine whether two sounds belong to the **same phoneme** (as allophones) or to **different phonemes**
  - If one phoneme has **multiple allophones**, we need a **rule** to determine which allophone appears where
7. Some key points to remember

• **Natural classes** are essential in stating allophone distributions or phonological rules
  - The **environment** of a rule is often a natural class
  - An entire class may also **undergo** a rule

• Every part of a rule is stated in terms of **properties**, even if only one sound is involved
  - This is how the mental grammar **represents** sounds
  - Phonological rules are part of the mental grammar

• The mental grammar can represent natural classes **because** it represents sounds with **properties**