1 Introduction

Components of the Grammar (so far)

1. **Distinctive Features**: The set of (phonetically-defined) phonological features that create contrast and define natural classes in a language

2. **Phonemic Inventory**: The set of contrastive sound units in a language

3. **Phonological Rules**
   (a) **Context-Free**
   \[ X_{[+F,+G]} \rightarrow X_{[-F]} \]
   - Cantonese: \( C_{[+nasal,+cor]} \rightarrow C_{[-nasal,+lateral]} \)
   - Northern Paiute: \( C_{[-SON]} \rightarrow C_{[\pm cont, \pm voice]} \)
   (b) **Context-Sensitive**
   \[ X_{[+G]} \rightarrow X_{[+F]} / W_{[+F]} \rightarrow Z_{[-H]} \]
   - English: \( C_{[+nas,+cor]} \rightarrow [+high,-low,-back] / V_{[+high,-low,-back]} \)

4. **Rule-Ordering**
   - Blackfoot: Glide-Deletion < t-Affrication < ...

5. **1 + 2 → Phonetic Inventory**: The set of sound units in a language

**Review and Practice**: With Distinctive Features

STUDENT QUESTIONS

1. The Northern Paiute generalization was actually that a bilabial obstruent can surface as \{[p, b, β]\}, an alveolar obstruents as \{[t, d, r]\} and velar obstruents as \{[k, g, γ]\}. This means the rule as formalized above makes a wrong prediction...

   - Can you identify this prediction?
   - Can you think of a another way to formulate the rule?

   Phonemic Inventory = \{p t k kʷ m n ñ s h ŋ tʃ w j i u o a\}

2. What is the relationship between **Distinctive Features** and the language’s **Phonemic Inventory**?

3. What is the relationship between **Distinctive Features** and the types of **Phonological Rules** in that language?

**Observation**: We often use things like \( ω \) when formulating our rules i.e., we make reference to **Phonological Domains** like word \( ω \)

...but we don’t have any way of representing phonological domains in our model of the grammar yet

**This Week**: The phonological domain **Syllable** \( σ \)!

**Syllable**: A string of segments arranged in sonority sequences, which behaves as a prosodic category:

1. **Nucleus** (the sonority peak)
2. Optional\(^1\) lower-sonority **Onset** to the left, and
3. Optional lower-sonority **Coda** to the left:

\(^1\)Optional in the sense that not all syllables require **Margin** sequences, but all syllables require a nucleus.
1.1 Evidence for Phonological Constituents

Samoan Reduplication
How do you form the plural subject verb forms from the singular subject verb forms?

If [malosi] means ‘he is strong,’ how do you say ‘they are strong’?

(1) a. mate 'he dies' (2) a. mamate 'they die'
   b. nofo 'he stays'       b. nonofo 'they stay'
   c. galue 'he works'      c. galulue 'they work'
   d. tanu 'he buries'      d. tatanu 'they bury'
   e. alofa 'he loves'      e. alolofa 'they love'
   f. taoto 'he lies'       f. taoto 'they lie'
   g. atama?i 'he is intelligent' g. atamama?i 'they are intelligent'

- The penultimate (second to last) syllable is reduplicated:
  [ma.te] becomes [ma.ma.te]
  [ga.lu.e] becomes [ga.lu.lu.e]
  [ta.o.to] becomes [ta.o.o.to]

Prediction: [ma.lo.si] would become [ma.lo.lo.si]

→ The rule to form S.PL verb forms refers to vowel-centric strings of segments that act like a unit (SYLLABLES)

- i.e., you can’t formalize the rule in terms of taking the two sound segments that are two segments from the end of the singular form

→ you need to break up the word into vowel-centric units (SYLLABIFICATION) and count those units

• The Samoan data is evidence that a language’s grammar can manipulate vowel-centric strings of sounds as a unit

→ So we can propose a theoretical entity SYLLABLE

1.2 Domain-Sensitive Phenomena

1.2.1 R-less English

• Kahn 1976 observes that “r-less” dialects of English lack [ɹ] in two cases:

   (i) When the following segment is a consonant, and
   (ii) At the end of a word

(3) a. car [kʰaː] d. card [kʰaːd]
   b. cartel [kʰaːtel] e. carry [kʰɛːɹ]
   c. cart [kʰaːt] f. rack [ræk]

• This would require a rule like this:
  \( r \rightarrow \emptyset \{C, \} \_ \)

• Kahn 1976 points out that this sort of conditioning environment for phonological rules is very common cross-linguistically...

• ...but \( \{C, \} \_ \) isn’t a NATURAL CLASS!
  → They don’t share any common feature!

• Proposing the existence of a SYLLABLE allows us to unify these two contexts

Generalization:
Rhotic segments are not pronounced at the end of a syllable
\( r \rightarrow \emptyset |C| \)

1.2.2 English CC Clusters

- Consider the following data from English, showing CC clusters:
  (Data from Mohanan 1993)

(4) a. sent [sEnt]  
   b. limp [lImp]  
   c. sink [sInk]  
   d. nymph [nImf]  
   e. rinse [ôIns]

(5) a. dreamt [dôEmt]  
   b. exempt [Ig.zEmt]  
   c. warmth [wAômT]  
   d. act [ækt]  
   e. apt [æpt]

(6) a. *[sInp]  
   b. *[sInk]  
   c. *[sImk]  
   d. *[sIpk]  
   e. *[sIkp]  
   f. *[sItp]  
   g. *[sInf]

- Question: Do you notice any patterns in terms of the allowed Place of Articulations in the CC clusters?

What’s the difference between the examples in (4) and (5) VS (6)

→ What’s the generalization?

- Now consider the following data:

(7) a. congressional [kan.ɡiə.ʃə.nəl]  
   b. convict [kan.vikt]  
   c. Stanford stæn.fəd

- Does this data fit with your generalization?

- Observation: The place restrictions on CC clusters in English are restricted to within a syllable

- In order to propose a rule, we need to refer to the theoretical entity SYLLABLE

1.2.3 American English Nasal Vowels

- Q: Are oral vs nasal vowels (e.g., i VS ˜i) contrastive in American English?

(8) a. [sɪŋ]  
   b. [sɪn]  
   c. [hʌm]  
   d. [bʊm]  
   e. [bæŋ]  
   f. [tɒm]

(9) a. [pʰ.i.ˈnal]  
   b. [hə.ˈni]  
   c. [və.ˈni]  
   d. [sə.ˈmɪ]  
   e. [tʰi.ˈm.pʰɛ]n

- Observation: English vowels are only nasal before a tautosyllabic nasal; they are non-nasal otherwise

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2Since the nasal vs non-nasal nature of English vowels is predictable, linguists often don’t bother transcribing it (narrow vs broad transcription).
In order to propose a rule, we need to refer to syllables.

**STUDENT EXERCISE**

Propose a phonological rewrite rule for the nasalization phenomenon illustrated above, using distinctive features.

There are both morphological rules and phonological rules that rely on dividing words up into syllables.

2 Adding Syllable Structure to our Theory

Q: How can we incorporate syllables into our phonological theory?

Should we just represent syllabification using dots, like the IPA does?

flips = [flıps] congressional = [kan.gıı̂r.ıə.nal]

This is a linear representation
- there is a single level of representation (a string of segments)

This contrasts with the hierarchical structure proposed by Kahn 1976, 2015, which adds a tier that represents syllables:

This system would allow the grammar to count the number of syllables (number of σ nodes, or number of dots + 1)

But we have no instructions/rules about how to syllabify eg., That Samoan [taoto] is [ta.o.to] (as opposed to *[tao.to], *[ta.o.t.o], *[taot.o], *[ta.ot.o])?

And how do we account for the observations that
- All of the syllables have a single vowel in them?
- consonants preceding the vowel behave differently from the consonants that follow the vowel?

We need a way to refer to the C vs V status of segments within a syllable...

2.1 CV-Tier Theory

**CV-TIER THEORY**: Multiple levels/tiers of phonological representation

This distinguishes between syllable peaks (V) and margins (C)

Each element on the CV-tier is interpreted as a timing unit
- Geminates are single segments linked to two C slots
- Long vowels are single segments linked to two V slots
- Affricates are two segments linked to a single C slot

eg., CV-tier for Blackfoot [kakó] ‘go ahead!’ VS [kakkóo] ‘pigeon’

But the Samoan data provided only contain single vowels. Other languages allow other kinds of syllables.

Later on we will look at another way of introducing syllables into our phonological theory - Moraic Theory, which lacks a CV-Tier of representation.
eg., CV-tier for Polish [tʃi] trzy “three” VS [atʃi] czy “whether”

• Adding the CV-tier to our phonological representation allows us to formulate rules on the Cs and Vs that make up a language’s syllables

• Clements & Keyser 1983 observe four basic syllable types:
  1. CV eg., [ka], [ki], [ku], [ke], [ko]
  2. V eg., [a], [i], [u], [e], [o]
  3. CVC eg., [kip], [mit], [lus]
  4. VC eg., [it], [if], [iv]

• Clements & Keyser 1983: CV is the Universal Syllable, and a language’s syllable template may be operated on by the following rules:
  (i) Delete syllable initial C
  (ii) Insert syllable final C
  (iii) C → C* (C* indicates multiple C elements)
  (iv) V → V* (V* indicates multiple V elements)

→ All languages start with CV
   Any combination of these operations then define its syllable inventory

• Operations (i) and (ii) predict a typology of syllable inventories:
  (I) CV eg., Senufo
  (II) CV, V eg., Maori
  (III) CV, CVC eg., Klamath
  (IV) CV, V, CVC, VC eg., English

• And it predicts that no language will have:
  *{V, VC}, *{CV, V, CVC}
  *{CVC, VC}, *{CV, VC}
  *{CV, V, VC}, *{V, CVC}
  *{CV, CVC, VC}, *{V, VC, CVC}

→ This reflects what many have claimed to be IMPLICATIONAL UNIVERSALS

<table>
<thead>
<tr>
<th>Implicational Universal: Onsets</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ \sigma V... \Rightarrow \sigma CV... ]</td>
</tr>
<tr>
<td>(If L has syllables that lack an onset, then it also has syllables with an onset.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Implicational Universal: Codas</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ ...VC\sigma \Rightarrow ...V\sigma ]</td>
</tr>
<tr>
<td>(If L has closed syllables, it also has open syllables)</td>
</tr>
</tbody>
</table>

• Operation (iii) reflects an observation about tautosyllabic CC clusters:

<table>
<thead>
<tr>
<th>Implicational Universal: Complex Margins</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ \sigma CCV... \Rightarrow \sigma CV ]</td>
</tr>
<tr>
<td>(If L allows complex onsets, it also allows simple ones)</td>
</tr>
<tr>
<td>[ ...VCC\sigma \Rightarrow ...V\sigma ]</td>
</tr>
<tr>
<td>(If L allows complex codas, it also allows simple ones)</td>
</tr>
</tbody>
</table>

• In addition to (iv), they allow a language to have CV* as its core syllable

• Altogether, the choice of core syllable and allowed operations can define a language’s MAXIMAL SYLLABLE

eg., English (C)(C)(C)V(C)(C)(C) as in [spöInts]

• The MAXIMAL SYLLABLE (or SYLLABLE TEMPLATE) can be augmented with SYLLABLE STRUCTURE CONDITIONS (SSCs)

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Clements & Keyser 1983 imported the notion of a CV-tier from McCarthy 1981’s work on non-concatenative morphology in Arabic.
The positive SSC above reflects another proposed universal about languages - the SSP

2.2 More Levels of Representation: Nucleus, Coda, Rhyme, Onset

- In stating the universal implications, I used the terms **onset** and **coda**
- Q: Are these just descriptive terms for the Cs before and after the vowel... ...or real linguistic elements that need to be represented in our theory?
- Many linguists have proposed more hierarchical levels within a syllable:

• In order to justify their place in our theory, we need to show that the grammar somehow **refers to** or **manipulates** these categories

STUDENT EXERCISE

1. What is **the maximal syllable** for Thai?
2. What sort of **syllable structure constraints** does Thai have?
3. Do your SSCs need to refer to consonants VS vowels? What about the notion of **onset**, **coda**, **nucleus** or **rhyme**?

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Although there are the very famous cases of consonantal syllable nuclei in Tashlhiyt Berber (Dell & Elmedlaoui 1985) and Nuxalk/Bella Coola (Hoard 1978).
2.3 Syllabification Principles

1. **Nucleus Assignment** (acc. to SSP)
   Assign the most sonorant segment as V/the nucleus

2. **Maximal Onset Principle** (acc. to max. σ and SSCs)
   Assign as many consonants as possible as onset

3. **Minimal Coda Principle** (acc. to max. σ and SSCs)
   Assign the remaining consonants to coda position

2.4 Moraic Theory: Heavy VS Light Syllables

- Not all syllable theories assume a CV-TIER - eg., MORAIC THEORY

Q: What is a MORA?

- Syllables can be distinguished according to their weight
  (Hyman 1985, Hayes 1989)

- **MORA (µ):** A weight-bearing unit

(10) Moraic Theory (Hayes 1989)

a. Light Syllables (one mora)  b. Heavy Syllables (two morae)

![Diagram of syllable structures]

- Syllable weight may affect stress assignment, compensatory lengthening, tone assignment, minimal word requirements, reduplication, etc.

2.5 Different ontology; Different Predictions

- The CV-TIER Theory and MORAIC Theory differ in their ontology
e - i.e., what they assume to be the basic building blocks of the grammar

- This affects the rules that a linguist adopting each theory can propose
eg., Assuming moraic theory, rules cannot make reference to Cs and Vs

STUDENT QUESTION

Is this sort of restriction a desirable component of a theory? Why or why not?

- It also makes different predictions about the sorts of phenomena we expect
to see cross-linguistically
  - **CV Theory:** There should be processes that count CV segments (the way we see processes that count syllables)
  - **Moraic Theory:** There should be processes that count morae (the way we see processes that count syllables)

- Any weight-sensitive phenomenon is an example of the latter, but we
don’t seem to see any examples of the former (Hayes 1989)

(11) English: Weight Sensitive (Halle & Chomsky 1968)

a. rigorous, maximal, vigilant  
   Antepenultimate  
   [ˈrɪɡərəs], [ˈmæk.ʃənəl], [ˈvɪl.dʒi.lɪnt]

b. mediéval, désirous, décorous  
   Heavy Penult  
   [məˈdi.ə.val], [dəˈsaɪə.ləs], [daˈkoʊə.ləs]

c. reluçrant, abýsmal, moméntous  
   Heavy Penult  
   [əˈlək.tənt], [əˈbaɪz.əl], [məˈməntə.ləs]

- Whether or not a coda consonant is moraic is a language-specific property,
  which we formalize as the parameter Weight-by-Position
Components of the Grammar (so far)

1. **Distinctive Features:**
   The set of (phonetically-defined) phonological features that create contrast and define natural classes in a language

2. **Phonemic Inventory:**
   The set of contrastive sound units in a language

3. **Phonological Rules**
   (a) **Context-Free**
   \[ X_{+[F,G]} \rightarrow X_{[-F]} \]
   Cantonese: \( C_{+[\text{nasal}, +\text{cor}]} \rightarrow C_{[-\text{nasal}, +\text{lateral}]} \)
   Northern Paiute: \( C_{[-\text{SON}]} \rightarrow C_{[\pm \text{cont}, \pm \text{voice}]} \)
   (b) **Context-Sensitive**
   \[ X_{+[G]} \rightarrow X_{+[F]}/W_{+[F]} \rightarrow Z_{[-H]} \]
   English:
   \[ C_{+[\text{nas}, +\text{cor}]} \rightarrow [+\text{high, -low, -back}]/V_{+[\text{high, -low, -back}]} \]

4. **Rule-Ordering**
   Blackfoot: Glide-Deletion < t-Affrication < ...

5. **1 + 2 \rightarrow Phonetic Inventory:**
   The set of sound units in a language

6. **Syllable Structure**
   (i) **Hierarchical Structure:** syllable, mora, CV-tier, nucleus, ...
   (ii) **Operations/Rules:** Template-formation rules, syllable structure constraints (SSCs), ...

- We’ve only scratched the surface of **autosegmental** representations in phonology...
- **Selkirk (1986):** The Prosodic Hierarchy and Strict Layering Hypothesis

(12) **The Prosodic Hierarchy:**

\[
\begin{array}{c}
\text{Utt (Utterance)} \\
\text{IPh (Intonational Phrase)} \\
\text{PrPh (Prosodic Phrase)} \\
\text{PrWd (Prosodic Word)} \\
\phi (\text{foot}) \\
\sigma (\text{syllable}) \\
\mu (\text{mora})
\end{array}
\]

**References**


