# Week 5: Distinctive Feature Theory

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## 1 Introduction: Motivation for Distinctive Features

**Components of the Grammar (so far)**

1. Phonemic Inventory:
   The set of contrastive sound units in a language
2. Phonological Rules
   (a) Context-Free Rules $X \rightarrow Y$
   **Cantonese:** /n/ → [n, l]
   **Northern Paiute:** /b/ → [β, b, p]
   (b) Context-Sensitive Rules $X \rightarrow Y / W \_\_\_ Z$
   **English:**
   /n/ → [ɲ]/___j (/n/ → [n] elsewhere)
3. Rule-Ordering
   **Blackfoot:** Glide-Deletion ≺ t-Affrication ≺ ...
4. 1 + 2 → Phonetic Inventory:
   The set of sound units in a language

- **Question:** Where does the phonemic inventory come from?
  → Are there any restrictions on the types of sounds that a language can have in its phonemic inventory?
- **Question:** What determines which sounds undergo change in a phonological rule? Or which sounds trigger a change?

  **Today:** distinctive features and natural classes

### 1.1 Organized Phonemic Inventories

- Consider the phonemic inventory of Rotokas:

**Consonants:**

| p | t | k |
|---|---|---|
| b ~ β | d ~ ɾ | g ~ ɣ |

**Vowels:**

| | |
|---|---|
| i, i: | u, u: |
| e, e: | o, o: |
| | ɑ, ɑ: |

- Consider the phonemic inventory of Dyirbal

**Consonants:**

| | | | |
|---|---|---|---|
| p | t | c | k |
| m | n | ɲ | ŋ |
| w | ɾ, ɽ, l | j | |

**Vowels:**

| | | |
|---|---|---|
| i | | u |
| | | |
| | a | |

- Consider the phonemic inventory of Tagalog

**Consonants:**

| | | | | |
|---|---|---|---|---|
| p | t | t͡ʃ | k | P |
| b | d | d͡ʒ | g | |
| | s | ʃ | | h |
| m | n | ɲ | ŋ | |
| w | ɾ, l | j | | |

**Vowels:**

| | | |
|---|---|---|
| i, i: | | u, u: |
| iw | | uj |
| ɛ, ɛ: | | o, o: |
| | a, a: | |
| | aj, aw | |

- **Observation:** These phonemic inventories are quite balanced in terms of their phonetic features, i.e., they involve

  ± voice pairs of bilabial, alveolar, palatal, and nasal PoAs

  ± nasal pairs of bilabial, alveolar, palatal, and nasal PoAs

  ± long pairs of high front, high back, mid, etc., vowels

- We don't see languages with disorganized inventories like this:

**Consonants:**

| | | | | | |
|---|---|---|---|---|---|
| | | c | k | | ʔ |
| | ð | | | ɢ | |
| ɸ | | | | | |
| ʘ | | ɲ | | | |

**Vowels:**

| | | |
|---|---|---|
| y | | |
| ø | ə | |
| æ | a, a: | |

- **Q:** Why don't we see random phonemic inventories like this?
- This is another pattern that we should be able to account for in our phonological theory

## 1.2 Natural Classes

- **Consider Japanese Palatalization**:
  {t, d, s, z} → {t͡ɕ, d͡ʑ, ɕ, ʑ}/__i

  The set {t, d, s, z} are all ALVEOLAR sounds...this rule doesn't affect velar and labial consonants

  **Why?** Is this just a coincidence?

- **Consider Canadian Raising**
  {aj, aw} → / __{t, s, p, k θ}

  The set {t, s, p, k θ} are all VOICELESS OBSTRUENTS...this rule isn't triggered by voiced obstruents, or by sonorants

  **Why?** Is this just a coincidence?

- **Consider Kimatuumbi Place Assimilation** (Odden 2005)

| **Singular** | **Plural** | **Translation** |
|---|---|---|
| lwɪ́mo | ɲ́mo | land being weeded |
| lwaámbo | ɲaámbo | bead |
| lweémbe | ɲeémbe | shaving knife |
| lugolóká | ŋgolóká | straight |
| lubáu | mbáu | rib |
| lud͡ʒiíŋgjá | ɲd͡ʒiíŋgjá | entered |
| lulaála | ndaála | pepper |
| lupaláaíˊ | mbaláaíˊ | bald head |
| lutéelá | ndéelá | piece of wood |
| lut͡ʃwiít͡ʃwi | ɲd͡ʒwiít͡ʃwi | tomato |
| lukíligo | ŋgíligo | place for initiates |
| luk´li | ŋg´li | palm |

**Optional Vowel Deletion Rule**

| | | |
|---|---|---|
| ni-bálaaŋgite | m-bálaaŋgite | "I counted" |
| ni-d͡ʒíiŋgiile | ɲ-d͡ʒíiŋgiile | "I entered" |
| ni-góoɲd͡ʒite | ŋ-góoɲd͡ʒite | "I slept" |
| mu-páalite | m-páalite | "You (pl) wanted" |
| mu-téliike | n-téliike | "You (pl) cooked" |
| mu-t͡ʃáawiile | ɲ-t͡ʃáawiile | "You (pl) ground" |
| mu-káatite | ŋ-káatite | "You (pl) cut" |

**STUDENT QUESTION**

1. What allomorphs of the singular prefix do you observe? The plural prefix? The 1sg prefix? The 2pl prefix?
2. What phonological processes can explain the allomorphy?
3. Propose some phonological rules to account for the alternations - how many rules do you need?
4. Can you characterize all of the segments that undergo the assimilation process with a single phonetic property?

- **Observation:** Phonological rules tend to occur to sets of sounds that can be characterized by common phonetic properties
- i.e., you never see a phonological rule like
  {!, t, ɲ, ð, ɸ, m} → ʔ/__]$_\omega$
  (Where segments {n, ŋ, p', k, θ, ...} are unaffected)
- **Idea:** A language's phonemic inventory - i.e., the contrastive segments, are not PRIMITIVES: they are composed of a bundle of DISTINCTIVE FEATURES

  /p/ = {-syllabic, +consonantal, +anterior, -voice, -cont, -nas, -SG, ...}

  Rules target sets of sounds defined with particular FEATURE SPECIFICATIONS -sets of sounds that can be so defined are called NATURAL CLASSES

## 2 Distinctive Feature Theory (based on Odden 2005)

- **Q:** What sorts of NATURAL CLASSES are there?
  → Only those that can be defined by a set of DISTINCTIVE FEATURES
- What DISTINCTIVE FEATURES are active in the world's languages?
  ...the IPA articulatory features? Yes, but...
- **Observation:** We also need broader categories
- There are different ways to formalize DISTINCTIVE FEATURES
- Different sets of features make for different predictions about the range of variation in language, in terms of
  - possible phonemes/phonemic inventories
  - possible phonological rules
- Odden 2005 gives the following distinctive features:[1]

1. MAJOR CLASS FEATURES
   ± syllabic (syl), ±sonorant (son), ± consonantal (con)
2. VOWEL PLACE FEATURES
   ± high, ±low, ±back, ±round, ±tense, ±ATR
3. CONSONANT PLACE FEATURES
   ±coronal, ±anterior, ±strident, ±distributed
4. MANNER FEATURES
   ±continuant (cont), ±delayed release (del.rel), ±nasal (nas), ±lateral (lat)
5. LARYNGEAL FEATURES
   ±spread glottis (SG), ±constricted glottis (CG), ± voice
6. PROSODIC FEATURES
   ± long, ±stress

[1] Odden 2005's features are based on Halle & Chomsky 1968's SPE.

- Each of these features is associated with
  (i) a phonetic definition (either articulatory or acoustic), and
  (ii) a binary specification (i.e., + or -)

### 2.1 Major Class Features (Odden 2005:137-138)

SYLLABIC: "forms a syllable peak (and thus can be stressed)"
→ This is meant to distinguish **vowels** from **consonants**

eg., Vowels are [+syl], as are so-called "syllabic" consonants [ɾ̩], [l̩], [n̩]

SONORANT: vocal tract configuration supports spontaneous voicing
→ This is meant to distinguish **sonorants** from **obstruents**

eg., vowels, liquids, approximants are [+son] because they lack the sort of constriction that causes voicing to be difficult

- Many phonological contrasts and processes only target the class of [+sonorant] or [-sonorant] segments - i.e., OBSTRUENTS (Hayes 2011:74)
  - Voicing contrasts commonly restricted to obstruents
    (eg., Spanish, Japanese, Swahili, ...)
  - Voicing assimilation processes commonly apply only to obstruents
    (eg., French, Catalan, Russian, ...)
  - Devoicing processes commonly apply only to obstruents
    (eg., Greek, Dutch, Polish, ...)
  - Contour tones often restricted to syllables closed with sonorants
    (eg., Lithuanian, dialects of ancient Greek, ...)

CONSONANTAL: "major obstruction in the oral cavity"

Sometimes vowels, glides and laryngeals (h, ʔ) pattern together to the exclusion of the other sonorants

→ This feature is used to group these as a natural class

- Hayes 2011 also includes the feature [±approximate], in order to distinguish between all steps on the SONORITY HIERARCHY

(1) **The Sonority Hierarchy**

Vowels < Glides < Liquids < Nasals < Obstruents

| **Vowels** | **Glides** | **Liquids** | **Nasals** | **Obstruents** |
|---|---|---|---|---|
| [+syllabic] | [-syllabic] | | | |
| [-consonantal] | [+consonantal] | | | |
| [+approximant] | | [-approximant] | | |
| [+sonorant] | | | | [-sonorant] |

→ The addition of this feature predicts that vowels, glides and liquids pattern as a natural class, to the exclusion of nasals and obstruents

- Hayes 2011 notes, however, that [±approx] would have to have an *acoustically-defined*, as opposed to articulatorily defined definition

## 2.2 Vowel Place Features (Odden 2005:140)

HIGH: "body of tongue is raised from the neutral position"

LOW: 'body of tongue is lowered from the neutral position"

BACK: 'body of tongue is retracted from the neutral position"

ROUND: "lips are protruded"

TENSE: "requiring deliberate, accurate, maximally distinct gestures that involve considerable muscular effort"

ADVANCED TONGUE ROOT (ATR): "produced by drawing the root of the tongue forward" [a]

[a] [±ATR] is commonly used to characterize the vowels of sub-Saharan African languages. There is debate over whether both ATR and [±tense] are required.

- High vowels like {i, u, y, ...} are [+high, -low]
- Mid vowels like {e, o,...} are [-high, -low]
- Low vowels like {a, æ, ɑ ...} are [-high, +low]

## 2.3 Consonant Place Features (Odden 2005:142)

CORONAL: "blade or tip of tongue raised from the neutral position"

eg., dentals, alveolars, alveopalatals, retroflex consonants

ANTERIOR: "obstruction located at or in front of the alveolar ridge"

eg., labials, labiodentals, dentals, alveolars

DISTRIBUTED: "constriction...extends for a considerable distance along the direction of air flow"

This is only relevant for coronal consonants

→ it distinguishes between the traditional APICAL vs LAMINAL distinction

- i.e., whether you use the tip or blade of the tongue respectively

STRIDENT: "produced with greater noisiness" - i.e., "greater turbulence"

→ This contrasts strident/noisy [f, v ,s] from non-strident [ɸ, β, θ][2]

[2] Hayes 2011 adopts a different feature set, including a feature [+labiodental], which distiguishes these sounds. He also adopts a [+strident] feature, but he classifies [f,v] as [-strident].

**STUDENT QUESTION**

What combination of the above features would you use to characterize

1. Bilabial VS Dental VS Labiodental sounds? eg., [ɸ] VS [θ] vs [f]
2. Labial VS Alveolar VS Velar sounds? eg., [p] VS [t] VS [k]
3. Dental VS Alveolar sound? eg., [θ] VS [s]

- **Q:** How do we distinguish between different dorsal PoAs?
  eg., palatal, velar vs uvular vs pharyngeal vs glottal?
- In addition to {-ant, -cor}, the VOWEL FEATURES [± high], [±low], [±back] :

  **palatal:** +high, -low, -back
  **velar:** +high, -low, +back
  **uvular:** -high -low, +back
  **pharyngeal:** -high, +low, +back
  **glottal:** -high, -low, -back

- **Note:** Many consonants have SECONDARY ARTICULATIONS
  - i.e., palatalized, velarized, labialized or pharyngealized consonants
- The VOWEL FEATURES [± high], [±low], [±back] and [±round] can also be used on [-syllabic] segments to indicate these secondary articulations
  - Labialized [$p^w$] is [+round]
  - Palatalized [$p^j$] is [+high]
  - Velarized [$p^ɣ$] is [+back]
  - Pharyngealized [$p^ʕ$] is [+low]
- Campbell 1974, Anderson 1974 (interalia) observed that rules like the following were common cross-linguistically:
  b → w/ __C
  w → b / $\overline{C}_{[+nasal]}$__
  w → v
  i → u / {p, b, m, w, u, o} __
- Can we account for these sorts of rules using the set of features from Halle & Chomsky 1968? Why or why not?
- Many feature theorists have proposed the following:

  LABIAL: "produced with the lips" (Odden 2005:163)

## 2.4 Manner Features (Odden 2005:145)

CONTINUANT: primary constriction does not block airflow through the oral cavity

eg., vowels, glides, fricatives and [h]

DELAYED RELEASE: "release of total constriction is slowed so that a fricative is formed after the stop portion"

eg., affricates

NASAL: "velum is lowered which allows air to escape through the nose"

LATERAL: "mid section of the tongue is lowered at the side"

## 2.5 Laryngeal Features (Odden 2005:146)

SPREAD GLOTTIS: "'vocal folds are spread far apart'

eg., aspirated obstruents, breathy sonorants

CONSTRICTED GLOTTIS: "vocal folds are tightly constricted"

eg., implosives, ejective obstruents, laryngealized/creaky sonorants

VOICE: "vocal folds vibrate"

### 2.6 Prosodic Features(Odden 2005:147)

LONG: "has greater duration"

STRESS: "has greater emphasis, higher amplitude and pitch, longer duration"

- This SPE-based approach has no way to formalize tone[3]
- For now we can assume [±High Tone], [±Low Tone]

**STUDENT QUESTION**

How can we use these two features to distinguish between three different levels of tone?

How do you think we should account for CONTOUR TONES?

## 3 Practice Using Distinctive Features

### 3.1 Defining Inventories and Natural Classes with DFT

**STUDENT QUESTIONS** (Odden 2005)

For the following question, assume a language with the following phonemic inventory:

{p, t, k, b, d, m, n, ɣ, ɸ, f, s, l, a, i, o, u, j}

1. Using as few features as possible, characterize the following sets
   (a) {ɣ} {i} {n}
   (b) {b, d} {a, o} {o, u},
   (c) {ɣ, f, s} {p, t, k} {m, n, l}

For the following questions, assume a language with the following phonemic inventory:

{p, t, k, v, d, g, f, s, x, v, ɣ, w, j, l, m, n, a, e, i, o, u, y}

1. Produce a feature matrix for each of these segments, using the features SYLLABIC, SONORANT, CONSONANTAL, VOICE, CONTINUANT, NASAL, LATERAL, ANTERIOR, CORONAL, HIGH, BACK, LOW, and ROUND

   (Use the tables on the following page)

2. Use DFT specifications to define the following natural classes
   (a) {p, t, k, f, s, x}
   (b) {p, t, b, d, f, s, v, l, m, n}
   (c) {w, j, l, m n, a, e, i, o u, y}
   (d) {p, k, b, g, f, x, v, ɣ}
   (e) {j, l, m, n, a, e, i}
   (f) {v, ɣ, w, j, a, e, i , o, u, y}

1. How many of the distinctive features do you require to characterize the phonemic inventory of Rotokas? Which ones?

   What about Dyirbal and Tagalog?

2. How many distinctive features do you require to characterize the phonemic inventory of Thai? Do you need to propose **more** features than we've discussed here?

[3] Tone is usually analysed using an *autosegmental* approach. Before we can discuss that, we'd need to learn a bit more about phonotactics and larger phonological constituents like syllables (next week!)

| Feature | p | t | k | b | d | g | f | s | x | v | ɣ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SYL | | | | | | | | | | | |
| SON | | | | | | | | | | | |
| CONS | | | | | | | | | | | |
| VOICE | | | | | | | | | | | |
| CONT | | | | | | | | | | | |
| NASAL | | | | | | | | | | | |
| LATERAL | | | | | | | | | | | |
| ANTERIOR | | | | | | | | | | | |
| CORONAL | | | | | | | | | | | |
| HIGH | | | | | | | | | | | |
| BACK | | | | | | | | | | | |
| LOW | | | | | | | | | | | |
| ROUND | | | | | | | | | | | |

| Feature | w | j | l | m | n | a | e | i | o | u | y |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SYL | | | | | | | | | | | |
| SON | | | | | | | | | | | |
| CONS | | | | | | | | | | | |
| VOICE | | | | | | | | | | | |
| CONT | | | | | | | | | | | |
| NASAL | | | | | | | | | | | |
| LATERAL | | | | | | | | | | | |
| ANTERIOR | | | | | | | | | | | |
| CORONAL | | | | | | | | | | | |
| HIGH | | | | | | | | | | | |
| BACK | | | | | | | | | | | |
| LOW | | | | | | | | | | | |
| ROUND | | | | | | | | | | | |

### 3.2 Formulating Rules with DFT

**STUDENT QUESTIONS** (Odden 2005)

1. For the following question, assume a language with the following phonemic inventory:
   {p, t, k, b, d, m, n, ɣ, ɸ, f, s, l, a, i, o, u, j}

   Which features are changed in the following rules?

   (a) p → f
   (b) t → ŋ
   (c) k → s
   (d) s → t
   (e) a → i

2. Formalize the rules on the left assuming the segmental inventories on the right

   (a) b, d, g → β, ð, ɣ/V__ {p t k b d g β ð ɣ m n ŋ r i u a ə}
   (b) p, k, q → β, ɣ, ʁ/V__ {p t t͡ʃ ʈ k q β r ʒ ɣ ʁ m i ĩ e ẽ æ o u ũ }
   (c) ∅ → j / i,e __ o, u,a {p t k b d n j w i y e æ o u a}
   (d) t → s / __ i {p t k h v d s r l m n j i y e ø a o u}
   (e) s → r / V__V {p t k b d g s r l m n h w j e i o u a}

## 4 Ways of Formalizing Distinctive Features

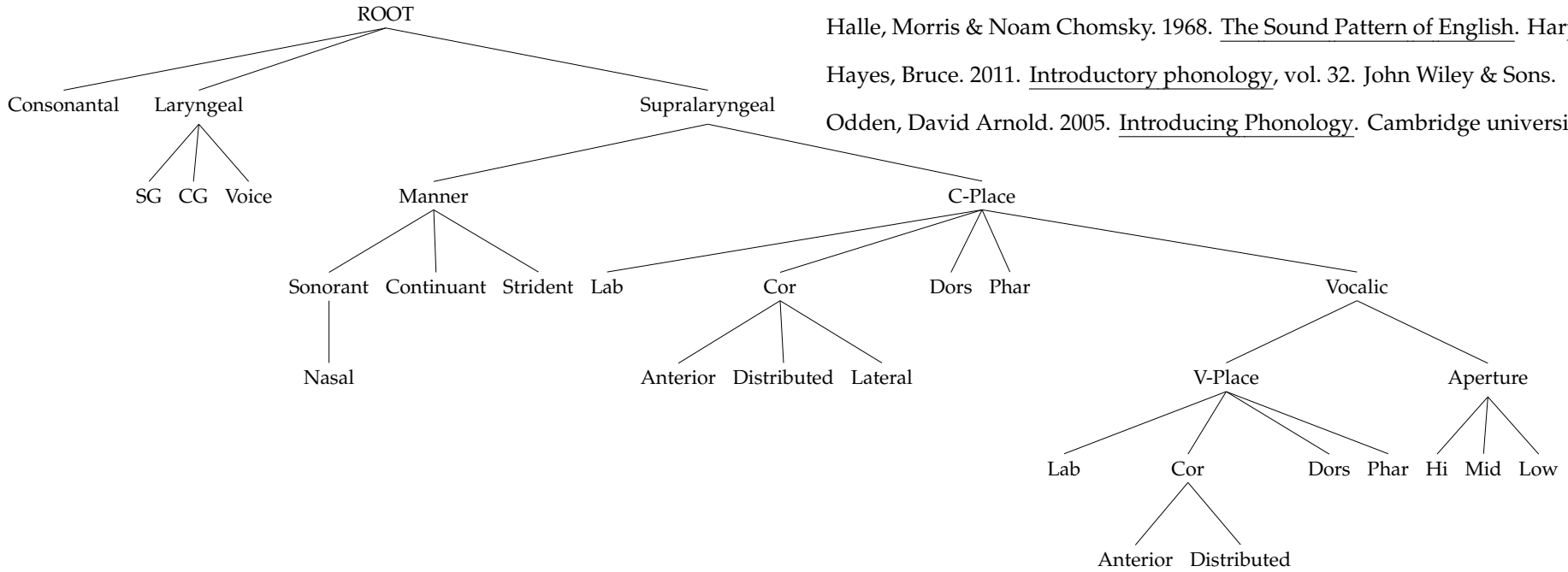
### 4.1 Feature Geometry

- The system we've been discussing treats segments as UNSTRUCTURED bundles of features
- Another way of incorporating features is given in Clements 1985, where features are hierarchically arranged in a FEATURE GEOMETRY

→ This is meant to account for feature dependencies

eg., [±distributed] being relevant only for [+coronal] segments

- Features (or classes of features) are represented as NODES
- Features that are only relevant to segments with some other feature are treated as DEPENDENT NODES[4]




- Of course, different arrangements of nodes makes different predictions
- **Next Week:** More about STRUCTURE in phonology (syllable structure)

[4]The C-Place and V-Place nodes are adapted from the UNIFIED FEATURE THEORY approach (cf. Clements & Hume (1995))

## References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