Class 10: Structure below the segment III/downward interfaces again

<table>
<thead>
<tr>
<th>To do</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ McCarthy &amp; Prince 1994 study question due Wednesday</td>
</tr>
<tr>
<td>☐ Chaha autosegmentalism homework due Friday</td>
</tr>
</tbody>
</table>

Overview: Further structure below the segment, relationship of sub-segment structure to phonetics.

1 Feature geometry

- We’re not really using it in this course after today, but at least you’ll know what it is

❔ Discuss: what are we really doing when use [place] in a rule or constraint?

Example—from McCarthy 1988, a systematic overview of feature geometry

❔ For each of these, let’s fill in the features in the \( A \rightarrow […] / \__ […] \) rule

- **[anterior] can spread with all the place features**
  as in Malayalam (Dravidian language from India with about 36 million speakers)
  \[
  n \rightarrow \begin{array}{c}
  m / \__ \text{bilabials} \\
  \eta / \__ \text{dentals} \\
  n / \__ \text{alveolars} \\
  \eta / \__ \text{retroflexes} \\
  \eta / \__ \text{palatals} \\
  \eta / \__ \text{dorsals}
  \end{array}
  \]

- **[anterior] can spread with just the other tongue-tip/blade feature**
  **English t,d,n ([+anterior, –distributed])**
  \[
  \begin{align*}
  &\rightarrow \text{dental} / \__ \theta, \delta \quad ([+\text{anterior, +distributed}]) \\
  &\rightarrow \text{palatoalveolar} / \__ t\check{f}, d\check{f}, \check{f}, \check{z} \quad ([–\text{anterior, +distributed}]) \\
  &\rightarrow \text{retroflex}^1 / \__ \check{t} \quad ([–\text{anterior, –distributed}])
  \end{align*}
  \]

- **[anterior] can spread on its own**
  **Navajo sibilant harmony**
  \[
  s \rightarrow \check{s} / \__ X_0 \{t\check{f}, d\check{f}, \check{f}, \check{z}\} \\
  \check{s} \rightarrow s / \__ X_0 \{ts, dz, s, z\}
  \]

\(^1\) for speakers who have a retroflex \( r \)
• This suggests a hierarchical organization of features:

\[ \text{place} \]
\[ \text{labial} \quad \text{coronal (=tongue blade/tip)} \quad \text{dorsal (= tongue body)} \]
\[ \text{anterior} \quad \text{distributed} \]

**The general idea**

• Certain features seem to group together in their behavior.
• Such grouping gave rise to an elaborated theory of feature geometry in autosegmental representations.
  ▪ The idea was that not only features can spread and delink, but also **nodes** that dominate multiple features, or nodes that dominate intermediate nodes.

• Here’s a proposed full geometry, more or less the one in McCarthy 1988—the top, “root” node, is what attaches to the C-V skeletal tier (or to the syllable structure, for skeleton-less theories):

\[
\begin{array}{c}
\text{son} \\
\text{cons} \\
\text{[continuant]} \\
\text{[nasal]} \\
\end{array}
\]

\[
\begin{array}{c}
\text{laryngeal} \\
\text{[constr. gl.] [sprd gl.] [voice]} \\
\text{labial} \\
\text{coronal} \\
\text{dorsal} \\
\text{pharyngeal} \\
\text{[round]} \\
\text{[distrib.] [anterior] [lateral] [high] [low] [back]} \\
\end{array}
\]

• McCarthy’s **evidence** for each grouping comes from...
  ▪ assimilation as a group (=spreading; see examples above for coronal and place)
  ▪ deletion as a group (=delinking)

  _debuccalization:_ Spanish dialects \( s \rightarrow h / \_ \)_syll
  English dialects, some Ethiopian languages \( C^2 \rightarrow ? \)

  _laryngeal neutralization:_ Korean obstruents have 3-way laryngeal distinction, collapsed to 1 value in codas

• Obligatory Contour Principle (OCP) effects: adjacent (-on-their-tier) identical elements are prohibited.
  ▪ Not only is two Hs in a row on the tone tier bad, two +s in a row on the [anterior] tier is bad too, and so is two +s in a row on the coronal tier.
  ▪ Manifested as restrictions on allowable sequences (no two labials in an Arabic root), behaving as a block
2 Relationship to phonetics—my personal opinion

- Features that correspond to an articulatory gesture behave autosegmentally
  - [+nasal]: lower the velum
  - [+dorsal]: use the tongue body
  - [+back]: back the tongue body

- Features that don’t correspond to a gesture really are just properties of a sound (true features), not autosegments
  - [–sonorant]: total or near-total obstruction of airflow
  - [+consonantal]: significant supraglottal interference with airflow

3 “Privative” features

- One more thing to know about features is that some researchers think that for some features, there’s no [–F] vs. [+F] vs. nothing
  - but rather only [+F] (or “[F]”) vs. nothing. (The idea goes way back—see Steriade 1995 for review.)
  - Such features are called privative or monovalent

- E.g., maybe there’s no [–nas] in representations:
  - In linear rule theory: rules can only refer to [+nas], or not refer to nasality at all
  - In autosegmental rule theory: also no rules can insert, delete, or move [–nas]
  - In linear OT’s no markedness constraints can refer to [–nas]
  - In autosegmental OT: also no MAX([-nas]), DEP([-nas]), ALIGN([-nas])
  - A segment that previously was represented as [–nas] is now just underspecified for [nasal]

- Relationship to phonetics?
  - If the [–F] value is just the resting position, there’s no need to specify its articulation
    - The articulator can just relax back towards its resting position
  - So features like [dorsal] or [voice] are likely to be privative/monovalent
  - Features like [sonorant] or [consonantal] are likely to be bivalent

4 If time: vowels vs. consonants in feature geometry (Clements & Hume 1995, Padgett 2011 for an overview)

- Do Vs and Cs share features? Sometimes Vs and Cs interact, sometimes they don’t.
  - Spreading: in many languages, velar and labial consonants can become coronal before front vowels (so are front vowels coronal?)

Maltese: prefix vowel copies the stem vowel, unless stem begins with coronal consonant

kotor jo-ktor ‘to increase’
ʔasam ja-ʔsam ‘to break’
heles je-hles ‘to set free’
daħal ji-dhol ‘to enter’
talab ji-tlob ‘to pray’
sehet ji-shet ‘to curse’
dʒabar ji-dʒbor ‘to collect’ (Padgett 2011 p. ?—see there for references)
OCP: in many languages, sequences of featurally-similar Vs and Cs are prohibited

* Cantonese: round V can’t occur after kw, kʰw; round V can’t be followed by a labial coda C (though there are also some C-V similarity requirements in Cantonese!)

<table>
<thead>
<tr>
<th>older speakers’</th>
<th>becomes younger speakers’</th>
</tr>
</thead>
<tbody>
<tr>
<td>[kʷɔːk³³]</td>
<td>[kɔːk³³]</td>
</tr>
<tr>
<td>[kʷuːn⁵⁵…]</td>
<td>[kuːn⁵⁵…]</td>
</tr>
<tr>
<td>[kʷʌj³³]</td>
<td>[kʷʌj³³] no change</td>
</tr>
</tbody>
</table>

yes words like  

pʰun ‘a plate’

pʰo²¹ ‘an old lady’婆婆

no words like  

*Cup, *Com, *Cyw, *Cøp （Cheng 1989）

*Com
*Cyw
*Cøp

Yet vowel harmony generally skips right over consonants, suggesting that the consonants are underspecified for the features in question.

Clements & Hume propose something along these lines:

- Explains why single consonantal features can skip vowels (as [anterior] in Navajo), but the whole Place node seems never to skip vowels (what would that look like?).
5 Long-distance effects

• Sibilant harmony in Navajo (Na-Dene language from the U.S. with about 149,000 speakers; discussion based on Martin 2004)

• Simple version: two [+strident] segments within a word must agree in [anterior]—the feature [anterior] is contrastive only among stridents (others are unspecified):

\[
\begin{align*}
/sì + tʃ\ddash id/ & \rightarrow \ddash jì + tʃ\ddash id & \text{‘he is stooping over’} \\
/sì + tɛːʒ/ & \rightarrow \ddash jì + tɛːʒ & \text{‘they two are lying’} \\
/jì + s + lɛːʒ/ & \rightarrow jì + j + tʃɛːʒ^2 & \text{‘it was painted’} \\
/jì + s + tiz/ & \rightarrow jì + s + tiz/ & \text{‘it was spun’} \\
/tʃɛː + tʃɛːʔ/ & \rightarrow tʃʰɛ + tʃɛːʔ & \text{‘amber’} \\
/tʃaː + nɛːz/ & \rightarrow tʃaː + nɛːz & \text{‘mule’}
\end{align*}
\]

Write a linear rule to account for this.

• The linear rule must skip over [–strid] segments
  ▪ which happen to be, plausibly, just those segments that are unspecified for [anterior] in Navajo.
• But the rule gets no special credit for this
  ▪ it is valued the same as a rule that skipped over all the [+voice] segments, say.
• This seems to miss something.
  ▪ Cross-linguistically, long-distance rules of assimilation seem to skip over segments that don’t bear the feature in question
  ▪ so we would like this kind of skipping to be valued more highly than other types.

• Autosegmental representation of ‘mule’ UR, assuming underspecification of nonstridents for [anterior]—IPA symbols stand for the rest of the features:

\[
\begin{array}{c|c|c|c|c|c|c|c|c|c|c}
[-\text{ant}] & [-\text{ant}] & [\text{ant}] & [\text{ant}] & [\text{ant}] & [\text{ant}] & [\text{ant}] & [\text{ant}] & [\text{ant}] & [\text{ant}] & [\text{ant}] \\
C & V & V & + & C & V & C & V & C & V & C \\
\downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\
\ddash tS & a & n & é & Z & capitalization on this tier indicates agnosticism as to [ant]
\end{array}
\]

Propose an autosegmental rule of strident harmony

How about in OT?

2 Not sure if there’s another process going on with /l/ vs. [ɭ] or this is just a mistake. Sorry.
6 Phonetic basis of long-distance effects?
• Some researchers have argued most long-distance assimilations are, articulatorily, local. E.g. Gafos 1999.
• For instance, in a rounding-harmony system like this:

\[
\begin{array}{c}
V \\
\downarrow \\
[\text{round}]
\end{array}
\begin{array}{c}
C_0 \\
V
\end{array}
\]

we could reasonably claim that (and test instrumentally whether) the Cs that are skipped by the rule actually take on the lip-rounding value that spreads.

7 Locality: transparent vowels in Hungarian (Benus & Gafos 2007)
• Front non-round vowels in Hungarian allow front/back harmony to spread right over them:

<table>
<thead>
<tr>
<th>Front</th>
<th>Back</th>
</tr>
</thead>
</table>

Let’s draw some autosegmental representations, and maybe some gestural ones too.

• B&G argue that the tongue actually remains in front or back(ish) position during the transparent vowel.
• So why does it still sound front? Because, especially for [i] (the most-transparent of the transparent vowels; see (Hayes et al. 2009)), the tongue has to get fairly back before it makes much acoustic difference.
8  **Locality: Kinyarwanda coronal harmony (Walker, Byrd & Mpiranya 2008)**

<table>
<thead>
<tr>
<th>(3)</th>
<th>-sas+i</th>
<th>→</th>
<th>[ʂaʂi]</th>
<th>‘bed maker’</th>
<th>cf.</th>
<th>[sasa]</th>
<th>‘make the bed (INF STEM)’</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-soːnɔz+i</td>
<td>→</td>
<td>[ʂɔnɔz]i</td>
<td>‘victim of famine’</td>
<td>cf.</td>
<td>[sɔnɔza]</td>
<td>‘be hungry (INF STEM)’</td>
</tr>
<tr>
<td></td>
<td>-sáːz+i-e</td>
<td>→</td>
<td>[ʂáːz]e</td>
<td>‘become old (PERF)’</td>
<td>cf.</td>
<td>[sáːza]</td>
<td>‘become old (INF STEM)’</td>
</tr>
<tr>
<td></td>
<td>n-sáːz+i-e</td>
<td>→</td>
<td>[ŋaːz]e</td>
<td>‘I am old (PERF)’</td>
<td>cf.</td>
<td>[ńaːza]</td>
<td>‘become old (INF STEM)’</td>
</tr>
<tr>
<td></td>
<td>-úzuz+i-e</td>
<td>→</td>
<td>[uːzuzu]e</td>
<td>‘fill (PERF)’</td>
<td>cf.</td>
<td>[ńuːzuza]</td>
<td>‘fill (INF STEM)’</td>
</tr>
<tr>
<td></td>
<td>ɓa-n-ziz-i+ize</td>
<td>→</td>
<td>[ɓaːnziizize]</td>
<td>‘they punished me (for sth) (PERF)’</td>
<td>cf.</td>
<td>[ɓaːnziiza]</td>
<td>‘they punish me (for sth) (IMPERF)’</td>
</tr>
</tbody>
</table>

- EMA study: receiver pellets attached to tongue tip and blade; magnetometer tracks their position (along with reference receivers on nose and gums).
- Result: tongue tip remains angled upward during intervening segments, as in [ɓaʂamáːzɛ]
  - i.e., the retroflexness spreads to vowels too

9  **Non-locality: Guaraní nasal harmony (Walker 1999)**

<table>
<thead>
<tr>
<th>(3)</th>
<th>/n-do-roi-n’du’pä-i/</th>
<th>→</th>
<th>[nɔroːɨn’pãi]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>not + I-you + beat + NEG</td>
<td>‘I don’t beat you’</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>/ro-mbɔ-po’rã/</td>
<td>→</td>
<td>[rɔmɔpɔ’ɾã]</td>
</tr>
<tr>
<td></td>
<td>I-you + CAUS + nice</td>
<td>‘I embellished you’</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>/i’dja,kãra’ku/</td>
<td>→</td>
<td>[iñã,kãrã’ku]</td>
</tr>
<tr>
<td></td>
<td>‘is hot-headed’</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>/a,kãra’ywe/</td>
<td>→</td>
<td>[ã,kãrã’ywe]</td>
</tr>
<tr>
<td></td>
<td>‘hair (of the head)’</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Are the transparent Cs actually nasal?
- Acoustic study, but found no evidence for nasal airflow
  - if there was any, it wasn’t enough to produce detectable turbulence
  - the stops did have a release burst, meaning air pressure was building up in the oral cavity, so it’s unlikely to have been venting out the nose

🤔 Let’s discuss the theoretical implications (see Smith 2016)
10 A problem: gradient long-distance effects

- The autosegmental account above predicts that it doesn’t matter how much material intervenes between the two stridents—they are still adjacent as far as the [anterior] tier is concerned.

- But Martin found that, in compounds, agreement is gradient: the more material intervenes between the two sibilants, the more likely they are to agree:

(There is an additional twist that I’ll refer you to the thesis and to Martin 2007 for: much of the agreement in compounds comes not from alternation but from the underlying forms!)

- See Kimper 2011, Zymet 2014 for gradient distance effects in vowel harmony and even dissimilation.

Does this mean autosegments are all-or-nothing? Can gestures help?

11 Illusory assimilations and deletions

- We saw that Hall 2006 argues that a gap between consonants can lead to something that sounds like a vowel even though there’s no vowel gesture.

Let’s review what such a representation looks like.

- Similarly, if two consonants are two overlapped, one may be inaudible though it was produced.

Let’s draw the gestural score for a famous one (Browman & Goldstein 1987), perfect memory, with the t being inaudible because of overlap by k and m.
• Here’s how the articulatory data looked:

![Diagram of articulatory data]

Figure 13. X-ray pellet trajectories for “perfect memory.” (a) Spoken in a word list ([po-fek-t#mem...]). (b) Spoken in a phrase ([po-fek-mem...]).

(p. 20)

• The same thing could happen in place assimilation.

❔ Let’s draw the autosegmental representation for another one from (Browman & Goldstein 1987), seve[m] plus seven.
Here’s how the articulatory data looked:
12 If extra time: Tibetan compounds exercise

- Data from Meredith (1990). (I am simplifying some of the tones!! For instance, 3 is really 2. Sorry for missing data; Meredith often doesn’t give concrete examples, just schematics)

- Draw representations for tones 5, 53, 31 (there’s also 3 but worry about that later)

- Look at the data and develop an analysis of the tone changes that occur in compounds
  - You’ll need to invent a constraint on tones in non-word-final syllables
  - You’ll need to invent a quite arbitrary constraint on tones in the second member of a compound.

<table>
<thead>
<tr>
<th>1st member</th>
<th>2nd member</th>
<th>compound</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>5</td>
<td>5-5</td>
</tr>
<tr>
<td>53</td>
<td>5</td>
<td>5-5</td>
</tr>
<tr>
<td>yum 3</td>
<td>chēē 5</td>
<td>yum-chēē 3-5 ‘mother-hon.’ (mother+great)</td>
</tr>
<tr>
<td>31</td>
<td>5</td>
<td>3-5</td>
</tr>
<tr>
<td>5</td>
<td>53</td>
<td>5-53</td>
</tr>
<tr>
<td>thuu 53</td>
<td>caa 53</td>
<td>thuu-caa 5-53 ‘iron banner fixture’ (banner+iron)</td>
</tr>
<tr>
<td>3</td>
<td>53</td>
<td>3-53</td>
</tr>
<tr>
<td>31</td>
<td>53</td>
<td>3-53</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>5-5</td>
</tr>
<tr>
<td>see 53</td>
<td>yöö 3</td>
<td>see-yöö 5-5 ‘intellectual’ (knowledge+possessor)</td>
</tr>
<tr>
<td>phöö 3</td>
<td>mi 3</td>
<td>phöö-mi 3-5 ‘Tibetan’ (Tibet+person)</td>
</tr>
<tr>
<td>ree 31</td>
<td>see 3</td>
<td>ree-see 3-5 ‘cotton robe’ (cotton+robe)</td>
</tr>
<tr>
<td>cu 5</td>
<td>kēē 31</td>
<td>co-pkēē 5-53 ‘eighteen’ (eight+ten)</td>
</tr>
<tr>
<td>53</td>
<td>31</td>
<td>5-53</td>
</tr>
<tr>
<td>3</td>
<td>31</td>
<td>3-53</td>
</tr>
<tr>
<td>31</td>
<td>31</td>
<td>3-53</td>
</tr>
</tbody>
</table>
13 If extra time: Terena exercise

- Arawakan language from Brazil with 15,000 speakers. Bendor-Samuel 1970, 1966, which transcribe NCs differently.

❓ Propose underlying forms for the first- and second-person affixes.

<table>
<thead>
<tr>
<th>Terena</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>e'moʔu</td>
<td>'his word'</td>
</tr>
<tr>
<td>'ayõ</td>
<td>'my word'</td>
</tr>
<tr>
<td>'owoku</td>
<td>'his house'</td>
</tr>
<tr>
<td>'ahyaʔaʃo</td>
<td>'he desires'</td>
</tr>
<tr>
<td>'piho</td>
<td>'he went'</td>
</tr>
<tr>
<td>'tuti</td>
<td>'his head'</td>
</tr>
<tr>
<td>'nokone</td>
<td>'his need'</td>
</tr>
<tr>
<td>o'topiko</td>
<td>'he cut down'</td>
</tr>
<tr>
<td>'ayõ</td>
<td>'his brother'</td>
</tr>
<tr>
<td>ku'rikena</td>
<td>'his peanut'</td>
</tr>
<tr>
<td>'piho</td>
<td>'he went'</td>
</tr>
<tr>
<td>'nene</td>
<td>'his tongue'</td>
</tr>
<tr>
<td>'xerere</td>
<td>'his side'</td>
</tr>
<tr>
<td>'paho</td>
<td>'his mouth'</td>
</tr>
</tbody>
</table>

❓ Let’s play with AGREE and ALIGN constraints.

To sum up

- There may be further structure within features (feature geometry)
- Not all segments are specified for all features
- Maybe locality of phonological processes is not just abstract (tier-adjacency), but totally concrete: an autosegment is a phonetic gesture that extends over a continuous span.
- We should think not just about the acoustics (do we hear a vowel between those Cs? do we hear a consonant that is underlying?) but also about the articulation underlying them.

Next time: turning to upward interfaces (phonology-morphology interface)

- Prosodic morphology
- Maybe some phonology & morphology revisited

(Rose & Walker 2004), (Zuraw 2002), (Hansson 2001)
References
Meredith, Scott. 1990. Issues in the Phonology of Prominence. MIT.