1. **Geminate inalterability**

First, note that the first half of a geminate often behaves differently from other consonants (see, e.g., Hayes (1986a)\(^1\)):

- Japanese: non-nasal coda is OK if first half of a geminate
- Persian: \( v \rightarrow w \) / V __ \{C, #\} unless first half of geminate
  
  /nov+ru:z/ \rightarrow [nowru:z] ‘New Year’
  
  /d\(\text{\textasciitilde}\ae v\)/ \rightarrow [d\(\text{\textasciitilde}\ae w\)] ‘barley’
  
  but [\(\text{\textasciitilde}\ae \text{\textasciitilde}\text{\textasciitilde}\ae\)] ‘first’, [qolo\(\text{\textasciitilde}\ae \text{\textasciitilde}\ae\)] ‘exaggeration’

This is explainable using a C-V skeleton:

\[
|   |   \ | \ | \ \\
| g\ a\ k\ o\ o|
| V\ C\ C\ V\ C|
|   |   \ | | |
| æ\ v\ æ\ l|
\]

(escapes prohibition on [+cons, –nas] unless followed by [–cons])

But it would also be explainable with linear representations, if we allow the feature [long] (how?).

Last time I was confused about [qolo\(\text{\textasciitilde}\ae \text{\textasciitilde}\ae\)] ‘exaggeration’. In a nutshell, Hayes’ proposal is that association lines in the structural description of the rule of \( v \rightarrow w \) are interpreted exhaustively—that is, the association lines shown for [] and __ must be the only association lines between those melodic positions and the skeletal tier (this explains also why the rule doesn’t apply after long vowels):

\[
\sigma
\]

/ \ / \ / \ / \ / \ \\
| V\ C|
|   |   |   |   |
\[
\text{v} \rightarrow w / [ ] __
\]

[But see Schein & Steriade 1986 for a different view—they propose that any time there is a structure \( n \), a rule can alter \( n \) only if both \( a \) and \( b \) satisfy the structural description of the rule.]

\[
/ \| /
| a\ b|
\]

---

2. Behavior of assimilated structures

Consider the linear versions of two rules from Toba Batak, from Hayes (1986b):²

\[ \text{glottal formation} \left[ \begin{array}{c} -\text{son} \\ -\text{cont} \end{array} \right] \rightarrow ? / _{-} _{\text{C}} \]

\[
\begin{align*}
\text{/ganup tawn/} & \rightarrow \text{ganuʔ tawn} \quad \text{‘every year’} \\
\text{/dohət laʔi/} & \rightarrow \text{dohəʔ laʔi} \quad \text{‘and the hen-harrier’} \\
\text{/halak batak/} & \rightarrow \text{halaʔ batak} \quad \text{‘Batak person’} \\
\text{/lap piŋgoʔ/} & \rightarrow \text{laʔ piŋgoʔ} \quad \text{‘wipe off the ear’} \\
\text{/maŋihoʔ tawn/} & \rightarrow \text{maŋihuʔ tawn} \quad \text{‘according to the year’} \\
\text{/halak korean/} & \rightarrow \text{halaʔ korean} \quad \text{‘Korean person’}
\end{align*}
\]

\[ \text{denasalization} \left[ \begin{array}{c} _{\text{C}} \\ +\text{nas} \end{array} \right] \rightarrow \left[ \begin{array}{c} -\text{nas} \\ -\text{voice} \end{array} \right] / _{-} _{\text{C}} \]

\[
\begin{align*}
\text{/maŋihoŋ tawak/} & \rightarrow \text{maŋihoŋ tawak} \quad \text{‘drink palm wine’} \\
\text{/maŋan pulpen/} & \rightarrow \text{maŋan pulpen} \quad \text{‘or a pen’} \\
\text{/holom saʔtik/} & \rightarrow \text{holom saʔtik} \quad \text{‘somewhat dark’} \\
\text{/maŋanom pirin/} & \rightarrow \text{maŋanom pirin} \quad \text{‘bury a dish’} \\
\text{/mamereŋ kalabbu/} & \rightarrow \text{mameresk kalabbu} \quad \text{‘look at a mosquito net’}
\end{align*}
\]

○ Order? (we determined last time that glottal formation must precede denasalization, for a counterfeeding interaction)

○ Glottal formation applies within morphemes—it’s not a derived-environment rule—yet it doesn’t apply to a morpheme-internal geminates—can we patch up the linear account to explain this?

\[
\begin{align*}
\text{/diktaʔor} & \rightarrow \text{diʔtator} \quad \text{‘dictator’} \\
\text{/roʔtrɔt/} & \rightarrow \text{roʔtrɔt} \quad \text{‘to knock down’} \\
\text{but} & \\
\text{/dekke/} & \rightarrow \text{dekke} \quad \text{‘fish’} \\
\text{/pittu/} & \rightarrow \text{pittu} \quad \text{‘door’} \\
\text{and} & \\
\text{/aŋsa/} & \rightarrow \text{aksə} \quad \text{‘fish’}
\end{align*}
\]

○ What about these cases across a morpheme boundary?

\[
\begin{align*}
\text{/adat+ta} & \rightarrow \text{adatə} \quad \text{‘our custom’} \\
\text{/suddut+ta/} & \rightarrow \text{suddatə} \quad \text{‘our generation’}
\end{align*}
\]

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³ How do we know this is the underlying form? In careful speech, all these rules are optional.
⁴ How do we know this is the underlying form? In careful speech, all these rules are optional.
Hayes’s argument: yes, we can capture the Toba Batak facts with linear rules. But, in the linear theory a glottalization rule that fails to apply in just these environments...
- where n-assimilation (not shown) or denasalization has applied
- to a tautomorphemic geminate
...is not given a higher value than a rule that applied in some other combination of circumstances.

Hayes contends that treating tautomorphemic geminates and clusters that have undergone assimilation the same way—resistant to rules that would apply to the first half; compare to underlying $C_i+C_i$ sequences or non-geminate CC sequences where no rule has applied—is a common, highly valued behavior. Therefore, we prefer the theory that can express this situation simply.

*In order to reproduce Hayes’ result, let’s assume that the features are split onto two tiers:*
- **central tier (lips and tongue):** [sonorant, continuant, labial, coronal, dorsal, anterior, hi, ...]
- **peripheral tier (velum and larynx):** [nasal, voice, spread glottis, constricted glottis]

*How could we write the two rules autosegmentally?*

*Why do they fail to apply just where they do?*

Moral: assimilation creates a special relationship between two segments involved, which influences how they behave with respect to later rules. Autosegmental representations can capture this directly, but linear representations can’t (a grammar that displays the phenomenon is valued no more highly than a grammar that doesn’t).
3. **Long-distance effects**

Sibilant harmony in Navajo (Na-Dene language from the U.S. with about 149,000 speakers; see Andy Martin’s M.A. thesis)

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

\[
\begin{align*}
/si+\tilde{f}i\ddagger d/ & \rightarrow \tilde{\jmath}i+\tilde{f}i\ddagger d & \text{‘he is stooping over’} \\
/si+\ddagger t\ddagger e;3/ & \rightarrow \tilde{\jmath}i+\ddagger t\ddagger e;3 & \text{‘they two are lying’} \\
/ji+s+l\ddagger e;3/ & \rightarrow ji+s+\ddagger t\ddagger e;3/ & \text{‘it was painted’} \\
/ji+s+t\ddagger iz/ & \rightarrow ji+s+t\ddagger iz/ & \text{‘it was spun’} \\
/t\ddagger s\ddagger e+t\ddagger j\ddagger e;3/ & \rightarrow \ddagger t\ddagger s\ddagger e+t\ddagger j\ddagger e;3/ & \text{‘amber’} \\
/t\ddagger j\ddagger a:+n\ddagger e;3/ & \rightarrow t\ddagger s\ddagger a:+n\ddagger e;3 & \text{‘mule’}
\end{align*}
\]

○ 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’s UR, assuming underspecification of nonstridents for [anterior]—IPA symbols stand for the rest of the feature matrix (not including [anterior], which has been put on its own tier):

\[
\begin{array}{c|c|c|c|}
\text{[-ant]} & \text{[+ant]} \\
\hline
\text{C V V} & \text{+ C V V C} \\
\hline
\text{tS a n é Z} \\
\end{array}
\]

○ Propose an autosegmental rule of strident harmony

---

5 How do we know this is the underlying form? In careful speech, all these rules are optional.
4. **Phonetic basis of long-distance effects?**

Some researchers have argued most long-distance assimilations are, articulatorily, local. (See, for instance, Adamantios Gafos (1999) *The Articulatory Basis of Locality in Phonology*. New York: Garland.)

For instance, in a rounding-harmony system \((V \rightarrow \{\text{round}\} / \_C_0\left[\text{\text{C\text{round}}}\right])\), we could reasonably claim that (and test instrumentally whether) the \(C\)s that are skipped by the rule actually take on the lip-rounding value that spreads.

5. **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:

p. 23:

(13) Navajo sibilant pair agreement

![Graph showing sibilant pair agreement](image)

(There is an additional twist that I’ll refer you to the thesis for; it concerns how much of the agreement in compounds comes from alternation and how much is already there in the underlying forms.)
6. Feature geometry
We probably won’t talk about this again in the course, but you should know what it is.

We’ve seen, informally, that certain features seem to group together in their behavior. This is the justification for the abbreviation “place” ([labial, coronal, dorsal, anterior, distributed, hi, lo, back] and maybe some others), and for Hayes’ division of central vs. peripheral tier.

This clustering of feature behavior 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.

Example:

[anterior] can spread with all the place features
as in Malayalam (Dravidian language from India with about 36 million speakers)
   n → m / __ bilabials
   η / __ dentals
   n / __ alveolars
   η / __ palatals
   η / __ dorsals

[anterior] can spread with the other tongue-tip/blade feature
English t,d,n ([+anterior, –distributed])
   → dental / __ θ, δ ([+anterior, +distributed])
   → palatoalveolar / __ tʃ, dʒ, ʃ, ʒ ([–anterior, +distributed])
   → retroflex\(^6\) / __ r ([–anterior, –distributed])

[anterior] can spread on its own
Navajo sibilant harmony
   s → ʃ / __ X₀ ʃ
   ʃ → s / __ X₀ s

This suggests a hierarchical organization of features:

\[ \begin{align*}
X \\
| \quad \text{place} \\
| \quad \text{labial coronal (=tongue blade/tip)} \\
| \quad \text{dorsal} \\
| \quad \text{anterior distributed}
\end{align*} \]

\( ^6\) for speakers who have a retroflex r
Here’s a proposed geometry, from McCarthy 1988 (more or less)—the top, “root” node, is what attached to the skeletal tier (or to the syllable structure, for skeleton-less theories):

![Feature Geometry Diagram](attachment:image.png)

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 $s \rightarrow h / \_ \_ \_ \_ \_ \_ \text{syl}$
  English dialects, some Ethiopian languages $C^\theta \rightarrow ?$
- laryngeal neutralization: Korean codas
- OCP effects (can show up as inalterability effect, indicating a single node, multiply linked; or as restrictions on allowable sequences)

OCP example

**Chickasaw**
Muskogean language with fewer than 1,000 speakers in Oklahoma and Los Angeles

\[
\begin{array}{ll}
V & \left[ \begin{array}{c}
C \\
+\text{nas}
\end{array} \right] \rightarrow \left[ \begin{array}{c}
+\text{long} \\
+\text{nas}
\end{array} \right] / \_ \_ \_ \_ \_ \_ \text{syl}
\end{array}
\]

But, rule doesn’t apply when the nasal shares place of articulation with a following C (e.g. ampa).

**7. Vowels vs. consonants in feature geometry**

Do Vs and Cs share features? Sometimes Vs and Cs interact, sometimes they don’t.

Examples of V-C interaction
- **Spreading**: in many languages, velar and labial consonants can become coronal before front vowels (so are front vowels coronal?)
  *Maltese*: certain vowels become [i] before coronal consonants
- **OCP**: in many languages, sequences of featurally-similar Vs and Cs are prohibited. 
  *Cantonese*: a round V may not occur after $k^w$ or $k^{hw}$; a round V may not be followed by a labial coda C.

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

You will sometimes see proposals along these lines (e.g., Clements & Hume)

![Diagram](attachment:image.png)

This explains why single consonantal features can skip vowels (as [anterior] in Navajo), but the whole Place node seems never to skip vowels (what would it look like to have a rule that did that?)