So far we have introduced just one mechanism to express phonological generalizations: the rewrite rule in which a sound or sound sequence is altered on the basis of the phonological, morphological, or syntactic context. But there are many generalizations that are part of a speaker's knowledge of language which are more properly expressed by constraints that state static generalizations over the lexicon, the surface output, or both. These constraints may trigger or block the application of phonological rules.


<table>
<thead>
<tr>
<th>kak-u</th>
<th>kusa</th>
<th>sato</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘write’</td>
<td>‘grass’</td>
<td>‘village’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>kago</th>
<th>kaze</th>
<th>kado</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘basket’</td>
<td>‘wind’</td>
<td>‘corner’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>gake</th>
<th>das-u</th>
<th>buta</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘cliff’</td>
<td>‘take out’</td>
<td>‘pig’</td>
</tr>
</tbody>
</table>

\[ \text{*gVg, *dVz, *bVd} \]

- Lyman’s Law: two (or more) voiced obstruents are not permitted in a single stem
- A rewrite rule is not feasible since there is no unique output for a given input: a /gVg/ input could be transformed into a variety of outputs: kVg, gVk, kVk, gVŋ,
- Thus, we need a constraint on morpheme shape

\[ \text{^[sonorant, + voice] .... [sonorant, + voice]} \]

[2] *NT

- The contrast between voiced and voiceless obstruents is suspended after a nasal in Yamato
- Only voiced obstruents are found

<table>
<thead>
<tr>
<th>tombo</th>
<th>kangae</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘dragonfly’</td>
<td>‘thought’</td>
</tr>
</tbody>
</table>

- Alternations where an underlying voiceless stop is voiced after a nasal
• It appears that the rule of post-nasal voicing applies to satisfy the *NT constraint

[3] redaku (sequential voicing) and Lyman’s Law

• The initial obstruent of the second (head) element in a compound is voiced if Yamato (cf. English mark-s-man, German Liebe-s-brief, etc)

| se     | ‘back’   | neko-ze    | ‘hunchback’|
| kaki   | ‘writing’| yoko-gake  | ‘horizontal writing’|
| tosi   | ‘year’   | hebi-dosi  | ‘snake year’|
| sono   | ‘garden’ | hana-zono  | ‘flower garden’|

• Lyman’s Law blocks rendaku voicing

| kado   | ‘corner’ | hito-kado  | ‘first point’|
| sabi   | ‘rust’   | aka-sabi   | ‘red rust’|
| tubo   | ‘jar’    | tya-tubo   | ‘tea jar’|
| kurage | ‘jellyfish’| denki-kurage | ‘electric jellyfish’|
| tokage | ‘lizard’ | ao-tokage  | ‘green lizard’|

• Redundant voicing after a nasal also blocks Lyman’s Law
• If voicing after a nasal assigned by a rule then Lyman’s Law holds over the output of that rule
  kangae ‘thought’ sirooto-kangae ‘layman’s idea’
• Conclusion: rules controlling alternations can be blocked (e.g. rendaku) or activated (post-nasal voicing) in order to conform to a constraint (Lyman’s Law, *NT) that governs “static” generalizations of the lexicon
• Outstanding research problem: how do we formalize the relation between rules and constraints?

[4] Lardil

• Minimal word requirement: all words at least two syllables in length

* PW (Prosodic Word)
  | σ (syllable)
• Blocks apocope rule

<table>
<thead>
<tr>
<th>Blocks apocope rule</th>
<th>mayar</th>
<th>mayara-n</th>
<th>mayara-ɾ</th>
<th>rainbow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mela</td>
<td>mela-n</td>
<td>mela-ɾ</td>
<td>sea</td>
</tr>
<tr>
<td></td>
<td>wiṭe</td>
<td>wiṭe-n</td>
<td>wiṭe-ɾ</td>
<td>interior</td>
</tr>
</tbody>
</table>

• Triggers augmentation

| Triggers augmentation | yaka | yak-in | yak-uŋ | fish |

• Grammar with simplest rules should allow the following derivations

\[
\begin{align*}
/\text{wiṭe}/ & \quad /\text{yak}/ \\
\text{wiṭa} & \quad \text{yaka} \\
\end{align*}
\]

V \rightarrow \emptyset / ___ #
\text{Ø} \rightarrow \sigma / \sigma ___ #

• Some notion of minimal departure from input to satisfy the constraint seems necessary
• Let asterisk denote a change, check denote no change

\[
\begin{align*}
/\text{wiṭe}/ & \quad *[σ]PW \quad \text{Apocope} \quad \text{Epenthesis} \\
\text{wiṭe} & \quad \checkmark \quad \checkmark \quad \checkmark \\
\text{wiṭ} & \quad * \quad * \quad \checkmark \\
\text{wiṭa} & \quad \checkmark \quad * \quad * \\
/\text{yak}/ & \quad \checkmark \quad \checkmark \quad \checkmark \\
\text{yaka} & \quad \checkmark \quad \checkmark \quad * \\
\end{align*}
\]

• In the first case \text{wiṭe} has the fewest violations and so is best
• In the second case \text{yak} and \text{yaka} tie so we must prioritize the constraints so that *[σ]PW dominates Epenthesis or assigns a higher penalty
• Rendaku

\[
\begin{align*}
/\text{sirooto-kanKae}/ & \quad \text{Rendaku} \quad \text{Lyman’s Law} \quad *[NT] \\
\text{sirooto-kangae} & \quad * \quad \checkmark \quad \checkmark \\
\text{sirooto-gangae} & \quad \checkmark \quad * \quad \checkmark \\
\text{sirooto-gankae} & \quad \checkmark \quad \checkmark \quad * \\
\end{align*}
\]

• In order for \text{sirooto-kangae} to be the output Lyman’s Law and *[NT] must have higher priority (greater weight) than Rendaku
another motivation for constraints is that many rules can be interpreted as alternative repairs to
the same illicit sound sequence or structural configuration

- Cross-linguistic typology (McCarthy 2002)

\*N\(\frac{\lambda}{\rho}\) avoid a nasal plus voiceless consonant sequence

i. denasalization

Toba Batak (Hayes 1986)

/\textsl{holom sa\text{"o}tik} / > holop sa\text{"o}tik ‘somewhat dark’

ii. nasal deletion

Standard Malay Kelantan Malay
pintu pitu ‘door’
hampas hapas ‘husk’

iii. voicing consonant

Japanese

Nonpast past
tabe-ru tabe-ta ‘eat’
sin-u sin-da ‘die’
yom-u yon-da ‘read’

typology
\[ \begin{array}{cccc}
\text{NC} & \ [+\text{nasal}] & \rightarrow & \ [+\text{nasal}] & \ N & \rightarrow & \Ø & \ [+\text{voice}] & \rightarrow & \ [+\text{voice}] \\
\text{Toba-Batak} & - & + & - & - \\
\text{K-Malay} & - & - & + & - \\
\text{Jap} & - & - & - & + \\
\text{English} & + & - & - & - \\
\end{array} \]

- In same language (aka “conspiracies”)

Ilokano hiatus resolution (Hayes & Abbad 1989)

\*V V

High vowel devocalizes to glide
Low vowel inserts a glottal stop since low vowel glide not possible

\textbf{Infin} \quad \textbf{focus}
gatan \quad gatan-\text{-en} ‘buy’
san\text{"i}t \quad san\text{"i}t-\text{-en} ‘cry’
babawi \quad babawj-\text{-en} ‘regret’
masahe \quad masahj-\text{-en} ‘massage’
maneho \quad manehw-\text{-an} ‘drive’
basa \quad basa-\text{-en} ‘read’
saka \quad pag-saka-\text{-en} ‘walk barefoot’
[6] Phonotactic constraints: restrictions on the possible shapes of words

- Judgements of wellformedness (Halle 1962)
  
  $brick$ occurring
  
  $blick$ nonoccurring but possible
  
  $bnick$ nonoccurring but impossible

- gradient judgments among nonoccurring
  
  $bnick > bdick, bzick$

- is this judgment derived from exisiting lexicon or does it involve some UG prior/bias?

- Albright (2008)
  
  ➢ 30 monosyllabic nonwords
  
  ➢ subjects rate on 7 point scale (“impossible….fine English word”)
  
  ➢ word pronounced to make sure proper stimulus elicited
  
  ➢ a bias for rising sonority clusters obtained: $bw > bn > bz, bd$
  
  ➢ one model for judging similarity to existing words (Generalized Neighborhood model) fails to distinguish among the unattested clusters
  
  ➢ AA proposes model that invokes natural feature classes: $bw$ and $bn$ judged better than $bz, bd$ because they fall under a generalized $bl, br = [-contin] + [+sonorant]$ schema
  
  ➢ But they also fall under $[-contin] + [+consonantal]$
  
  ➢ Why is $[-contin] + [+sonorant]$ better? Possible answer: greater perceptibility of stop cues

[7] Constraints in Loanword Adaptation

Mandarin Chinese (Hsieh et al 2009)

- CVC syllable but coda restricted to $[w,j,n,ŋ]$
- $[a]$ and $[α]$ in complementary distribution
- $[an] and [an]$ but $*[an], *[αn]$
- English loans contain all four combinations of $\{æ, α\} + \{n, ŋ\}$
- In case of conflict what decides?

<table>
<thead>
<tr>
<th>English</th>
<th>Mandarin</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$[æn]$</td>
<td>$[an]$</td>
<td>anchovy</td>
<td>an.chou</td>
<td>31/36</td>
</tr>
<tr>
<td>$[αŋ]$</td>
<td>$[αŋ]$</td>
<td>Congo</td>
<td>gang.uo</td>
<td>5/7</td>
</tr>
<tr>
<td>$[an]$</td>
<td>$[αŋ]$</td>
<td>monsoon</td>
<td>maŋ.xun</td>
<td>24/24</td>
</tr>
<tr>
<td>$[æŋ]$</td>
<td>$[an]$</td>
<td>tank</td>
<td>tan.e</td>
<td>9/13</td>
</tr>
</tbody>
</table>
• Conflict resolved in favor of phonetically more salient vowel over phonologically contrastive nasal place feature

[8] Cantonese loans from English (Silverman 1993)

9. final consonants

| Stops:     | sharp      | [sap] |
|           | cut        | [kAp] |
|           | Jack       | [tsik] |
| Nasals:    | jam        | [tsem] |
|           | gin        | [tsin] |
|           | bowling    | [poulip] |
| s:         | lace       | [leisi] |
|           | office     | [ofisi] |

clusters:

| band       | [pan]    | shaft     | [sap]    | notes    | [mksi] |
| friend     | [fen]    | post      | [pousi]  | tips     | [tipsi] |
| pump       | [pum]    | cast      | [kasi]   | licence  | [laisun] |
| stamp      | [sitam]  | toast     | [tosi]   | inch     | [ints] |
| sink       | [siuj]   | waist     | [wesi]   |          |        |
| foul       | [fAu]    | fight     | [fAi]    |          |        |
10. initial cluster reduction

- disyllabic minimal word preference
- no complex onsets or codas
- sC clusters repaired by epenthesis while CR repaired by deletion of liquid—a contrast in contextual saliency
- but, liquid is retained if output would fall below two syllables (Silverman)
- data from Chan & Kwok ’82 and other sources

<table>
<thead>
<tr>
<th>CR deleted</th>
<th>CR preserved</th>
</tr>
</thead>
<tbody>
<tr>
<td>printer</td>
<td>p'en.ta S 92</td>
</tr>
<tr>
<td>broker</td>
<td>puk.k'a</td>
</tr>
<tr>
<td>floorshow</td>
<td>fowsov</td>
</tr>
<tr>
<td>freezer</td>
<td>fi.sa</td>
</tr>
<tr>
<td>place</td>
<td>p'ei.si</td>
</tr>
<tr>
<td>professor</td>
<td>pou.fu.sa</td>
</tr>
<tr>
<td>high-class</td>
<td>hai.k'a.si</td>
</tr>
<tr>
<td>blender</td>
<td>p'en.ta S '92</td>
</tr>
<tr>
<td>strawberry</td>
<td>sitawpeley Y '93</td>
</tr>
</tbody>
</table>

proton          | pow.ton S 92    |
price           | p'ay.si S 92    |

exceptions

<table>
<thead>
<tr>
<th>friend</th>
<th>fen</th>
<th>dacron</th>
<th>dik.k'ek.loηη</th>
</tr>
</thead>
<tbody>
<tr>
<td>gross</td>
<td>lо</td>
<td>brandy</td>
<td>putt.lan.tei</td>
</tr>
<tr>
<td></td>
<td></td>
<td>clutch</td>
<td>kik.lik.tsi</td>
</tr>
</tbody>
</table>

striking contrasts

- fluke > fuluk vs. place > pheisi and blonde > pilan vs. blender > phenta