Finnish Consonant Gradation is a Stochastic Phonotactic Constraint

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Finnish Consonant Gradation

Lenition

/p, t, k/ weaken in the onsets of closed syllables:

/mato-n/  'ma.don  ‘worm-GEN’

/aurinjko-n/  'au.rinj.ŋon  ‘sun-GEN’
Finnish Consonant Gradation

Lenition

/p, t, k/ weaken in the onsets of closed syllables

/mato-n/ 'ma.don ‘worm-GEN’

/auriŋko-n/ 'au.rinŋ.ŋon ‘sun-GEN’

Degemination

/pp, tt, kk/ shorten in the onsets of closed syllables

/matto-n/ 'ma.ton ‘mat-GEN’

/ulappa-n/ 'u.la.pan ‘open.sea-GEN’
Analogical extensions (Hakulinen 1961:60, Kiparsky 2003)

Both alternations have spread outside their historical environment

- from onsets of closed syllables (\( .\text{CVC} \))
- to onsets of stressed heavy syllables (\( .\text{CVV} \)).
Analogical extensions (Hakulinen 1961:60, Kiparsky 2003)

Both alternations have spread outside their historical environment

- from onsets of closed syllables (.CVC)
- to onsets of stressed heavy syllables (.CVV)

where

- they often remain variable (strong ~ weak)
- morphology seems to matter (e.g., case differences)
- lenition and degemination don’t work alike
Puzzle 1: Apparent morphological conditions on lenition

Lenition is possible in the partitive and genitive plural...

(a) /auriŋko-i-ta/  
?‘auriŋ ɪŋoi.ta ~ 'auriŋ.ko.ja  
/Lauri Viita/  
/sun-PL-PAR’

/baauriŋko-i-ten/  
?‘auriŋ ɪŋoi.den ~ 'auriŋ.ko.jen

... but not in the essive and illative plural:

(b) /auriŋko-i-na/  
*‘auriŋ ɪŋoi.na / 'auriŋ.koi.na  
/sun-PL-ESS’

/baauriŋko-i-hVn/  
*‘auriŋ ɪŋoi.hin / 'auriŋ.koi.hin  
/sun-PL-ILL’
Puzzle 2: No morphological conditions on degemination

Degemination is optionally possible everywhere:

(a) /logiikka-i-ta/                ‘logic-PL-PAR’
    ḫlo.giiˌkoj.ta ~ ḫlo.giik.ko.ja
/logiikka-i-ten/                  ‘logic-PL-GEN’
    ḫlo.giiˌkoj.den ~ ḫlo.giik.ko.jen

(b) /logiikka-i-na/                ‘logic-PL-ESS’
    ḫlo.giiˌkoj.na ~ ḫlo.giik.ko.ja
/logiikka-i-hVn/                  ‘logic-PL-ILL’
    ḫlo.giiˌkoj.hin ~ ḫlo.giik.ko.ji.hin
Summary

• Puzzle 1:
  Why does morphological case matter (e.g., PAR vs. ESS)?
  Answer: In fact, it doesn’t. It is all phonology.

• Puzzle 2:
  Why do these effects only emerge in lenition?
  Answer: This is morphology (stems vs. words).

• Puzzle 3:
  Where does the variation come from?
  Answer: Probabilistic ranking/weighting.
The constraints

$\Sigma = \text{prominent syllable, i.e., either stressed or heavy}$
$H = \text{heavy syllable}$

The lenition constraint:

$\Sigma[\text{−voice}]\Sigma \quad \text{‘Assign a violation to a short voiceless consonant between adjacent prominent syllables.’}$

The degemination constraint:

$\Sigma H C C H \quad \text{‘Assign a violation to a long consonant or a consonant cluster between adjacent heavies.’}$
Consonant gradation is a phonotactic constraint

'X.H.L.X
'X.H.,H.X

'ma.nee.re.ja ~ 'ma.nee.rei.ta ‘mannerism-PL-PAR’

'ma.nee.se.ja ~ ??'ma.nee.sei.ta ‘manège-PL-PAR’

*Σ[−voice]Σ
Consonant gradation is a phonotactic constraint

\[ \text{\textbf{\textmd{Consonant gradation is a phonotactic constraint}}}
\]

\[ 'X.H.L.X \quad \quad 'X.H.ˌH.X \]

\[ '\text{ma.nee.re.ja} \sim '\text{ma.neeˌrei.ta} \quad \text{\textmd{mannerism-PL-PAR}} \]

\[ '\text{ma.nee.se.ja} \sim '\text{ma.neeˌsei.ta} \quad \text{\textmd{manège-PL-PAR}} \]

\[ *\Sigma[\text{−voice}]\Sigma \]

\[ 'X.H.L.X \quad \quad 'X.H.ˌH.X \]

\[ '?\text{sai.raa.lo.ja} \sim '\text{sai.raaˌloi.ta} \quad \text{\textmd{hospital-PL-PAR}} \]

\[ '\text{a.lus.to.ja} \sim '?\text{a.lusˌtoi.ta} \quad \text{\textmd{base-PAR-PL}} \]

\[ *\text{HCCH} \]
What are your intuitions?

(a) huokailuita  ?huokaisuita  ’sighing’
  kirmailuita  ?kirmaisuita  ’sprinting’

(b) tehtailuita  ’manufacturing’
  mahtailuita  ’ostentation’
  puuhailuita  ’tinkering’

(c) ?kirkaisuita  ’screaming’
  ?potkaisuita  ’kicking’
  ?karjaisuita  ’roaring’
Preliminary statistical evidence

Preliminary support from an internet-based corpus of partitive plurals collected on April 12, 2005:

- 6,148 noun stems
- 9,280,395 partitive plural tokens, e.g., maneereja ~ maneereita

cluster = TRUE if the stem penult-ultima interlude has a consonant cluster in the t-retention form, else cluster = FALSE.

voice = TRUE if the stem penult-ultima interlude has no voiceless consonants in the t-retention form, else voice = FALSE.
Regression modeling

A logistic regression model (R Core Team 2019):

- **Response:**
  
  **Partitive plural variant:** *t*-deletion vs. *t*-retention

- **Predictors:**
  
  **voice** \(= \Sigma [\pm \text{voice}] \Sigma\)  
  **cluster** \(= \text{H[CC/no CC]} \text{H}\)

- **Controls:**
  
  **rv.del:** syllable weight and vowel height  
  
  (Anttila, Borgeson, and Magri 2019)  
  **total.freq.log:** lexical frequency (logged)
### Model summary

```r
corr3.glm <- glm(cbind(finndata$del.freq, finndata$ret.freq) ~
    rv.del + total.freq.log + cluster + voice,
    data = finndata, family = binomial(link="logit"))
```

|         | Estimate  | Std. Error | z value | Pr(>|z|) |
|---------|-----------|------------|---------|----------|
| (Intercept) | -6.140e+00 | 1.362e-02  | -450.74 | <2e-16 *** |
| rv.del    | 1.413e-02  | 1.944e-05  | 726.92  | <2e-16 *** |
| total.freq.log | 4.163e-02 | 4.710e-04  | 88.37   | <2e-16 *** |
| clusterTRUE | 4.544e+00  | 5.866e-03  | 774.67  | <2e-16 *** |
| voiceTRUE | -2.384e+00 | 4.366e-03  | -546.07 | <2e-16 *** |
Interpretation

(a) In general, $t$-retention is favored (= faithfulness), but $[-\text{voice}]$ disfavors it, preferring $t$-deletion.

$[+\text{voice}]: \text{'ma.nee.\textit{rei.ta}}$ favored, $\text{'ma.nee.\textit{re.ja}}$ disfavored

$[-\text{voice}]: \text{'ma.nee.\textit{se.ja}}$ favored, $\text{'ma.nee.\textit{sei.ta}}$ disfavored

violates $*\Sigma [-\text{voice}] \Sigma$
Interpretation

(a) In general, $t$-retention is favored (= faithfulness), but $[-\text{voice}]$ disfavors it, preferring $t$-deletion.

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violates $*\Sigma [−\text{voice}] \Sigma$

(b) In general, $t$-retention is favored (= faithfulness), but CC-cluster disfavors it, preferring $t$-deletion.

No cluster: $\text{ˈsai.raa.ˌloi.ta} \text{ favored, ˈsai.raa.lo.ja} \text{ disfavored}$

CC-cluster: $\text{ˈa.lus.to.ja} \text{ favored, ˈa.lus.ˌtoi.ta} \text{ disfavored}$

violates $*\text{HCCH}$
Puzzle 1: Why are partitive and essive different?

This is a side effect of SUFFIXAL CONSONANT GRADATION: a short voiceless stop /p, t, k/ is deleted outside a metrical foot (Keyser and Kiparsky 1984, Kiparsky 2003, Anttila 2012).

/maa-i-tA/ → (mái.ta) ‘land-PL-PAR’
/talo-i-tA/ → (tá.lo)ja ‘house-PL-PAR’
/korjaamo-i-tA/ ‘repair shop-PL-PAR’
   → (kór.jaa)(mòi.ta) ~ (kór.jaa.mo)ja

The deletion applies to /t/ (partitive), but not to /n/ (essive).
The essive vs. partitive difference

Why optional lenition in the partitive, but not in the essive?

?(au.rin)(ŋoi.ta) ~ (au.rin.ko)ja  ‘sun-PL-PAR’
*(au.rin)(ŋoi.na) ~ (au.rin.koi)na  ‘sun-PL-ESS’
The essive vs. partitive difference

Why optional lenition in the partitive, but not in the essive?

?(au.rin)(ŋoi.ta) ~ (au.rin.ko)ja ‘sun-PL-PAR’
*(au.rin)(ŋoi.na) ~ (au.rin.koi)na ‘sun-PL-ESS’

Answer:
• We can leave /n/ outside a foot, but we can’t leave /t/.
• Instead, we must scramble for less perfect options:
  (a) Keep the suffixal /t/ and do gradation: ?(au.rin)(ŋoi.ta)
  (b) Delete the suffixal /t/: (au.rin.ko)ja
The essive vs. partitive at the stem level: /aurinko/ ‘sun’

<table>
<thead>
<tr>
<th></th>
<th>1. /aurinko-i-na/</th>
<th>2. /aurinko-i-ta/</th>
<th>Outcome:</th>
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<td>(‘au.rin)(,koi.na)</td>
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<td>Stressed /oi/ is heavy, unstressed /oi/ is light (Keyser and Kiparsky 1984).</td>
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/n/ survives outside of a foot, /t/ deletes.

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Outcome: Two partitives in free variation, deletion preferred.

Assumption: Stressed /oi/ is heavy, unstressed /oi/ is light (Keyser and Kiparsky 1984).
Puzzle 2: Why does this only happen in lenition?

This time the difference is truly **morphological**:

- \*Σ[−voice]Σ (= lenition) is located at the stem level.
- \*HCCCH (= degemination) is located at the word level.
Puzzle 2: Why are lenition and degemination different?

This time the difference is truly morphological:

- $\Sigma[-\text{voice}]\Sigma$ (= lenition) is located at the stem level.
- $\text{HCCH}$ (= degemination) is located at the word level.

Prima facie evidence: Degemination counterfeeds lenition.

\[
\begin{array}{l}
/mato\text{-}n/ \quad \text{‘worm-GEN’} \\
\text{Stem level:} \quad \text{'ma.don}\quad \text{-}\quad \text{-} \\
\text{Word level:} \quad \text{-}\quad \text{'ma.ton}\quad \text{‘mat-GEN’} \\
/\text{matto}\text{-}n/ \quad \text{‘mat-GEN’} \\
\end{array}
\]
No degemination at the stem level: /mellakka/ ‘riot’

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<th>/mellakka-i-na/</th>
<th>*)t</th>
<th>*Σ[−voice]Σ</th>
<th>MAX(C)</th>
<th>ALIGN-L</th>
<th>ID(clos)</th>
</tr>
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<tr>
<td>a.</td>
<td>(mel.lak)(koi.na)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>b.</td>
<td>(mel.lak.koi)na</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>b.</td>
<td>(mel.lak.koi)ta</td>
<td>1!</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>c.</td>
<td>(mel.lak.ko)ja</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
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</table>

Here stem-level grammar simply takes care of footing. No lenition, no degemination.
No degemination at the stem level: /mellakka/ ‘riot’

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</tr>
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<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>b. (mel.lak.koi)na</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<table>
<thead>
<tr>
<th>2. /mellakka-i-ta/</th>
<th>*)t</th>
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<td></td>
<td>2</td>
</tr>
<tr>
<td>b. (mel.lak.koi)ta</td>
<td>1!</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. (mel.lak.ko)ja</td>
<td></td>
<td></td>
<td></td>
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<td>1</td>
</tr>
</tbody>
</table>

- Two of these forms further degeminate at the word level:
  1b.  *mel.lak.koi.na ~ mel.la.koi.na* (ESS) optionally
  2a.  *mel.lak.koi.ta / mel.la.koi.ta* (PAR) obligatorily

- At the word level we have two new sources of variation:
  faithfulness to stem-level feet (FAITH-Ft) and foot binarity (FTBIN) (Kiparsky 2003).

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Optional degemination at the word level

<table>
<thead>
<tr>
<th>(mel.lak)(koi.ta)</th>
<th>FTBIN</th>
<th>FAITH-Ft</th>
<th>*HCCH</th>
<th>MAX(C)</th>
<th>ALIGN-L</th>
<th>ID(clos)</th>
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<tr>
<td>(mel.lak)(koi.ta)</td>
<td></td>
<td></td>
<td>2!</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>♦ (mel.la(k)oi.ta)</td>
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<td></td>
<td>1</td>
<td></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>(mel.lak.ko)ja</td>
<td>1</td>
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<td></td>
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<td>♦ (mel.lak.ko)ja</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>♦ (mel.lak)(ko,j)a</td>
<td></td>
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<td>1</td>
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A somewhat unsettling discovery

This implies that degemination does not change syllable weight: it satisfies \(^*\text{HCCH}\), but keeps the preceding syllable heavy. In other words, the shortened geminate (\(k\)) is ambisyllabic.

\[
\begin{align*}
\text{\(e\)}(\text{mel.la}(k)\text{oi.ta}) &= \text{\('H.H._1H._L\) \ (not \ 'H.L._1H._L)} \\
\text{\(e\)}(\text{mel.la}(k)\text{oi.na}) &= \text{\('H.H._1H._L\) \ (not \ 'H.L._1H._L)}
\end{align*}
\]

We learn that Finnish has “short geminates” that are moraic and ambisyllabic. This is good as it explains the puzzling opaque degemination in \(\text{'ha.tu.ton} \ ‘\text{hatless}’\) (cf. Kiparsky 1993).

\[
\text{\(e\)}(\text{ha(t)u(t)on}) = \text{\('H.H.H\) \ (not \ 'L.L.H)}
\]
Conclusion: What is consonant gradation (CG)?

• In modern Finnish, CG has become a PHONOTACTIC CONSTRAINT that applies as a filter, beyond segmental alternations.
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• CG targets the consonantal interlude between two PROMINENT SYLLABLES: \( \Sigma.\Sigma \) at the stem level, H.H at the word level.
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- Lenition happens at the STEM LEVEL, degemination happens at the WORD LEVEL.
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• In modern Finnish, CG has become a PHONOTACTIC CONSTRAINT that applies as a filter, beyond segmental alternations.
• CG targets the consonantal interlude between two PROMINENT SYLLABLES: Σ.Σ at the stem level, H.H at the word level.
• Lenition happens at the STEM LEVEL, degemination happens at the WORD LEVEL.
• The constraint ranking/weighting at both levels is STOCHASTIC, which results in free variation.
References


