Dutch Vowel Reduction, Stochastic Frameworks, and Harmonic Bounding

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Dutch Vowel Reduction

- Unstressed vowels optionally reduce to [ə] (Booij 1995, Kager 1989).
- Several factors affect vowels' propensity to reduce. The focus here: metrical structure.
- Unfooted vowels do not reduce unless footed vowels do, too (1).

(1) a. (ˌfo.no).lo.(ˈɣi) 'phonology'
(ˌfo.nə).lə.(ˈɣi)
(ˌfo.nə).lo.(ˈɣi)
*(ˌfo.no).lə.(ˈɣi)

b. (ˌlo.ko).mo.(ˈti.ef) 'locomotive'
(ˌlo.kə).mə.(ˈti.ef)
(ˌlo.kə).mo.(ˈti.ef)
*(ˌlo.ko).mə.(ˈti.ef)

c. (ˌfe.li).ci.(ˈteer) 'congratulate'
(ˌfe.lə).cə.(ˈteer)
(ˌfe.lə).ci.(ˈteer)
*(ˌfe.li).cə.(ˈteer)

- Two footed vowels (2): either both reduce or neither does.

(2) (ˌen.do)(ˌkri.no)(ˈloχ) 'endocrinologist'
(ˌen.də)(ˌkri.nə)(ˈloχ)
*(ˌen.do)(ˌkri.nə)(ˈloχ)
*(ˌen.də)(ˌkri.no)(ˈloχ)

- (1a) & (2): phonetic transcriptions from Nazarov (2019).
- (1b) & (1c): following Kager (1989), underlined vowels are rendered phonetically, everything else orthographically.

My argument

- Nazarov's (2019) Partial Orders (PO; Anttila 1997) analysis provides a better account than Noisy Harmonic Grammar (NHG; Boersma & Pater 2016) and MaxEnt (Goldwater & Johnson 2003).
- The reason: harmonic bounding suppresses unwanted candidates more reliably in PO than in NHG and MaxEnt.

Moraic Domains & Partial Orders

- Moraic Domains (MD; Nazarov 2019): a level of representation between the foot and syllable that groups moras together. Stressed Vs are moraic, but unstressed Vs may or may not be.
- < > = Moraic Domain; ( ) = foot
- Constraints:
  - *Struc-μ: one violation per mora
  - SWP(D$_\mu$): each MD containing a stressed syllable must be disyllabic
  - Project(V,μ): every V must be moraic
  - Project(V,μ)/Ft: every footed V must be moraic
  - Not shown here: constraints requiring non-moraic Vs to be [ə]
- Partial Orders: optionality arises from variation in the constraint ranking.

- (3) & (4): no fixed ranking among the top 3 constraints. Depending on the ranking chosen, any licit candidate can win.

(3)

/fonoloɣi/	*Struc-μ	SWP(D$_\mu$)	Proj (V,μ)	Faith	Proj (V,μ)/Ft
(☞) a. (<ˌfo$_\mu$><no$_\mu$>)<lo$_\mu$>(<ˈɣi$_\mu$>)	***(!)*	**(!)			
(☞) b. (<ˌfo$_\mu$.nə>)<lo$_\mu$>(<ˈɣi$_\mu$>)	***(!)	*	*(!)	*	*
(☞) c. (<ˌfo$_\mu$.nə>)lə(<ˈɣi$_\mu$>)	**	*	*(!)*	**	*
d. (<ˌfo$_\mu$><no$_\mu$>)lə(<ˈɣi$_\mu$>)	***(!)	**(!)	*(!)	*	

- Without Proj(V,μ)/Ft, candidate (d) is harmonically bounded.
- Proj(V,μ)/Ft is needed for typological reasons (Nazarov 2019), but it can be safely stashed at the bottom of the hierarchy.

(4)

/endokrinoloχ/	*Struc-μ	SWP(D$_\mu$)	Proj(V,μ)	Faith
(☞) a. (<ˌen$_{\mu\mu}$><do$_\mu$>)(<ˌkri$_\mu$><no$_\mu$>)(<ˈloχ$_{\mu\mu\mu}$>)	8(!)	**(!)*		
(☞) b. (<ˌen$_{\mu\mu}$.də>)(<ˌkri$_\mu$.nə>)(<ˈloχ$_{\mu\mu\mu}$>)	6	*	*(!)*	**
c. (<ˌen$_{\mu\mu}$><do$_\mu$>)(<ˌkri$_\mu$.nə>)(<ˈloχ$_{\mu\mu\mu}$>)	7(!)	**(!)	*(!)	*
d. (<ˌen$_{\mu\mu}$.də>)(<ˌkri$_\mu$><no$_\mu$>)(<ˈloχ$_{\mu\mu\mu}$>)	7(!)	**(!)	*(!)	*

- Proj(V,μ)/Ft omitted for space. It penalizes candidate (b) twice, (c), and (d).
- Candidates (a) and (b) collectively harmonically bound (c) and (d).

NHG & MaxEnt

- These frameworks were investigated using OTSoft (Hayes et al. 2013).
- NHG:
  - Constraint weights are perturbed; harmonically bounded outputs are impossible.
  - Proj(V,μ)/Ft prevents exclusion of candidate (d) in (5). All four candidates can win.
  - Because every constraint violated by (d) is violated by a licit candidate, no constraint can be elevated to rule out (d).
  - ⇒ NHG forces a choice between accuracy for Dutch and typological adequacy.

(5)

/fonoloɣi/	*Struc-μ 1.004	SWP(D$_\mu$) 2.15	Proj(V,μ) 0.896	Ident(V) 0.756	Proj (V,μ)/Ft 0.95	*H*
a. (<ˌfo$_\mu$><no$_\mu$>)<lo$_\mu$>(<ˈɣi$_\mu$>)	4	2				8.316
b. (<ˌfo$_\mu$.nə>)<lo$_\mu$>(<ˈɣi$_\mu$>)	3	1	1	1	1	7.764
c. (<ˌfo$_\mu$.nə>)lə(<ˈɣi$_\mu$>)	2	1	2	2	1	8.412
d. (<ˌfo$_\mu$><no$_\mu$>)lə(<ˈɣi$_\mu$>)	3	2	1	1		8.964

- MaxEnt:
  - All candidates are assigned probabilities.
  - Proj(V,μ)/Ft makes no difference.
  - Like NHG, changing weights in (5) to increase (d)'s penalty also harms licit forms.
  - Collective harmonic bounding (4): MaxEnt necessarily assigns the harmonically bounded forms probabilities between those of the bounders.
- Output probabilities:

Candidate	**NHG without** Proj(V,μ)/Ft	**NHG with** Proj(V,μ)/Ft	**MaxEnt**
(ˌfo.no).lo.(ˈɣi)	0.443	0.383	0.286
(ˌfo.nə).lo.(ˈɣi)	0.235	0.261	0.381
(ˌfo.nə).lə.(ˈɣi)	0.322	0.320	0.190
*(ˌfo.no).lə.(ˈɣi)	0.000	0.036	0.143
(ˌen.do)(ˌkri.no)(ˈloχ)	0.427	0.423	0.184
(ˌen.də)(ˌkri.nə)(ˈloχ)	0.573	0.577	0.327
*(ˌen.do)(ˌkri.nə)(ˈloχ)	0.000	0.000	0.245
*(ˌen.də)(ˌkri.no)(ˈloχ)	0.000	0.000	0.245

Harmonic bounding

- All three analyses rely on harmonic bounding to exclude illicit forms, but only PO does so robustly.
- PO: an "extraneous" constraint like Proj(V,μ)/Ft that disrupts harmonic bounding can be placed at the bottom of the ranking, where it is harmless.
- NHG: even zero-weighted constraints can influence the outcome (Flemming 2021, Hayes & Kaplan in submission): perturbation gives it a non-zero weight.
- MaxEnt: even harmonically bounded candidates get output probabilities.
  - Collective harmonic bounding is especially pernicious for MaxEnt: the bounded candidates necessarily have probabilities between those of the bounders.

References

• Anttila, A. 1997. Deriving Variation from Grammar, *Variation, Change and Phonological Theory*, edited by F. Hinskens, R. van Hout, & W. L. Wetzels, *Current Issues in Linguistic Theory*, vol. 146, 35–68, Philadelphia: John Benjamins. • Boersma, P. & J. Pater. 2016. Convergence Properties of a Gradual Learning Algorithm for Harmonic Grammar, *Harmonic Grammar and Harmonic Serialism*, edited by J. J. McCarthy & J. Pater, 389–434, Bristol, CT: Equinox. • Booij, G. 1995. *The Phonology of Dutch*, Oxford: Oxford University Press. • Flemming, E. 2021. Comparing MaxEnt and Noisy Harmonic Grammar, *Glossa: A Journal of General Linguistics* 6:1–42. • Goldwater, S. & M. Johnson. 2003. Learning OT Constraint Rankings Using a Maximum Entropy Model, *Proceedings of the Workshop on Variation within Optimality Theory*, 113–122, Stockholm University. • Hayes, B. & A. Kaplan. in submission. Zero-weighted constraints in Noisy Harmonic Grammar. • Hayes, B., B. Tesar, & K. Zuraw. 2013. OTSoft 2.6, www.linguistics.ucla.edu/people/hayes/otsoft. • Kager, R. 1989. *A Metrical Theory of Stressing and Destressing in English and Dutch*, Dordrecht: Foris. • Nazarov, A. 2019. Moraic Domains Between Feet and Syllables: An Argument from Vowel Reduction Typology, *Glossa* 4:1–43.

OTSoft files available here: `https://github.com/afkaplan/Dutch-Vowel-Reduction`