The logical phonology of Hungarian voicing assimilation

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This paper offers a new analysis of familiar data [e.g., 5] that allows us to explore the scope and limits of phonological computation in a rule-based framework. The rightmost member of an obstruent sequence generally determines the voicing of the whole cluster in Hungarian, as in (1) (we restrict discussion to sequences of length two in the abstract).

(1) Voicing neutralization in Hungarian

Noun	In N	From N	To N	
kuːt	kuːdban	kuːttoːl	kuːtnak	'well'
kaːd	kaːdban	kaːttoːl	kaːdnak	'tub'
büːn	büːnben	büːntöːl	büːnnek	'crime'

Sonorants like /n/ neither trigger assimilation (kuːtnak) nor undergo it (büːntöːl). Following [3, 4] and others, we account for such feature-changing processes in two steps, deletion of the first of two non-identical values for voicing on sonorants, and then insertion of a copy of the value from the final cluster member. We adopt the notation and the implementations of deletion as set subtraction and insertion as unification from [1]. Justification for details of the rules will become clear below.

(2) Deletion via set-subtraction

$$\begin{bmatrix} -\textsc{Son} \\ +\textsc{Cons} \end{bmatrix} - \{\alpha\textsc{Voi}\} \;/\; \_\_ \begin{bmatrix} -\textsc{Son} \\ -\alpha\textsc{Voi} \end{bmatrix}$$

Exx.: kaːdtoːl ⇝ kaːDtoːl AND kuːtban ⇝ kuːDban

(3) Insertion via unification

$$\begin{bmatrix} -\textsc{Son} \end{bmatrix} \sqcup \{\alpha\textsc{Voi}\} \;/\; \_\_ \begin{bmatrix} -\textsc{Son} \\ \alpha\textsc{Voi} \end{bmatrix}$$

Exx.: kaːDtoːl ⇝ kaːttoːl AND kuːDban ⇝ kuːdban

In these examples, the derived segment D denotes a /t/ or a /d/ that has lost its voicing value by rule (2), this deletion occurs only when adjacent obstruents have **opposite** values (dt, tb ⇝ Dt, Db), an assumption we will justify. By rule (3), the copied value is filled in (Dt, Db ⇝ tt, db).

Like, say, /d/, Hungarian (orthographic) *v* is a **target** of assimilation—it devoices to [f] before an underlying *t* or *s*. But *v* does **not trigger** voicing of a preceding voiceless segment like *t* or *k*:

(4)
- **Target:** /hiːvs/ ⇝ [hiːfs] 'you call', /oːvtam/ ⇝ [oːftam] 'I protected'; /reːvbe/ ⇝ [reːvbe] 'to port', /boːvli/ ⇝ [boːvli] 'junk', /sav/ ⇝ [sav] 'acid'
- **Non-trigger:** /kvart^s/ ⇝̸ *[gvart^s] 'quartz', /pitvar/ ⇝̸ *[pidvar] 'porch'; /medve/ ⇝[medve] 'bear', /olvas/ ⇝ [olvas] 'read', /kova/ ⇝ [kova] 'flint'

This behavior can be captured by positing that *v* is underlyingly unspecified for VOICED, denoted /V/. Without a value for VOICED, /V/ cannot trigger deletion of a value in a preceding obstruent via rule (2): /pitVar/ ⇝ pitVar. However, /V/ can undergo voicing assimilation to a following obstruent by rule (3): /o:Vtam/ ⇝ [o:ftam] and /re:Vbe/ ⇝ [re:vbe].

Notice that the decision to break down feature-changing into two explicitly expressed rules had unforeseen implications. It resulted in a simple account of the two-faced behavior of *v*. This is a good example of what Chomsky [2] identifies as one of the benefits of formalization: "a formalized theory may automatically provide solutions for many problems other than those for which it was explicitly designed". This methodological lesson is a main point of the paper, and we can provide yet another illustration from voicing assimilation in Hungarian.

Orthographic *h=ch* (phonetic [h~x], depending on syllable position) behaves in a complementary fashion to *v*. It acts as a **trigger** of voicing assimilation (/adhat/ ⇝ [athat]), but not as a **target** (/pehbö:l/ ⇝ [pehbö:l] ⇝ [pexbö:l]). This behavior can be captured by positing that *h* is underlying unspecified for CONSONANTAL, denoted /H/. This /H/ can trigger deletion of a voicing value in a preceding obstruent via rule (2), but it cannot be a target of that rule, since the target is specified +CONS. Since /H/ never loses its underlying value −VOICED, it will never be affected by the feature-filling unification rule (3), according to the semantics of unification rules that we adopt.

Two remaining rules are needed: (5a) to fill in +VOICED in forms like /pitVar/ ⇝ [pitvar] and /koVa/ ⇝ [kova], and (5b) to fill in +CONS in all tokens of /H/ ⇝ [h].

(5) Fill-in rules (to be fine-tuned)

a. $\begin{bmatrix} -\text{SON} \end{bmatrix} \sqcup \{+\text{VOICE}\}$ (Only remaining V undergoes non-vacuous unification)

b. $\begin{bmatrix} -\text{SON} \end{bmatrix} \sqcup \{+\text{CONS}\}$ (Only 'H' undergoes non-vacuous unification)

In our talk, we explain in detail the interpretation of these four rules and show that they are sufficient to derive all of the following Hungarian clusters:

(6) Derivations: boxed URs have some underspecification

UR	tp	tb	dp	db	Vp	Vb	tV	dV	Hp	Hb	tH	dH	V	H	VH	HV
(2)Delete $-\alpha$VOI	–	Db	Dp	–	–	–	–	–	–	–	–	DH	–	–	–	–
(3) Insert αVOI	VAC	db	tp	VAC	fp	vb	–	–	VAC	U.F.	VAC	tH	–	–	fH	–
(5a) Fill +VOI	U.F.	VAC	U.F.	VAC	U.F.	VAC	tv	dv	U.F.	U.F.	U.F.	U.F.	v	U.F.	U.F.	Hv
(5b) Fill +CONS	VAC	VAC	VAC	VAC	VAC	VAC	VAC	VAC	hp	hb	th	th	VAC	h	fh	hv
SR	tp	db	tp	db	fp	vb	tv	dv	hp	hb	th	th	v	h	fh	hv

We explain the three different kinds of "vacuous" rule application in this table: 'U.F.' refers to unification failure due to feature inconsistency (sets containing αF can't unify with sets containing $-\alpha$F); 'VAC' refers to vacuous application in the sense that two sets are unified, but one is a subset of the other (default fill-in of +VOICED to, say, /b/ or /n/); and '–' refers to cases where an input does not match a rule's structural description (there is no deletion of a voicing value when a cluster is underlyingly consistent in voicing, as in /tp/; we explain why we insist on an α-rule here).

This paper is a contribution to the 'deconstruction' of the '→' of phonological rules into formalizable operations like set deletion and unification. We explain why our treatment of vacuous application is consistent with the logic of function composition, which we use to model rule ordering. Our goal is to define the *formal* scope and limits of phonological computation in basic mathematical and logical terms, and thus questions such as *Why do* v *and* h *behave as they do?* are outside the domain we are examining.

[1] Alan Bale, Maxime Papillon, and Charles Reiss. Targeting underspecified segments: A formal analysis of feature changing and feature filling rules. *Lingua*, 148:240–253, 2014.

[2] Noam Chomsky. *Syntactic structures*. Mouton, The Hague, 1957.

[3] James W. Harris. Autosegmental phonology, lexical phonology and Spanish nasals. In Mark Aronoff and Richard T. Oehrle, editors, *Language sound structure*, pages 67–82. Cambridge, MA: MIT Press, 1984.

[4] William J. Poser. Are strict cycle effects derivable? In Sharon Hargus and Ellen M Kaisse, editors, *Studies in lexical phonology*, volume 4. Academic Press, San Diego, 1993.

[5] Péter Siptár, Péter Siptár, and Miklós Törkenczy. *The phonology of Hungarian*. Oxford University Press on Demand, 2000.