

Boundary-sensitive (morpho-)phonology using cyclic feature-filling

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1 Introduction: English stem-final voicing

- Final C of certain English nouns undergoes voicing in front of plural /-z/: *kni[f]e* ~ *kni[v]es* (Swadesh & Voegelin 1939). The possessive clitic /-z/ does not give rise to voicing (Lightner 1971): *kni[f]e* ~ *kni[f]e's*.

	Stem-final /f~v/			Stem-final /θ~ð/		
	Singular	Plural	Possessive	Singular	Plural	Possessive
(1)	cli[f]f	cli[f]f[s]	cli[f]f's	dea[θ]	dea[θ][s]	dea[θ]'s
	chie[f]	chie[f][s]	chie[f]'s	you[θ]	you[θ][s]	you[θ]'s
	kni[f]e	kni[v]e[z]	kni[f]e's	mou[θ]	mou[ð][z]	mou[θ]'s
	lea[f]	lea[v]e[z]	lea[f]'s	pa[θ]	pa[ð][z]	pa[θ]'s

- This is a famous pattern! And yet, no established analysis in the literature.
 - Recent literature *does* discuss variation (Becker, Nevins & Levine 2012, MacKenzie 2018).
 - The alternation is categorically blocked in possessives. That's what we address.
- 'Default' direction of assimilation is left-to-right. Stem-final voicing, however, is right-to-left.
 - Note the opaque interaction with epenthesis: *hou[s]e* ~ *hou[ziz]* vs. *bu[s]* ~ *bu[siz]*
 - See Appendix A for a discussion of a *devoicing* alt.
- What are the analytical options?
 - Double exceptionality: items like *knife* are exceptional undergoers, whereas plural -z is an exceptional trigger.
 - Exceptionality & cyclicity: items like *knife* are exceptional undergoers, the plural-possessive difference is derived from the affix/clitic distinction (*[the King of England]'s mother*).
- Our claim: an underspecification theory of exceptionality directly predicts patterns like English, provided cyclic phonological application

2 A cyclic analysis for English stem-final voicing

- Underspecification theory of lexical exceptionality (Inkelas & Orgun 1995 *et seq.*)
 - UR of *knife*: /naɪF/, UR of *cliff*: /klɪf/
 - /f/ is –VOICE, but /F/ has *no* VOICE value
 - Right-to-left voicing adds VOICE values, doesn't change them
- The Logical Phonology implementation (Bale, Papillon & Reiss 2014, Bale & Reiss 2018)
 - Segments as set-theoretic entities
 - /f/ is a stand-in for {–SON, +LABIODENT, +CONTINUANT, –VOICE},
 - /F/ is a stand-in for {–SON, +LABIODENT, +CONTINUANT}
 - No feature change: set subtraction, set unification (Samuels 2011 a.o.)
 - Devoicing of /z/ into [s]: (/z/ \ {+VOICE}) ⊆ {–VOICE}
 - Voicing of /F/ into [v]: /F/ ⊆ {+VOICE}
- An analysis of *kni[f]~kni[vz]*, *cli[f]~cli[fs]*

	naɪF	klɪf	naɪF-z	klɪf-z	
	—	—	naɪv-z	—	A1: [] ⊆ {+VOI} / __[–SON,+VOI]
(2)	—	—		klɪf-Z	A2: [+VOI] \ {+VOI} / [–SON,–VOI]__
	naɪf	—		klɪf-s	A3: [] ⊆ {–VOI}
SR:	naɪf	klɪf	naɪvz	klɪfs	

- Note: an underspecification theory requires late context-free unification with {–VOICE}
- With cyclic application, a prediction emerges: no exceptionality at the second cycle
- An analysis of the possessives

	Cycle 1:	naɪF	klɪf	naɪF-z	klɪf-z	
		—	—	naɪv-z	—	A1: [] ⊆ {+VOI} / __[–SON,+VOI]
		—	—		klɪf-Z	A2: [+VOI] \ {+VOI} / [–SON,–VOI]__
		naɪf	—		klɪf-s	A3: [] ⊆ {–VOI}
(3)	Cycle 2:	naɪf#z	klɪf#z	naɪvz	klɪfs	
		naɪf#Z	klɪf#Z	—	—	A2
		naɪfs	klɪfs	—	—	A3
SR:		naɪfs	klɪfs	naɪvz	klɪfs	
		knife's	cliff's	knives	cliffs	

- Opacity in *hou[z]es* is easy: epenthesis follows regressive unification, but precedes progressive subtraction-plus-unification.

	bəs	hauZ	bəs-z	hauZ-z	
	—	—		hauz-z	A1: $[\] \sqcup \{+VOI\} / ___[-SON, +VOI]$
(4)	—	—	bəs-iz	hauz-iz	E: $\epsilon \rightarrow i / [+COR, +STRID] ___ [+COR, +STRID]$
	—	—	—	—	A2: $[+VOI] \setminus \{+VOI\} / [-SON, -VOI] ___$
	—	haus	—	—	A3: $[\] \sqcup \{-VOI\}$
SR:	bəs	haus	bəsiz	hauziz	

- Finally, we predict the alternation to be blocked if there is *any* cyclic boundary
- (5) a. Denominal verbs, a *v*-induced cycle: *kni[f]e* ~ *kni[v]es*, but *to kni[f]e* ~ *he kni[f]es*
b. Compound-internal cycles: *li[f]e* ~ *li[v]es*, but *still li[f]e* ~ *still li[f]es*
- English stem-final voicing, together with a structurally similar pattern in Polish (Section 4), favor our analysis over three major theoretical alternatives

	Parallel OT	Stratal OT	Cophonologies	Our system (LP)
(6) English	✗	✗	✓	✓
Polish	✗	✓	✗	✓

3 Against the alternatives for English

- Our approach is serial, cyclic, and segment-oriented (underspecification).
- Alternative #1: fully parallel. Abandon all three qualities of our analysis
- Such as Parallel OT with lexical indexation (Pater 2008).
- The pattern is doubly exceptional. The target and trigger morphemes have to “be right”
 - Sande (2020) discusses a general problem double exceptionality raises for lexical indexation. How to prevent the constraints from having an effect when one of the triggers is absent?
 - Pater’s locality: a violation mark is incurred if the locus of violation contains a segment belonging to an indexed exponent
- Illustration of Sande’s problem
 - Assimilation: Agree[voi] plus positional faithfulness (Lombardi 1999).
 - Devoicing of both plural and possessive /-z/ after voiceless obstruents: FaithRoot > Agree[voi]

- Voicing of stem-final fricative: FaithPl. How to make voicing specific to *knife*-type nouns?
 - ★ Option 1: index FaithRoot to *cliff*-type items. However, voiceless obstruent-final suffixes trigger devoicing of plural /-z/ too, e.g. *membershi[ps]* — the undergoers are exceptional.
 - ★ Option 2: something penalizing stem-final [−VOICE] indexed to *knife*-type items.
 - ★ Something... like what? Consider the problem for a *[−VOICE]Env_L constraint that penalizes −VOICE obstruents in *some* environment that is exemplified by the plural
- What constraint could prefer the winner for *knives* without preferring the loser for *knife's*?

(7)

	AGREE	*[−VOICE]Env _L	FAITHRT	FAITHPL
☞ a. knife _L -s [vz]			*	
b. knife _L -s [fs]		*W	L	*W
c. knife _L -s [fz]	*W	*W	L	
☞ d. cliff-s [fs]				*
e. cliff-s [vz]			*W	L
f. cliff-s [fz]	*W			L
:(g. knife _L 's [fs]		*		
h. knife _L 's [vz]		L	*W	
i. knife _L 's [fz]	*W	L		

- Plus, there is the counterbleeding interaction with epenthesis to account for.
- Alternative #2: stratal OT. Retain cyclicity, abandon serialism and segment-orientation.
 - Two /-z/s are in different cycles. Lexical indexation is still necessary

(8) Inflectional cycle (for plural /-z/)

	AGREE	*[−VOICE]Env _L	FAITHRT
a. knife _L -s [fs]		*W	L
☞ b. knife _L -s [vz]			*
c. knife _L -s [fz]	*W	*W	L
☞ d. cliff-s [fs]			
e. cliff-s [vz]			*W
f. cliff-s [fz]	*W		

(9) Clitic cycle (for possessive /-z/)

	AGREE	FAITHRT	*[−VOICE]ENV _L
☞ a. knife _L 's [fs]			*
b. knife _L 's [vz]		*W	L
c. knife _L 's [fz]	*W		*
☞ d. cliff's [fs]			
e. cliff's [vz]		*W	
f. cliff's [fz]	*W		

- It is a stratal approach: counterbleeding opacity with epenthesis in *hou[z]es* is accounted for.

(10) a.	house _L -z	AGREE	*[−VOICE]ENV _L	FAITHRT
	☞ a. house _L -s [zz]			*
	b. house _L -s [ss]		*W	L
	c. house _L -s [sz]	*W	*W	L
b.	houses [zz]	*[+COR,+STRID][+COR,+STRID]		DEP
	a. houses [zz]	*W		L
	☞ b. houses [ziz]			*

- (Note: the ranking above predicts **buse[s]*; see Appendix C)
- The main challenge to the stratal account is posed by denominal verbs like *to kni[f]e*.
 - ★ No voicing before 3SG /-z/

(11) He *kni[f]es* through the offensive line

- ★ The substring /fz/ still passes through the inflectional affix stratum
- ★ Again: *any* cyclic boundary between the target and the trigger suffices
- ★ 3SG /-z/ in a later cycle than plural? That's cophonologies
- Alternative #3: co-phonologies. Again, only retain cyclicity.
- Weighted cophonologies by phase (in the style of Sande 2020)
 - The idea: exponents come with their own weights that override the language weighting.
 - In cophonologies by phase (Sande, Jenks & Inkelas 2020),
 - ★ The effects are bound to the first cycle where the morpheme appears
 - ★ CbP shares the 'becoming a non-undergoer' part of our analysis

(12) Both plural and *knife* add weight to *[-voice]Env

	AGREE	*[-VOICE]ENV	FAITHRT	TOTAL
a. knife-s [fs]		-5 - 3 - 3		-11
☞ b. knife-s [vz]			-10	-10
c. knife-s [fz]	-20			-20
☞ d. cliff-s [fs]		-5 - 3		-8
e. cliff-s [vz]			-10	-10
f. cliff-s [fz]	-20			-20
☞ g. knife's [fs]		-5		-5
h. knife's [vz]			-10	-10
i. knife's [fz]	-20			-20

- As a cyclic approach, it is also able to account for counterbleeding (but see Appendix C)
- Summing up
 - Parallel OT with lexical indexation fails at double exceptionality and counterbleeding with *hou[z]es*—also, what could the *[-voice]Env constraint even be?
 - Stratal OT faces a problem from zero-derivation facts: the distinction is between first cycle and the rest, not between plural and possessive cycles
 - Cophonologies by Phase account for the data by sharing the crucial property of our account: *becoming a non-undergoer at a later cycle*
 - Unlike cophonologies, our account is segment-, rather than morpheme-oriented
 - We predict similar effects to arise on the level of individual *phonemes*

4 Beyond lexical exceptionality: Polish Cv and C#v clusters

- In our cyclic setup, we predict:
 - An exceptional target becoming non-target (English)
 - Exceptional external sandhi: a segment that only triggers a process outside of the first cycle
- From the exceptional segment perspective, (Standard) Polish /v/ exemplifies both.

(13) The generalization (Gussmann 2007):

- $C_{-VOICE}V \mapsto C_{-VOICE}f$ (progressive assimilation inside a word)
- $C_{-VOICE}\#V \mapsto C_{+VOICE}\#V$ (regressive assimilation across a boundary)

- (14) *szew-ek* [ʃɛvɛk] ‘seam-DIM’ ~ *szw-y* [ʃfi] ‘seam-NOM.PL’ (PVA in Cv)
stek-u [stɛku] ‘load-GEN.SG’ ~ *stek wyzvisk* [stɛgvizvɪsk] ‘load of.abuse’ (RVA in C#v)
dech [dɛx] ~ *dch-u* [txu] ‘breath’, *wesz* [vɛʃ] ~ *wsz-y* [ffɪ] ‘louse’ (RVA in CC)

- The analysis is the same as English stem-final voicing
 - Progressive devoicing is feature unification: only targeting segments with no $\pm$ voice
 - After default feature unification at the first cycle:
 - ★ Progressive devoicing doesn’t apply (applies vacuously)
 - ★ Surface [v] corresponds to a trigger of regressive assimilation

(15) Rule application for Polish

Cycle1:	dx	ʃV	V	(only clusters for space)
	—	ʃf	—	B1: [] $\sqcup$ {−VOI}/[−SON, −VOI]__
	Dx	—	—	B2: [−SON]\{−αVOI}/__[αVOI]
	tx	—	—	B3: [−SON] $\sqcup$ {αVOI}/__[αVOI]
	—	—	v	B4: [] $\sqcup$ {+VOI}
Cycle 2:	tx	ʃf	k#v	
	—	—	—	B1 applies vacuously
	—	—	G#v	B2
	—	—	g#v	B3
	—	—	—	B4 applies vacuously
SR:	tx	ʃf	g#v	

- Alternative #1: a parallel account. Suppose M([v]) forces progressive devoicing of /v/.

/dxu/	AGREE[VOI]	M([v])	FAITH[VOI]PREV
(16) a. a. txu			
b. dɣu			*W
c. dxu	*W		
/ʃvi/	AGREE[VOI]	M([v])	FAITH[VOI]PREV
b. a. ʃfi			*
b. ʒvi		*W	L
c. ʃvi	*W		L

- RVA for word-initial /v/ is enforced by an even higher ranked faithfulness constraint (like word-initial faithfulness)—wrongly predicting PVA in /vC/ clusters.

(17) a.	/stek#v/	AGREE[VOI]	FAITH[v]INIT	M([v])	FAITH[VOI]PREV
	☞ a. steg#vi			*L	
	b. stek#fi		*W		*W
	c. stek#vi	*W		*W	

b.	/vfi/	AGREE[VOI]	FAITH[v]INIT	M([v])	FAITH[VOI]PREV
	:(a. ffi		*		
	b. vfi	*W	L		
	c. v3i		L		*W

- Alternative #2: strata. M([v]) is dominated by Faith[voi]PreV at the later strata.
- Note: cophonologies (Alternative # 3) is not available here. The pattern is not exponent- or category-specific

	Parallel OT	Stratal OT	Cophonologies	Our system (LP)
(18) English	✗	✗	✓	✓
Polish	✗	✓	✗	✓

5 Conclusion

- Underspecification accounts of exceptionality need context-free feature unification (feature-filling)
- In a cyclic setup, it automatically predicts patterns like English stem-final voicing and the behavior of Polish Cv/C#v clusters. Alternative approaches don't.
- Note also that this property only holds of underspecification accounts
- Diacritic feature-based exceptional segment theories do not predict this effect

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Appendix A: English as exceptional *devoicing*

- What if UR of *knife* is actually /naiv/?
- Analysis: exceptional devoicing at the right edge of the prosodic word

(19) a.		$[\text{kni}[\text{v}]\text{e}_L]_\omega$	$*[+ \text{VOI}]_L]_\omega$	AGREE[VOI]	FAITH[VOI]Rt
	☞ a.	kni[f]e			*
	b.	kni[v]e	*W		L

b.		$[\text{kni}[\text{v}]\text{e}_{L-z}]_\omega$	$*[+ \text{VOI}]_L]_\omega$	AGREE[VOI]	FAITH[VOI]Rt
	☞ a.	kni[v]e[z]			
	b.	kni[f]e[s]			*W
	c.	kni[f]e[z]		*W	*W
	d.	kni[v]e[s]		*W	

c.		$[\text{kni}[\text{v}]\text{e}_L]_\omega - 'z$	$*[+ \text{VOI}]_L]_\omega$	AGREE[VOI]	FAITH[VOI]Rt
	☞ a.	kni[f]e[s]			*
	b.	kni[f]e[z]		*W	*
	c.	kni[v]e[s]	*W	*W	L
	d.	kni[v]e[z]	*W		L

- Advantages:
 - No opaque interaction with epenthesis
 - Compatible with any theory of exceptionality
 - E.g., lexical indexation
- An argument against it comes from further derivational morphology

- (20) a. lea[f] ~ lea[vz] ~ lea[f]y
 b. li[f]e ~ li[v]e[z] ~ to li[v]e, li[f]eless, still li[f]e[s]
 c. el[f] ~ el[v]es ~ el[f]ish
 d. wi[f]e ~ wi[v]es ~ wi[f]ely

- Embedded prosodic words in $[[\text{leaf}]_\omega \text{ } y]_\omega$, $[[\text{life}]_\omega \text{ less}]_\omega$, $[[\text{elf}]_\omega \text{ ish}]_\omega$, $[[\text{wife}]_\omega \text{ ly}]_\omega$?
- Probably not. Those are not phrasal clitics like possessive -z. Inflectional affixes like plural -z attach rather late (from a lexical phonology perspective) — whereas what the devoicing analysis needs is for the plural affix to attach to a smaller prosodic constituent than -y, -less, -ish, -ly.

Appendix B: English zero derivation

- The final wrinkle comes from the derivational triplets (Lightner 1971)

	<i>noun-sg</i>	<i>noun-pl</i>	<i>verb</i>
voice only in plural	knife	knives	to knife
(21) voice only in verb	belief proof	beliefs proofs	to believe to prove
voice both in plural and verb	life bath (θ)	lives baths (ð)	to live to bathe (ð)

- Directionality of zero derivation is hard to figure out (cf. Grestenberger & Kastner 2022),
 - Plural only group: denominal verb. In $[\nu [n \sqrt{\text{Root}}]]$ structure, $[n \sqrt{\text{Root}}]$ is a cycle. Resulting in voiceless realization of /F/ in the verb through $\{-\text{VOICE}\}$ unification at the $[n \sqrt{\text{Root}}]$ cycle.
 - Verb only group: deverbal noun. In $[n [\nu \sqrt{\text{Root}}]]$ structure, $[\nu \sqrt{\text{Root}}]$ is a cycle. Resulting in voiceless realization of /F/ in the noun through $\{-\text{VOICE}\}$ unification at the $[\nu \sqrt{\text{Root}}]$ cycle.
 - Both: no directionality. The noun is $[n \sqrt{\text{Root}}]$, the verb is $[\nu \sqrt{\text{Root}}]$.
- This only gives us voiceless-final verbs. Why do voiced-final verbs not alternate?
- $\{+\text{VOICE}\}$ might be associated with exponence of ν attached to n (Chomsky & Halle 1968:232, Albright 2008: Section 3.4)
- This is related to featural affixation: a topic yet to be discussed in LP

Appendix C: full stratal OT account

- Consider the derivation for *hou[z]es*

	house _L -z	AGREE	*[−VOICE]ENV _L	FAITHRT
(22) a.	☞ a. house _L -s [zz]			*
	b. house _L -s [ss]		*W	L
	c. house _L -s [sz]	*W	*W	L
b.	houses [zz]	*[+COR,+STRID][+COR,+STRID]		DEP
	a. houses [zz]	*W		L
	☞ b. houses [ziz]			*

- It derives *buse[s]* instead of *buse[z]*

(23) a.	bus-z	AGREE	*[−VOICE]ENV _L	FAITH _{RT}
	:(a. bus-s [sz]	*		
	b. bus-s [ss]	L		
	c. bus-s [zz]	L		*W
b.	buss [ss]	*[+COR,+STRID][+COR,+STRID]		DEP
	☞ a. buses [sis]			*
	b. buses [ss]	*W		L

- A revised inflectional cycle grammar. It requires for *[−voice]Env_L to penalize any voiceless obstruent that belongs to an indexed morpheme and precedes -s and/or -z.

(24)		*[−VOICE]ENV _L	FAITH	AGREE	FAITH _{RT}
	☞ a. bus-s [sz]			*	
	b. bus-s [ss]		*W	L	
	c. bus-s [zz]		*W	L	*W
	☞ d. house _L -s [sz]		*	*	*
	e. house _L -s [ss]	*W	*	L	L
	f. house _L -s [zz]	*W	L	L	L

- *[−voice]Env_L ends up being a non-explanatory bigram constraint: voiceless obstruents are dis-preferred in front of -s/-z, which just so happens to be the exact environment of the alternation and the surface structure which the alternation destroys.
- Cophonologies-by-phase framework has to enforce a similar ranking to fully account for counterbleeding.