Paradigm Uniformity in Czech Prefix Vocalization

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1 Introduction

Consonant-final prefixes in Czech sometimes require a vowel (in Czech, always [ɛ]) after them when attaching to a root (what I call *prefix vocalization*). We can see from (1) that this is not purely phonological:

(1)

a. *CCVC root, unvocalized prefix*	b. *CC root, vocalized prefix*
pod-brad-ɛk	podɛ̲-br-a-l
under-chin-DIM	under-take-THEM-PAST
"double chin"	"scooped (masc. sg.)"

My focus: prefix vocalization in short (specifically, CC and CCV) verb roots like (1b). I will:

- Show that prefix vocalization occurs in verbs with *multiple consonants* and *no vowels* in the surface form, which I analyze using a markedness constraint on the shape of the root
- Argue that prefix vocalization overapplies due to *paradigm uniformity*, analyzing this using the framework of Optimal Paradigms (McCarthy, 2005)
- Compare my analysis to previous accounts like Ziková (2016) and Rubach (1993)—who discusses very similar facts in Slovak—and show that using the paradigm as a unit of structure provides a better fit to the data than these accounts do (cf. Bobaljik, 2008)

2 Basic distribution

2.1 CC and CCV roots

Ziková (2016): prefix vocalization occurs before roots comprising multiple consonants and no vowels, regardless of sonority.

All C-final prefixes participate—no difference in behavior between lexical and superlexical prefixes (Svenonius, 2004).

(2) *Prefixes vocalize before CC(C) roots with thematic vowels*[1]
   a. rozɛ-rv-a-l "tear up"
   b. rozɛ-stl-a-l "prepare (a bed)"
   c. rozɛ- tr̥̩ -ɛ-l "spread"

Contrast with: CCV roots without thematic vowels, like [krɪ]:

(3)

CC roots: no vowel in non-past, vocalized prefix			*CCV roots: vowel in non-past, unvocalized prefix*		
a.	tr̥̩ - ɛ -l	"rub (past)"	d.	krɪ -Ø -l	"cover (past)"
b.	tr̥̩ -Ø-ɛ	"rub (non-past)"[2]	e.	krɪj-Ø-ɛ	"cover (non-past)"
c.	sɛ-tr̥̩ - ɛ -l	"rub away (past)"	f.	s-krɪ -Ø -l	"hide (past)"

Analysis: prefix vocalization is epenthesis (like Rysling (2016) and Czaykowska Higgins (1988) argue for Polish) driven by a markedness constraint on the shape of the root:

(4) CCROOTVOWEL: If a verb root follows a consonant and contains at least two consonants, it must also contain a [+syllabic] segment.

CONTIGUITY-IO$_{root}$ (Kenstowicz, 1994) ensures that the vowel is epenthesized before the root, not within it:

(5) CONTIGUITY-IO$_{root}$: Adjacent root input segments must correspond to adjacent output segments.

CCROOTVOWEL must outrank DEP-IO-V, which penalizes vowel epenthesis.

Also: high-ranking MAX-IO-C, which penalizes consonant deletion. (I omit this constraint and candidates violating it from my tableaux.)

These constraints yield prefix vocalization in [tr̥̩-ɛ-l] (CC root with thematic vowel) but not in [krɪ-l] (CCV root with no thematic vowel):

[1] Although the citation form of a Czech verb is the infinitive (in these cases, [rozɛrvat], [rozɛstlat], and [rozɛtr̥̩ːt]), here and throughout, I present the masculine singular past form, because the infinitive displays length alternations that would be confusing here. Unless otherwise noted, examples are from the SYN2015 corpus of the Czech National Corpus (Křen et al., 2016).

[2] Unless otherwise noted, non-past forms are third person singular. These forms have a present meaning for imperfective verbs and a future meaning for perfective verbs. In these cases, unprefixed verbs are imperfective and prefixed verbs are perfective. I assume that the [ɛ] in the non-past forms is part of the inflection, not the theme vowel.

(6) *Prefix vocalization is triggered in CC roots*

s-[tr̥]$_{root}$-ɛ-l	CCROOT VOWEL	CONTIGUITY-IO$_{root}$	DEP-IO-V
a. s[tr̥]$_{root}$ɛl	*!		
b. ☞ sɛ[tr̥]$_{root}$ɛl			*
c. s[tɛr̥]$_{root}$ɛl		*!	*

(7) *Prefix vocalization is not triggered in CCV roots*

s-[krɪ]$_{root}$-Ø-l	CCROOT VOWEL	CONTIGUITY-IO$_{root}$	DEP-IO-V
a. ☞ s[krɪ]$_{root}$l			
b. sɛ[krɪ]$_{root}$l			*!

2.2 CCV roots with thematic vowels

Caha and Scheer (2008) compare [fiɾaːl] and [rval]:

- the vowel of [fiɾaːl] is long in the past, while in [rval] it is short
- [fiɾaːl] has a [j] in the non-past, [rval] does not

(8)

Standard CC pattern			*New pattern*		
short vowel in past, no vowel in non-past			*long vowel in past, vowel in non-past*		
a.	rv- a -l	"tear (past)"	c.	fiɾ -aː-l	"warm (past)"
b.	rv-Ø-ɛ	"tear (non-past)"	d.	fiɾɛj-Ø-ɛ	"warm (non-past)"

My conclusion: The root is /fiɾɛ/

- non-past: like [krɪj-ɛ] (3e)
- past: thematic vowel [a], which swallows up root vowel and lengthens

Prefixes vocalize before [fiɾaːl]:

(9)

CC root + thematic vowel			*CCV root + thematic vowel*		
vocalized prefix			*vocalized prefix*		
a.	rozɛ-rv-a-l	"tear up (past)"	b.	rozɛ-fiɾ-aː-l	"start to warm up (past)"

Recall definition of CCROOTVOWEL, repeated from (4):

(10) CCROOTVOWEL: If a verb root follows a consonant and contains at least two consonants, it must also contain a [+syllabic] segment.

Applies to surface *output forms* (since it's a markedness constraint).

If the root vowel gets deleted (/roz-fɪ̯rɛ-a-l/ → [rozɛ-fɪ̯r-aː-l]), CCROOTVOWEL is violated and must be repaired.

Analysis for unprefixed /fɪ̯rɛ-a-l/ [fɪ̯r-aː-l]. We need:

- The fix for hiatus is vowel deletion rather than consonant epenthesis or metathesis
- The root vowel is deleted rather than the thematic vowel
- The thematic vowel lengthens

I handle these with the following constraints, respectively:

- DEP-IO-C and LINEARITY-IO (McCarthy and Prince, 1995), which penalize consonant epenthesis and metathesis, respectively, outranking MAX-IO-V, which penalizes vowel deletion (I omit LINEARITY-IO and candidates that violate it from my tableaux)
- MAX-IO-MORPH (Abu-Mansour, 2011), which requires that every morpheme with a segment in the input have a segment in the output (see also Kurisu, 2001)
- MAX-IO-μ, which penalizes the deletion of a mora, outranking IDENT-IO(length), which penalizes changes in segment length

This gives us:

(11) *CCV root + theme vowel: root vowel deletes, theme vowel lengthens*

[fɪ̯rɛ]$_{root}$-a-l	*VV	DEP-IO-C	MAX-IO-MORPH	MAX-IO-μ	MAX-IO-V	ID-IO (length)
a. [fɪ̯rɛ]$_{root}$al	*!					
b. [fɪ̯rɛ]$_{root}$jal		*!				
c. [fɪ̯rɛ]$_{root}$l			*!	*!	*	
d. [fɪ̯r]$_{root}$al				*!	*	
e. [fɪ̯rɪː]$_{root}$l[3]			*!		*	*
f. ☞ [fɪ̯r]$_{root}$aːl					*	*

To get prefix vocalization in [rozɛ-fɪ̯r-aːl]:

- DEP-IO-C must outrank DEP-IO-V, otherwise we would instead insert a glide to avoid vocalizing the prefix.
- CCROOTVOWEL is still undominated and must be repaired

(In this tableau I omit MAX-IO-MORPH, MAX-IO-μ, and CONTIGUITY-IO$_{root}$, as well as candidates that violate them.)

[3] In Czech, [ɛ] often lengthens to [iː].

(12) *Prefix + CCV root + theme vowel: root vowel deletes, prefix vocalizes*

roz-[fir̥ɛ]$_{root}$-a-l	CCROOT VOWEL	*VV	DEP-IO-C	MAX-IO-V	ID-IO (length)	DEP-IO-V
a. roz[fir̥ɛ]$_{root}$al		*!				
b. roz[fir̥ɛ]$_{root}$jal			*!			
c. roz[fir̥]$_{root}$aːl	*!			*	*	
d. ☞ rozɛ[fir̥]$_{root}$aːl				*	*	*

For the analysis of glide insertion in the present tense (/fir̥ɛ-ɛ/ → [fir̥ɛjɛ]), see Appendix A.

To summarize:

(13) Prefix vocalization occurs in roots with:
  a. *multiple consonants* and
  b. *no vowels* in the *surface form*.

Prefix vocalization almost always applies with a CC(C) root allomorph—see Appendix B.

3 Overapplication

3.1 Distribution

Ziková (2016) and others (e.g. Scheer, 2004; Rubach, 1993): prefix vocalization *overapplies* to some forms that do not satisfy the conditions in (13).

Root allomorphy: If a verb has

- a CC allomorph in some forms of a paradigm, and
- a CVC allomorph in others,

prefix vocalization applies across the board:

(14) *CC root in past, CVC root in non-past prefix vocalizes throughout*
  a. odɛ-br -a -l "take away (past)"
  b. odɛ-bɛr-∅-ɛ "take away (non-past)"

CVC root in past, CC root in non-past prefix vocalizes throughout
  c. odɛ-t͡ʃɛt-∅-l "subtract (past)"
  d. odɛ-t͡ʃt -∅-ɛ "subtract (non-past)"

What is the domain of overapplication? Ziková (2016):

- If perfective stems with CC root allomorphs (like [-br-a-l]) show prefix vocalization,
- so do the *secondary imperfective* forms (like [-biːr-a-l] below).

Her examples:

(15) *Some verbs: CC root allomorph in perfective, CVC root allomorph in imperfective, prefix vocalizes in perfective and imperfective*

	"take away"		"grind up"		"sign"	
a.	odɛ-br -a -l	d.	sɛ-ml -ɛ -l	g.	podɛ-ps -a -l	perfective past
b.	odɛ-bɛr-Ø-ɛ	e.	sɛ-mɛl-Ø-ɛ	h.	podɛ-piːʃ -Ø -ɛ	perfective non-past
c.	odɛ-biːr-a -l	f.	sɛ-miːl-a -l	i.	podɛ-pɪs-ova[4] -l	imperfective past

(Ziková, 2016: 178)

However, other verbs do not vocalize in the imperfective:

(16) *Other verbs: CC root allomorph in perfective, CVC root allomorph in imperfective, prefix vocalizes in perfective only*

	"gather"		"read aloud"		"rub in"	
a.	sɛ-br -a -l	d.	pr̥ɛdɛ-t͡ʃɛt-Ø -l	g.	vɛ-tr̥ -ɛ -l	perfective past
b.	sɛ-bɛr-Ø-ɛ	e.	pr̥ɛdɛ-t͡ʃt -Ø-ɛ	h.	vɛ-tr̥ -Ø-ɛ	perfective non-past
c.	z -biːr-a -l	f.	pr̥ɛ(t)-t͡ʃiːt-a -l	i.	f -tiːr-a -l	imperfective past

Are the examples in (16) just exceptions?

- Appendix B: overapplication within the perfective ([odɛ-br-a-l] → [odɛ-bɛr-ɛ]) is categorical with scattered exceptions
- Appendix C: overapplication from the perfective to the imperfective ([odɛ-br-a-l] → [odɛ-biːr-a-l]) is much more variable

We should not dismiss cases like (16) as exceptions! Instead:

Focus on [odɛ-bɛr-ɛ] cases, leaving the door open for a future analysis of [odɛ-biːr-a-l] and [z-biːr-a-l] cases.

The relevant domain is the *paradigm*.

3.2 The Czech verbal paradigm

How should we define the paradigm? I adopt the traditional view, examples for perfective [sɛ-br-a-l] and imperfective [z-biːr-a-l] from the Czech Internet Language Handbook (ÚJČ AV ČR, 2019):[5]

[4]The thematic element [ova] may be morphologically complex, but this does not affect my analysis. What is relevant is that it is not part of the root.

[5]I have omitted the mostly obsolete forms known as transgressives.

(17) *Perfective paradigm:* sɛbrat
Root allomorphs: br, bɛr
Vocalized prefixes throughout

	singular	plural
1st person	sɛbɛru	sɛbɛrɛmɛ
2nd person	sɛbɛrɛʃ	sɛbɛrɛtɛ
3rd person	sɛbɛrɛ	sɛbɛrou
imperative	sɛbɛr	sɛbɛrtɛ
active participle	sɛbral	
passive participle	sɛbraːn	
verbal noun	sɛbraːɲiː	

(18) *Imperfective paradigm:* zbiːrat
Root allomorphs: biːr
Unvocalized prefixes throughout

	singular	plural
1st person	zbiːraːm	zbiːraːme
2nd person	zbiːraːʃ	zbiːraːtɛ
3rd person	zbiːraː	zbiːraːjiː
imperative	zbiːrɛj	zbiːrɛjte
active participle	zbiːral	
passive participle	zbiːraːn	
verbal noun	zbiːraːɲiː	

Why choose this?

- Corresponds with traditional Czech grammarians' conception
- Semantically: more or less corresponds to all forms of a "lexical item", setting aside aspect
- Morphologically: Only a smallish class of verbs (the focus of this talk!) exhibit root allomorphy between the past and non-past stems, whereas the imperfective generally has an additional suffix, often with change in root (Nübler et al., 2017)

And of course, as argued above, verbs that require prefix vocalization in the perfective do not necessarily exhibit it in the imperfective.

3.3 The representation of root allomorphy

Many (e.g. Rubach, 1993; Scheer, 2004; Ziková, 2016) assume root allomorphs like [br], [bɛr], and [biːr] have a unified underlying representation with an unlinked vowel between the two consonants:

(19) *One account of CC/CVC root allomorphy: unlinked vowels*

```
C   V   C
|       |
b   ɛ   r
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Like Gouskova (2012) and Rysling (2016), I do not adopt the assumption of abstract/unlinked vowels.

Instead: I assume root allomorphs like [br], [bɛr], and [biːr] are listed in the lexicon as such:

(20) *Naïve lexical entry for* $\sqrt{\text{TAKE}}$
- a. $\sqrt{\text{TAKE}}$ ↔ biːr / prefix ___ imperfective
- b. $\sqrt{\text{TAKE}}$ ↔ bɛr / ___ {imperative, non-past}
- c. $\sqrt{\text{TAKE}}$ ↔ br / ___ elsewhere

[5]This is the form I have been labelling as past; the past tense and conditional are formed with periphrastic constructions using the active participle, agreeing with the subject in number and gender, and an auxiliary inflected for person and number.

Note: I am *not* assuming that *all* alternating vowels in Czech are listed like this, just these verbal root allomorphs.

3.4 Optimal Paradigms

Account for overapplication: Optimal Paradigms constraints (McCarthy, 2005):

- The entire paradigm (as defined in Section 3.2) is derived as a unit
- Each member of the paradigm is in output–output correspondence with every other.
- This is true *even when members of the paradigm have different root allomorphs*—the fundamental unit of analysis is the entire paradigm, not any subsection of it

Crucial constraint: DEP-OP-V, which enforces correspondence between vowels in all members of a paradigm:

(21) DEP-OP-V: For members of a paradigm P_1, P_2, any vowel that appears in P_2 must have a corresponding vowel in P_1.

We don't want root allomorphs to level—/br/ should stay [br] and /bɛr/ should stay [bɛr]:

- MAX-IO-V (penalizing vowel deletion) prevents /bɛr/ → [br]
- CONTIGUITY-IO$_{root}$ (penalizing epenthesis within the root) prevents /br/ → [bɛr]

Both constraints must outrank DEP-OP-V, else vowels would have to correspond throughout.

Overapplication: DEP-OP-V outranks DEP-IO-V—better for members of a paradigm to have corresponding vowels, even at the cost of epenthesis.

In (22) we see prefix vocalization triggered in [br] forms overapplying to [bɛr] forms.

Here I only count violations of DEP-OP-V in prefix and root, assuming there are additional constraints preventing theme vowels and inflectional endings (grayed out) from collapsing together:

(22) *Prefix vocalization triggered in CC root allomorphs, then overapplies across paradigm to CVC root allomorphs*

roz-{br-a-{l$_{past}$, …} / bɛr-Ø-{ɛ$_{non-past\ 3sg}$, …}}	CCROOT VOWEL	MAX-IO-V	CONTIG-IO$_{root}$	DEP-OP-V	DEP-IO-V
a. ⟨roz^{1}br^{1}al, roz^{2}bɛr^{2}ɛ, …⟩	^{1}*!			^{2}*	
b. ⟨roz^{3}ɛbral, roz^{4}ɛb^{5}rɛ, …⟩		^{5}*!			^{3,4}**
c. ⟨roz^{6}bɛral, rozbɛrɛ, …⟩			^{6}*!		^{6}*
d. ⟨roz^{7}ɛbral, roz^{8}bɛrɛ, …⟩				^{7,8}**!	^{7}*
e. ☞ ⟨roz^{9}ɛbral, roz^{10}ɛ^{11}bɛrɛ, …⟩				^{11}*	^{9,10}**

3.5 Overapplication in CCV roots with thematic vowels

In Section 2.2, I discussed CCV verbs where the root vowel deletes in certain forms: /fiɾ̩ɛ-a-l/ → [fiɾ̩aːl]. Prefix vocalization overapplies in forms where the root vowel surfaces:

(23)

Root vowel deleted in past, surfaces in non-past			*Vocalized prefixes throughout the paradigm*		
a.	fiɾ̩ -aː-l	"warm (past)"	c.	rozɛ-fiɾ̩ -aː-l	"warm up (past)"
b.	fiɾ̩ɛj-∅-ɛ	"warm (non-past)"	d.	rozɛ-fiɾ̩ɛj-∅-ɛ	"warm up (non-past)"

For the analysis of these forms, see Appendix A.

4 Other analyses

Two points of comparison:

- Analysis of prefix vocalization arguing for cyclicity (Rubach, 1993; Ziková, 2016)
- Analysis of a different phenomenon arguing that Czech paradigmatic effects are due to base–derivative correspondence, not Optimal Paradigms–style correspondence (Sturgeon, 2003)

4.1 Cyclicity

Although Rubach (1993) and Ziková (2016) have very different analyses of prefix vocalization (in Slovak and Czech, respectively), the key point is the same: the prefix vocalizes because it attaches

(a) before the theme vowel or inflectional suffixes have attached, and

(b) before the alternating vowel in the root (if there is one) has vocalized

Abstracting away from details, they account for overapplication in [rozɛ-bɛr-ɛ] as follows:

(24) a. *Stage 1: Prefix attaches to root with unlinked vowel*

C	V	C	V	-	C	V	C	
|	|	|			|		|	
r	o	z	ɛ		b	ɛ	r	[rozbr]

b. *Stage 2: Prefix vocalizes for morphophonological reasons*

C	V	C	V	-	C	V	C	
|	|	|	|		|		|	
r	o	z	ɛ		b	ɛ	r	[rozɛbr]

c. *Later stages: other affixes attach, root vocalizes*

C	V	C	V	-	C	V	C	-	V	
|	|	|	|		|	|	|		|	
r	o	z	ɛ		b	ɛ	r		ɛ	[rozɛbɛrɛ]

Predicts unvocalized prefix in CCV roots with thematic vowels (contra /roz-fiɾɛ-a-l/ → [rozɛfiɾaːl])

- After stage 1: [roz-fiɾɛ], no need to vocalize prefix
- The root vowel only deletes when the theme vowel is added ([roz-fiɾaː]), still nothing that needs repair

Predicts *categorical* prefix vocalization in secondary imperfectives like [rozɛ-biːr-a-l]

- Derivation is identical to that of [rozɛ-bɛr-ɛ]: [rozbr] after stage 1, prefix vocalizes to [rozɛbr], vowel in root only surfaces later in the derivation to get [rozɛbiːr]
- As I stated in Section 3.1, the [biːr] cases should *not* be treated the same way as the [bɛr] cases
- My analysis remains neutral on [biːr], allowing for a different analysis for it; the cyclical analysis does not

Conclusion: An account based in *paradigm uniformity* gives a better explanation of the facts than one requiring *cyclicity* and *unlinked vowels*.

4.2 Correspondence: base–derivative vs. paradigms

Sturgeon (2003) argues that in Czech nominal paradigms, the nominative singular acts as a privileged base and all other forms are in a correspondence relation with it.

Is there any verb form that can serve as a consistent base, as Albright (2002, 2010) suggests, or do we need Optimal Paradigms (or equivalent)?

Repeating (14) from above:

(25)

CC root in past, CVC root in non-past prefix vocalizes throughout		*CVC root in past, CC root in non-past prefix vocalizes throughout*	
a. odɛ-br -a -l	“take away (past)”	c. odɛ-t͡ʃɛt-Ø -l	“subtract (past)”
b. odɛ-bɛr-Ø-ɛ	“take away (non-past)”	d. odɛ-t͡ʃt -Ø-ɛ	“subtract (non-past)”

Forms with CC root allomorph ([br], [t͡ʃt]) triggers overapplication of prefix vocalization in forms with CVC root allomorph ([bɛr], [t͡ʃɛt]), *regardless of the morphological status of the two allomorphs*.

So no one form can serve as a privileged base, we need *symmetry* in the paradigm: any member can influence any of the others.

5 Prefix vocalization in Russian and Polish

Other Slavic languages like Russian and Polish also exhibit prefix vocalization, but unlike in Czech, it does not overapply (data from Zaliznjak, 1977; Saloni et al., 2015):

(26) *Russian: prefix vocalization for CC roots, no overapplication*

a.	rəzɐ-br	-a	-l	"take apart (past)"
b.	rəz- bʲɪrʲ-	Ø-	ot	"take apart (non-past)"
c.	rəz- bʲɪr	-a	-l	"take apart (imperf.)"

Polish: prefix vocalization for CC roots, no overapplication

d.	ɔdɛ-br	-a	-w	"take away (past)"
e.	ɔd- bʲɛʐ-	Ø	-ɛ	"take away (non-past)"
f.	ɔd- bʲɛr	-a	-w	"take away (imperf.)"

As Yearley (1995) notes, the standard account of Slavic alternating vowels (from Lightner, 1965) needs additional mechanisms to avoid overapplication (see Pesetsky, 1979).

See Gribanova (2015) for one such account of Russian prefix vocalization based on underlying defective vowels similar to those in Section 4.1.

In my analysis, CCROOTVOWEL is active in Polish and Russian, but the Optimal Paradigms constraint DEP-OP-V is not.

However, there are a couple of isolated cases in Russian showing overapplication. For example, prefixed forms of the inarguably suppletive "to go":

(27) *A case of prefix vocalization overapplication in Russian*

a.	pədɐ-jdʲ-	Ø-	ot	"approach (non-past)"
b.	pədɐ-ʂ	-o	-l	"approach (past)"

While these cases are small in number in Russian (and presumably other Slavic languages), they perhaps deserve some attention.

6 Conclusion

Main points

- Prefix vocalization occurs in CC verb roots, and also CCV verb roots where the root vowel is deleted. I model this with a markedness constraint on the shape of the root, CCROOTVOWEL
- Prefix vocalization then *overapplies* within an inflectional paradigm, but not necessarily beyond it. I model this with an Optimal Paradigms constraint
- This approach accounts for the data better than accounts based on cyclicity and unlinked vowels
- Room for future work: variable secondary imperfectives like [rozɛ-biːral] and [z-biːral] (base–derivative correspondence?)

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Appendix A CCV roots with thematic vowels: analysis

In Section 2.2 and Section 3.5, I presented the following forms, repeated here from (23), which I argued contain the verb root [fir̥ɛ]:

(28)

Root vowel deleted in past, surfaces in non-past			*Vocalized prefixes throughout the paradigm*		
a.	fir̥ -aː-l	"warm up (past)"	c.	rozɛ-fir̥ -aː-l	"start to warm up (past)"
b.	fir̥ɛj -ɛ	"warm up (non-past)"	d.	rozɛ-fir̥ɛj -ɛ	"start to warm up (non-past)"

In Section 2.2, I presented an analysis of the past forms [fir̥aːl] and [rozɛfir̥aːl]. In this section, I will extend this analysis to the unprefixed non-past form [fir̥ɛjɛ], which has glide insertion instead of vowel deletion, and the prefixed non-past form [rozɛfir̥ɛjɛ], where prefix vocalization overapplies.

First, let's look at non-past /fir̥ɛ-ɛ/ yielding [fir̥ɛjɛ]. Why do we not delete the root vowel and lengthen the inflectional ending [-ɛ]? I assume unviolated IDENT-IO$_{infl}$, a constraint that penalizes changes in inflectional endings.

What happens when we add this constraint?

- *VV says we can't have two long vowels [ɛɛ] in a row
- MAX-IO-MORPH says we can't delete the inflectional ending [ɛ] to give [fir̥ɛ-Ø] or [fir̥iː-Ø]
- MAX-IO-μ says if we delete one of the vowels, we have to lengthen the one that remains: /fir̥ɛ-ɛ/ → [fir̥-iː]
- IDENT-IO$_{infl}$ says that we can't lengthen the inflectional ending [ɛ] like we did with /fir̥ɛ-a-l/ → [fir̥-aː-l]
- So we have to insert a glide instead, which means that DEP-IO-C is violated by all of the constraints named above

In tableau form:

(29) *CCV root + inflectional ending: glide insertion*

[fir̥ɛ]$_{root}$-Ø-[ɛ]$_{infl}$	*VV	ID-IO$_{infl}$	MAX-IO-MORPH	MAX-IO-μ	DEP-IO-C	MAX-IO-V	ID-IO (length)
a. [fir̥ɛ]$_{root}$[ɛ]$_{infl}$	*!						
b. [fir̥iː]$_{root}$			*!			*	*
c. [fir̥]$_{root}$[ɛ]$_{infl}$				*!		*	
d. [fir̥]$_{root}$[iː]$_{infl}$		*!				*	*
e. ☞ [fir̥ɛ]$_{root}$j[ɛ]$_{infl}$					*		

To get overapplication of prefix vocalization, I extend the tableaux in (12) and (29) to include paradigm effects with DEP-OP-V.

In order to keep the tableau from becoming completely unreadable, I make these assumptions:

- I omit MAX-IO-MORPH MAX-IO-μ, and CONTIGUITY-IO$_{root}$, as well as any candidates that violate them. That is, the only repairs for *VV that I consider are glide insertion (as in [fiɾɛj-ɛ]) and deletion of the root vowel with corresponding lengthening of the remaining vowel (as in [fiɾ-aː-l]).
- I omit CONTIGUITY-IO$_{root}$, as well as any candidates that violate it.
- Because glide insertion can create Optimal Paradigms constraints violations in consonants as well as vowels, I use DEP-OP-V instead of DEP-OP-V to include both vowels and consonants. Its ranking does not change.
- Because the root in these forms interacts with the suffixes, I can no longer ignore violations of DEP-OP-V in the suffixes as I did in (22). I count the violations, but assume that IDENT-IO(length) prevents the inflections from collapsing together and omit candidates that collapse them, without worrying too much about the details.
- In particular, I assume that the non-past ending [ɛ] corresponds with neither the thematic vowel [a] nor the past ending [l]. Thus, for example, the strings [fiɾaːl] and [fiɾɛjɛ] will together incur five violations of DEP-OP-V, one for each of the segments [aː, l, ɛ, j, ɛ], since none are in correspondence with any of the others.

(30) *Prefix vocalization triggered in CC(V) root allomorph with deleted vowel then overapplies across paradigm to CCV root allomorph*

roz-{fiɾɛ-a-{l$_{past}$, …} / fiɾɛ-Ø-{ɛ$_{non-past\ 3sg}$, …}}	CCROOT VOWEL	*VV	ID-IO$_{infl}$	DEP-IO-C	MAX-IO-V	DEP-OP	ID-IO (length)	DEP-IO-V
a. ⟨rozfiɾɛal, rozfiɾɛɛ, …⟩		1 3 *!*				1 2 3 ***		
b. ⟨rozfiɾɛjal, rozfiɾɛjɛ, …⟩				1 4 **!		2 3 5 ***		
c. ⟨rozɛfiɾ aːl, rozɛfiɾ iː, …⟩			7 *!		2 6 **	3 4 7 ***	3 7 **	1 5 **
d. ⟨rozfiɾ aːl, rozfiɾɛjɛ, …⟩	1 *!			6 *	2 *	3 4 5 *** 6 7 **	3 *	
e. ⟨rozɛfiɾ aːl, rozfiɾɛjɛ, …⟩				6 *	2 *	1 3 4 *** 5 6 7 ***!	3 *	1 *
f. ☞ ⟨rozɛfiɾ aːl, rozɛfiɾɛjɛ, …⟩				7 *	2 *	3 4 6 *** 7 8 **	3 *	1 5 **

Appendix B Prefix vocalization in perfective verbs

The table below includes counts from the SYN2015 corpus (Křen et al., 2016) for of all prefixed verbal paradigms that have at least one member with a CC root allomorph. The counts do not include verbal nouns and most passive participles, which are classified in the corpus as separate lemmata. Cells showing unvocalized prefixes are in gray. These are rare and the counts within them are small.

				PREFIX																				
				nad(ɛ)		(v)ob(ɛ)		(v)od(ɛ)/ (v)ot(ɛ)		pod(ɛ)		pr̥̆d(ɛ)		roz(ɛ)		s(ɛ)		v(ɛ)		vz(ɛ)		z(ɛ)		TOTAL	
	root class	verb	root allomorph	nad	nadɛ	(v)ob	(v)obɛ	(v)od/ (v)ot	(v)odɛ/ (v)otɛ	pod	podɛ	pr̥̆d	pr̥̆dɛ	roz	rozɛ	s	sɛ	v	vɛ	vz	vzɛ	z	zɛ	__C	__Cɛ
VERB	alternating CC(C) and C(C)VC (or C) root allomorphs	bral	br						1869		39				746		3744							6398	
			ber						425		18				223		989							1655	
		t͡ʃɛtl	t͡ʃt						261						9		508							778	
			t͡ʃɛt					1	258						5		178						1	441	
		dral	dr												13		1		26				2	42	
			dɛr														8	2	2				2	10	
		hnal	hn		1		124		335				55		214		3622		197					4548	
			ʒɛn				2		67				10		24		1442	23					23	1545	
		mlɛl	ml								23				34		159							216	
			mɛl								5				37		97							139	
		pral	pr													21	6	1					22	6
			pɛr						1							3							3	1	
		psal	ps		68		1		537		5650		511		136		1468		305					8676	
			piːʃ		12		1		81		804		108		29		236	4	76					1347	
		sral	sr					3							4								2	3	6
			sɛr					10							7									10	7
		stal	stl						10		3				26									39	
			stɛl						2		2				2									6	
		ʃɛl[a]	jd		116		2070		3623		3		187		274		2458		2907		364			12002	
			j		6		1117		4389		4		699		205		1047	1	726		192		1	8385	
			ʃ		427		1918		12821				498		1433		5137		6072		956			29262	
			ʃɛd						1						1			1					1	2	
		ʒral	ʒr												19		701		4					724	
			ʒɛr												15		434							449	
	CC(C) root allomorph		tspal																111					111	
			t̥ʃkal														42							42	
			dmul																		193			193	
			dnul												191									191	
			drɛl					25	4						34		79						25	117	
			finul														730							730	
			lfial				67										1548		2					1617	
			lnul																4					4	
			lscɪl				158																	158	
			mdlɛl																				38	38	
			mk(nu)l[b]				117		899								321							1337	
			mnul												20				2					22	
			mrɛl																				15395	15395	
			ndal						3						1									4	
			pr̥ɛl						521		518				4						653			1696	
			ptal																				35265	35265	
			rval						21						124		153		3					301	
			r̥val												84		127							211	
			sx(nu)l[b]												2		78							80	
			sɲɪl						1						1				1					3	
			snul																				102	102	
			spal						1															1	
			str̥ɛl				141						141		43									325	
			ʃtkal												21									21	
			ʃtval												18									18	
			tkal				3										11068	1	24				1	11095	
			tk(nu)l[b]																100					100	
			tlɛl																				30	30	
			tmɲɛl[c]														477							477	
			tr̥ɛl												278		701		356					1335	
			vr̥ɛl						29142						889		3235							33266	
			zɲɪl		3		17		1		8								1					30	
			znal				2								2048		89							2139	
			zɲɛl					2	408						603								2	1011	
			zr̥ɛl				1		3												1			5	
	CCV root with root vowel sometimes deleted	fraːl	fr				21		4631				24		395		1969							7040	
			fira				4		1021				3		79		340							1447	
		fr̥aːl	fr̥										13		122									135	
			fr̥ɛ										199		277									476	
		smaːl	sm												2572									2572	
			smɲɛ[c]												388									388	
		staːl[d]	st			908		91	23															999	23
			sto			424		1																425	
		vlaːl	vl												19									19	
			vla												3									3	
	C-nasal roots (highly irregular!)[e]	jal/ jmul	jm				1339		159		1		3				675							2177	
			j(a)			2880		114		8		4				201				76				3283	
			j(ɛ)					2																2	
		pjal/ pnul	pn				52		118				22		750		278				38			1258	
			pj(a)				3		23					8	41	3	171			2	143		13	381	
		cal/ tnul	tn						2		10				78		83		3					176	
			c(a)					6		16				35		78							135		
			c(ɛ)											1		6							7		
		ʒal/ʒnul	ʒn														2								2
	pla:l/planul[f]		pl																	147				147	
			pla																	577				577	

[a] The highly irregular verb "to go" has infinitive [jiːt] and non-past [jdɛ]. The allomorph [ʃɛd] is only used in archaic forms.

[b] The thematic element [nu] often does not appear in past forms.

[c] [ɲ] regularly gets inserted between /m/ and /ɛ/; the roots here are /tm/ and /smɛ/.

[d] This verb shares its infinitive with the root [sta], whose root vowel never gets deleted. The forms are sometimes confused, even in writing.

[e] It is unclear whether [n] is part of the root or part of the thematic element. Example paradigm: infinitive [tnout] (archaic [ciːt]), past [cal] or [tnul], non-past [tnɛ], verbal noun [cɛciː].

[f] In the past, this verb can be either /pla-a-l/ [pl-aː-] or /pla-nu-l/ [pla-nu-l]. Thus, for speakers that use [planul], there is no form of this verb with a CC root allomorph.

Appendix C Prefix vocalization in imperfective verbs

The table below includes counts for secondary imperfective verbs derived from roots with CC allomorphs in at least one prefixed perfective form (see Appendix B). The counts do not include verbal nouns and most passive participles, which are classified in the corpus as separate lemmata. Cells showing unvocalized prefixes are in gray. These are much more common, with higher frequency, than in Appendix B.

					PREFIX																							
					nad(ɛ)		(v)ob(ɛ)		(v)od(ɛ)/ (v)ot(ɛ)		pod(ɛ)		pr̥ɛd(ɛ)		roz(ɛ)		s(ɛ)		v(ɛ)		vz(ɛ)		z(ɛ)		TOTAL	
	imperfective class	perfective class	perfective	imperfective	nad	nadɛ	(v)ob	(v)obɛ	(v)od/ (v)ot	(v)odɛ/ (v)otɛ	pod	podɛ	pr̥ɛd	pr̥ɛdɛ	roz	rozɛ	s	sɛ	v	vɛ	vz	vzɛ	z	zɛ	__C	__Cɛ
VERB	C(C)VC root allomorph	alternating CC(C) and C(C)VC root allomorphs	bral	biːral					8	1060		6			12	1049	6381	3							6401	2118
			t͡ʃɛtl	t͡ʃiːtal					26	190			711				458	11							1195	201
			mlɛl	miːlal				1		1	2	23			1	15		5							3	45
			psal	pɪsoval		19			15	145	20	991	46	469	1	120	15	349	50	10					147	2103
			stlal[a]	stiːlal						1		13				10										24
		CC(C) root allomorph	dmul	diːmal											3										3	
			lnul	liːnal															1		77				78	
			mk(nu)l	mɪkal/miːkal			1	31	21	197							159								181	228
			mrɛl	miːral																			90		90	
			sx(̊nu)l	sɪxal/siːxal														24								24
			tk(nu)l	tɪkal/tiːkal													1233		1						1234	
			t̥ɛl	ciːral											124		368		196						688	
			vrɛl	viːral					2301	4418					78	310	2911								5290	4728
			zr̥ɛl[a]	ziːral			15		2	39		657													17	696
		C-nasal roots (highly irregular!)[b]	jal/jmul	jiːmal			1663		77	1	1		341		224		591		12363						15260	1
			pjal/pnul	piːnal				255	1	26	1		4		418	212	150		2		200				776	493
			cal/tnul	ciːnal					5		3				26	3	49								83	3
			ʒal/ʒnul	ʒiːnal											8			4							8	4
	other root allomorphy	alt. CC and C root	ʃɛl	xaːzɛl	53		1368		7091		14		2509		663		4291		1306		64				17359	
		CC root allomorph	fɪnul	hiːbal											351		108								459	
	imperfective morpheme attached to CC(C)(V) root allomorph	alt. CCC and CCVC root	stlal[a]	stlaːval												1										1
		CCV root with root vowel sometimes deleted	fraːl	fraːval				7		4124				17		229		380								4757
			fr̥aːl	fr̥iːval										6		96							5		5	102
			smaːl	sm̥iːval												69										69
			staːl[c]	staːval			2		65																67	
			vlaːl	vlaːval												3										3
		CC(C) root allomorph	t͡spal	t͡spaːval																1						1
			dɲɪl	dɲiːval												134										134
			drɛl[d]	ɟiːral											105	4	19								124	4
			lɦal	lɦaːval				84										515								599
			ndal	ndaːval						1																1
			ptal	ptaːval																			1			1
			rval	rvaːval												6										6
			ʃtval	ʃtvaːval												6										6
			tkal	tkaːval														4264		9						4273
			tmɲɛl	tmiːval													482								482	
			zɟɪl	zɟiːval				3				1														4
			znal	znaːval												827		6								833
			zɲɛl	zɲiːval						74						58										132
			zr̥ɛl[a]	zr̥iːval								440														440

[a] These verbs sometimes appear with root allomorphy and sometimes with an imperfective affix.

[b] Although it is unclear from the perfective whether the [n] is part of the root for these verbs (see Appendix B), it does appear in the imperfective.

[c] The imperfective forms for this verb are identical to those of the verb [stal], which never has a CC root allomorph.

[d] These forms may also be imperfectives of [dral].