Reconstructing the Phonology of Proto-Indo-European Reduplication

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1 Introduction

- Prefixal partial reduplication is involved in the morphological exponence of a number of verbal categories in Proto-Indo-European (PIE) (see generally, e.g., Fortson 2010:103–104; for details and recent analyses, see Keydana 2006, 2012, Zukoff 2017a, Kim 2020).[1]

- In all the daughter languages that retain this type of reduplication, single-consonant-initial roots show a prefixal reduplicant in CV.
  - The consonant always corresponds to the base-initial consonant (C_1).
  - The languages differ on the nature of the vowel (I will not be focusing on this today).

(1) Example of C_1-copying reduplication to CVX– root in Ancient Greek
$\sqrt{d\bar{o}}$- 'give' → PERF *de*-$d\bar{o}$- 'have given'

- In (nearly) all of the languages which attest *stop-sonorant* (TR) bases, those bases reduplicate by copying the base-initial consonant followed by the reduplicative vowel.
- The systematic differences across the attested languages arise in the behavior of bases with other types of clusters, always including *s-stop* (ST).

(2) Indo-European reduplication by cluster type

	TR-bases	**ST-bases**
Old Irish	C_1-copying	C_1-copying
Sanskrit	C_1-copying	C_2-copying
Gothic	C_1-copying	cluster-copying
Ancient Greek	C_1-copying	non-copying
Latin	*not attested*	infixal C_1-copying
Hittite	cluster-copying	cluster-copying

[1] I will focus on the evidence from the perfect, but all the relevant points made today apply equally well to present and aorist reduplication (though probably not to the intensive).

- Perhaps the most commonly held view of the PIE reconstruction of this system (e.g. Rix 1992:202–203) posits a system equivalent to Gothic (and Proto-Anatolian; Yates & Zukoff 2018):

(3) Traditional PIE reconstruction
   a. C_1-copying for TR-bases: /RED, TRVX–/ → [TV-TRVX–]
   b. Cluster-copying for ST-bases: /RED, STVX–/ → [STV-STVX–]

- By positing cluster-copying for ST-bases in PIE, all of the attested patterns can be derived via reductions ("dissimilations") from the proto-language (cf. Kim 2020).

⋆ In this talk, I will argue for a different reconstruction: "across-the-board C_1-copying" (following recently, e.g., Keydana 2006, Byrd 2010:100–105).

(4) Alternative PIE reconstruction (to be argued for)
   a. C_1-copying for TR-bases: /RED, TRVX–/ → [TV-TRVX–]
   b. C_1-copying for ST-bases: /RED, STVX–/ → [SV-STVX–]

- This pattern is equivalent to the one attested in Old Irish (and elsewhere).

- The primary evidence for this (Brugmann & Delbrück 1897:40–41; see Byrd 2010:103–104) is **cognate archaisms** across the family that run counter to the (semi-)productive patterns represented above.

(5) Reduplicated presents of PIE $\sqrt{}$*$steh_2$ 'stand'
   a. A. Greek ἵστημι [hí-stɛ̄-mi] (< Proto-Greek *si-$stā$-mi) cf. perfect ἕσταλκα [é-stal-k-a]
   b. Latin *$sistō$* ([si-st-ō]) cf. perfect *$stetī$* [s-te-t-ī]
   c. Avestan *hi-$štaiti$*, *vi-$ša$-$star^ə$*
   d. Old Persian *a-hi-$štatā$*

- The fact that the Latin and Greek forms agree with each other and with the Iranian forms can only be explained if that pattern is reconstructed to Proto-Indo-European.

⋆ This precludes the "dissimilation" analysis of the changes into the daughter languages, demanding a new explanation.

- Today, I will outline a way of understanding these changes, in terms of systemic diachronic changes in Optimality Theoretic (Prince & Smolensky [1993] 2004) constraint-based synchronic grammars:[2]

(6) The various changes from "across-the-board" C_1-copying to the cluster-dependent alternations of the daughter languages result from independent promotion of the same markedness constraint, with different "repairs" in the different languages.

Roadmap

- In §2, I will provide constraint-based analyses of the attested languages, showing that the different systems can be derived by minimal re-ranking of a small set of well-motivated constraints.
- In §3, I will review the internal and comparative evidence for reconstructing "across-the-board" C_1-copying, and show how viewing the problem through the lens of constraint-based grammar change avoids the conceptual problems which have heretofore advocated for the traditional reconstruction.

[2] This is quite a similar approach to that employed by Keydana (2006), though the analyses differ quite substantially.

2 Synchronic analysis of attested IE reduplicative systems

- Putting aside for the moment the infixal pattern observed in Latin, the remaining systems can each be analyzed by a ranking of the following five constraints.

- Two are syllable structure markedness constraints, making demands on output syllable structure:
  - *CC (7a) penalizes having consonant clusters in the reduplicant.[3]
  - Onset (7b) penalizes a reduplicant that lacks an onset consonant.

(7) a. ***Cluster (*CC)**
Assign a violation * for each sequence of 2 consonants in the output. (*Don't have clusters!*)
b. **Onset**
Assign a violation * for each onsetless syllable. (*Have an onset!*)

- Two are "Base-Reduplicant" faithfulness constraints (McCarthy & Prince 1995), essentially making demands on the similarity between the base and the reduplicant:
  - Contiguity-BR (8a) requires contiguous copying from the base.
  - Anchor-L-BR (8b) requires copying that begins at the left edge of the base.

(8) a. **Contiguity-BR**
Assign one violation * for each pair of segments that are adjacent in the reduplicant but have non-adjacent correspondents in the base (no $\underline{X_1X_3}$-$X_1X_2X_3$). (*No skipping!*)
b. **Anchor-L-BR**
Assign a violation * if the segment at the left edge of the reduplicant does not stand in correspondence with the segment at the left edge of the base. (*Copy from the left edge!*)

- The last of the constraints is the novel No Poorly-Cued Repetitions constraint (Zukoff 2017a):

(9) **No Poorly-Cued Repetitions (*PCR)** [$\approx$ *$C_\alpha VC_\alpha$/_$C_{[-\text{sonorant}]}$]
For each sequence of repeated identical consonants separated by a vowel ($C_\alpha VC_\alpha$), assign a violation * if that sequence immediately precedes an obstruent.

⋆ The simplified definition in (9), which militates against locally repeated consonants in *pre-obstruent position*,[4] will be sufficient for today's purposes:
  - *PCR penalizes C_1-copying to STVX– (i.e. *s*-obstruent-initial) bases (10b), but not to TRVX– bases (10a). This is the motivation for the cluster-dependent behavior differences.

(10) Repetitions and satisfaction/violation of *PCR (schematic)

	Base type	C_1-copying	Repetition		Context	Satisfied?
a.	**TRVX–**	*pa-pr*ako	*pap*	/	_*r* (sonorant)	✓
b.	**STVX–**	*sa-st*ako	*sas*	/	_*t* (obstruent)	✗

[3] Markedness constraints penalize these structures anywhere they appear. However, if the markedness constraints rank below the relevant Input-Output (IO) faithfulness constraints, they will not have any impact outside of reduplication. These are therefore "emergence of the unmarked" effects (McCarthy & Prince 1994, 1995).

[4] A more fine-grained version of this constraint which is sensitive to the distribution of particular phonetic properties of consonants and consonant clusters is required to account for the different cluster-wise distributions of the reduplicative alternants (see Zukoff 2017a:Ch. 6).

- With the constraints introduced, I'll now show how they can be ranked to derive the full range of attested patterns.
  - ∗ Alongside each actual dataset, I will provide a schematic version to clarify which differences are relevant. I will also use these schematic forms to demonstrate the rankings in tableaux.

2.1 Hittite: across-the-board cluster-copying

- Hittite (11) displays "across-the-board cluster-copying" (Zukoff 2017a:Ch. 3, Yates & Zukoff 2018).
  - ○ In obstruent-sonorant–initial bases (11a), the reduplicant copies the whole cluster.
  - ○ In STVX– bases (11b), the reduplicant also copies the whole cluster.
  - ∗ Prothesis in STVX– bases is a general process in the language and not specific to reduplication.

(11) Across-the-board cluster-copying in Hittite (cf. Dempsey 2015)

	Root		Reduplicated stem	
a.	**TRVX– bases → cluster-copying**			
	√*par(a)i-*	'blow'	*parip(p)ar(a)i-*	[pri-pːr(a)i-]
	√*ḫal(a)i-*	'kneel'	*ḫaliḫal(a)i-*	[χli-χl(a)i-]
b.	**STVX– bases → cluster-copying**			
	√*stu-*	'become evident'	*išdušduške-*	[istu-stu-]

- A schematic version of this pattern is shown in (12):

(12) Across-the-board cluster-copying (schematic)

	Base Type	Root		Reduplicated	Red. Shape
a.	Singleton	√*mako*	→	*ma-mako*	C_1V_2
b.	Stop-sonorant	√*prako*	→	*pra-prako*	$C_1C_2V_3$
c.	*s*-obstruent	√*stako*	→	*sta-stako*	$C_1C_2V_3$

- The three most viable reduplicative candidates for a TR-initial base are those in (13).
  - ○ Copy the whole cluster (13a) [pra-prako]
  - ○ Copy just the first consonant (13b) [pa-prako]
  - ○ Copy just the second consonant (13c) [ra-prako]

- The three constraints that are relevant in choosing between these options are:
  - ○ *CC (7a), violated by (13a) because it creates a new cluster
  - ○ Contiguity-BR (8a), violated by (13b) because the reduplicant "skips" the base-second [r]
  - ○ Anchor-L-BR (8b), violated by (13c) because the reduplicant doesn't start with a copy of the base-initial [p].

• In order for candidate (13a) to win, *CC must rank below CONTIGUITY-BR and ANCHOR-L-BR.[5]

(13) Generating across-the-board cluster-copying: Hittite [pri-pːr(a)i-], [istu-stu-]

/RED, prako/		CONTIGUITY-BR	ANCHOR-L-BR	*CC
a. ☞	pra-prako			**
b.	pa-prako	*!		*
c.	ra-prako		*!	*

(14) **Hittite Ranking:** CONTIGUITY-BR, ANCHOR-L-BR ≫ *CC

2.2 Old Irish (and elsewhere): across-the-board C_1-copying

• Old Irish (15) displays "across-the-board C_1-copying".
  ◦ In obstruent-sonorant–initial bases (15a), the reduplicant copies just the first consonant.
  ◦ In STVX– bases (15b), the reduplicant also copies just the first cluster.
  ∗ The root-initial stops in the TRVX– roots undergo lenition (spirantization).

(15) Old Irish reduplicated preterites (Thurneysen [1946] 1980:424–428/§687–691)

	Root		Reduplicated preterite	
a.	**TRVX– roots → C_1-copying**			
	√*-glenn-*	'learn'	*-geglann*	[-ge-ɣlənn]
	√*-grenn-*	'persecute'	*-gegrann*	[-ge-ɣrənn]
	√*brag-*	'bleat'	*bebrag-*	[be-vrəɣ-]
	√*klad-*	'dig'	*cechlad-*	[ke-xləð-]
b.	**STVX– roots → C_1-copying**			
	√*skenn-*	'fly off'	*sescann-*	[se-skənn]

⋆ This pattern is also reconstructible to Pre-Greek (Zukoff 2017a:Ch. 2, 2017b), and potentially other prior stages within the Indo-European family.

• The schematic version of this pattern is shown in (16):

(16) Across-the-board C_1-copying (schematic)

	Base Type	Root		Reduplicated	Red. Shape
a.	Singleton	√*mako*	→	*ma-mako*	C_1V_2
b.	Stop-sonorant	√*prako*	→	*pa-prako*	C_1V_3
c.	*s*-obstruent	√*stako*	→	*sa-stako*	C_1V_3

[5] In all the IE languages, consonant clusters are allowed outside of reduplication. Therefore, MAX-IO and DEP-IO (McCarthy & Prince 1995) outrank *CC, and it is never optimal to repair the base-initial cluster. This means optimal candidates (such as (13a)) will always have at least one *CC violation.

- This pattern is derived by simply swapping the ranking of *CC and CONTIGUITY-BR (17).
  - This ranking means that avoiding the extra cluster (18a) is worth doing discontiguous copying (18b).

(17) **Old Irish Ranking:** ANCHOR-L-BR, *CC ≫ CONTIGUITY-BR [to be expanded]

(18) Generating across-the-board C_1-copying: Old Irish *bebrag-*

/RED, prako/		ANCHOR-L-BR	*CC	CONTIGUITY-BR
a.	pra-prako		**!	
b. ☞	pa-prako		*	*
c.	ra-prako	*!	*	

- This pattern also gives evidence about the ranking of *PCR (≈ *$C_\alpha VC_\alpha T$).
  - In ST-initial bases, the optimal C_1-copying candidate (19b) violates *PCR, because of its [sVst] sequence.
  - Since this violation isn't shared by the other candidates, *PCR must rank below ANCHOR-L-BR and *CC.

(19) Generating STVX– C_1-copying: Old Irish *sescann-*

/RED, prako/		ANCHOR-L-BR	*CC	CONTIGUITY-BR	*PCR
a.	sta-stako		**!		
b. ☞	sa-stako		*	*	*
c.	ta-stako	*!	*		

(20) **Old Irish Ranking:** ANCHOR-L-BR, *CC ≫ CONTIGUITY-BR, *PCR

2.3 Gothic: TRVX– C_1-copying, STVX– cluster-copying

- Gothic (21) will be the first system we look at which demonstrates distinct behavior by cluster type, which is more typical of the IE languages.
  - Like Old Irish, Gothic exhibits C_1-copying for TR-initial bases (21a), which is the default.
  - On the other hand, now like Hittite, Gothic displays cluster-copying for ST-initial bases (21b).

(21) Class VII preterites in Gothic (forms from Lambdin 2006:115; see also Jasanoff 2007, *a.o.*)

	Root	Infinitive		Preterite		
a.	**TRVX– roots → C_1-copying**					
	'to weep'	*gretan*	[grēt-an]	*gaigrot*	[gɛ-grōt]	(not **[grɛ-grōt])
b.	**STVX– roots → cluster-copying**					
	'to possess'	*staldan*	[stald-an]	*staistald*	[stɛ-stald]	(not **[sɛ-stald])
	'to divide'	*skaidan*	[skæːð-an]	*skaiskaiþ*	[skɛ-skæːθ]	(not **[sɛ-skæːθ])

- According to Yates & Zukoff (2018), we should also reconstruct Proto-Anatolian as having this pattern (see also Zukoff 2017a:Ch. 3; cf. Dempsey 2015).

- This pattern is schematized in (22):

(22) TRVX– C_1-copying, STVX– cluster-copying (schematic)

	Base Type	Root		Reduplicated	Red. Shape
a.	Singleton	$\sqrt{mako}$	→	*ma-mako*	C_1V_2
b.	Stop-sonorant	$\sqrt{prako}$	→	*pa-prako*	C_1V_3
c.	*s*-obstruent	$\sqrt{stako}$	→	*sta-stako*	$C_1C_2V_3$ (**sa-stako*)

- We can understand this alternation as being driven by a high ranking of *PCR (Zukoff 2017a: Ch. 4, Zukoff & Sandell 2015).
  - Namely, the same ranking as Old Irish, but with *PCR (and ANCHOR) above *CC:

(23) **Gothic Ranking:** *PCR, ANCHOR-L-BR ≫ *CC ≫ CONTIGUITY-BR

- Since *PCR isn't relevant for TR bases, this ranking has the same effect as that of Old Irish.
  - It prefers the C_1-copying candidate (24b) with only its low-ranked CONTIG violation.

(24) Generating TRVX– C_1-copying: Gothic *gaigrot*

/RED, prako/	*PCR	ANCHOR-L-BR	*CC	CONTIG-BR
a. pra-prako			**!	
b. ☞ pa-prako			*	*
c. ra-prako		*!	*	

- On the other hand, the equivalent C_1-copying candidate for ST-initial bases (25b) violates *PCR.
  - This forces the grammar to select the candidate with the next lowest-ranked violation, (25a), which violates *CC.

(25) Generating STVX– cluster-copying alongside TRVX– C_1-copying: Gothic *staistald*

/RED, stako/	*PCR	ANCHOR-L-BR	*CC	CONTIG-BR
a. ☞ sta-stako			**	
b. sa-stako	*!		*	*
c. ta-stako		*!	*	

→ In other words, it is generally preferable to avoid creating a consonant cluster in the reduplicant, but this is tolerated if it allows a pre-obstruent repetition to be avoided.

- Note also that this mode of generating cluster-copying is actually completely different from that in Hittite.
  - In Hittite, cluster-copying is motivated by a desire to have contiguous copying (high-ranked CONTIG).
  - In Gothic, it is motivated by a desire to avoid pre-obstruent repetitions: by copying the second consonant, the repetition is disrupted.

2.4 Sanskrit: TRVX– C_1-copying, STVX– C_2-copying

- Sanskrit (26) illustrates a different way of satisfying *PCR (Zukoff 2017a:Ch. 5).
  - TR-initial bases again show C_1-copying (26a).
  - Like Gothic, ST-initial bases *don't* show C_1-copying; but unlike Gothic's cluster-copying repair, Sanskrit repairs the *PCR problem by copying C_2 (26b).

(26) Perfects to cluster-initial roots in Sanskrit (forms from Whitney 1885)

	Root		Perfect Tense	
a.	**TRVX– roots → C_1-copying**			
	$\sqrt{b^h raj}$-	'shine'	*ba-b^{h}rāj-a*	(not **ra-b^{h}rāj-a)
	$\sqrt{prac^h}$-	'ask'	*pa-prāc^h-a*	(not **ra-prāc^h-a)
	$\sqrt{dru}$-	'run'	*du-druv-ē*	(not **ru-druv-ē)
	$\sqrt{tviṣ}$-	'be stirred up'	*ti-tviṣ-ē*	(not **vi-tviṣ-ē)
b.	**STVX– roots → C_2-copying**			
	$\sqrt{sparç}$-	'touch'	*pa-spṛç-ē*	(not **sa-spṛç-ē)
	$\sqrt{st^h ā}$-	'stand'	*ta-st^{h}ā-u*	(not **sa-st^{h}ā-u)
	$\sqrt{stamb^h}$-	'prop'	*ta-stamb^h-a*	(not **sa-stamb^h-a)

- This pattern is schematized in (27):

(27) **TRVX– C_1-copying, STVX– C_2-copying**

	Base Type	Root		Reduplicated	Red. Shape	
a.	Singleton	$\sqrt{mako}$	→	*ma-mako*	C_1V_2	
b.	Stop-sonorant	$\sqrt{prako}$	→	*pa-prako*	C_1V_3	
c.	*s*-obstruent	$\sqrt{stako}$	→	*ta-stako*	C_2V_3	(***sa-stako*)

- The difference between Sanskrit and Gothic can be framed as a difference in which constraint can be violated under pressure from *PCR.
  - In Gothic (23), it's *CC.
  - In Sanskrit (28), it's ANCHOR-L-BR:

(28) **Sanskrit Ranking:** *PCR, *CC ≫ ANCHOR-L-BR ≫ CONTIGUITY-BR

- When *PCR is not at stake, C_1-copying (29b) remains the preferred option:

(29) Generating TRVX– C_1-copying: Sanskrit *pa-prāc^h-a*

/RED, prako/		*PCR	*CC	ANCHOR-L-BR	CONTIG-BR
a.	pra-prako		**!		
b. ☞	pa-prako		*		*
c.	ra-prako		*	*!	

- When *PCR *is* at stake, C_1-copying (30b) is again ruled out. Since *CC outranks ANCHOR-L-BR, the preferred alternative is C_2-copying (30c), which violates ANCHOR-L-BR but not *CC (30a).

(30) Generating STVX– C_2-copying alongside TRVX– C_1-copying: Sanskrit *ta-stambh-a*

/RED, stako/		*PCR	*CC	ANCHOR-L-BR	CONTIG-BR
a.	sta-stako		**!		
b.	sa-stako	*!	*		*
c. ☞	ta-stako		*	*	

2.5 Ancient Greek: TRVX– C_1-copying, STVX– non-copying

- The last remaining non-infixal *PCR-avoidance strategy attested among the IE languages is to copy no consonant at all ("non-copying"), as schematized in (31), specifically (31c):

(31) TRVX– C_1-copying, STVX– non-copying (schematic)

	Base Type	Root		Reduplicated	Red. Shape	
a.	Singleton	√*mako*	→	*m-e-mako*	C_1-V	
b.	Stop-sonorant	√*prako*	→	*p-e-prako*	C_1-V	
c.	*s*-obstruent	√*stako*	→	*e-stako*	Ø-V	(*****s-e-stako***)

- This pattern is attested in Ancient Greek, as shown in (32):

(32) TRVX– C_1-copying, STVX– non-copying in Ancient Greek

	Root		Perfect Tense		
a.	**TRVX– roots → C_1-copying**				
	√*kri-*	'decide'	κέκριμαι	[k-e-kri-mai]	(not **[e-kri-mai])
	√*pneu-*	'breathe'	πέπνυμαι	[p-e-pnū-mai]	(not **[e-pnū-mai])
	√*tla-*	'suffer, dare'	τέτληκα	[t-e-tlɛ̄-k-a]	(not **[e-tlɛ̄-k-a])
b.	**STVX– roots → Non-copying**				
	√*stel-*	'prepare'	ἔσταλκα	[e-stal-k-a]	(not **[s-e-stal-k-a])
	√*strat-eu-*	'wage war'	ἔστρατευμαι	[e-strat-eu-mai]	(not **[s-e-strat-eu-mai])

• The first thing that we'll need to do to analyze this pattern is add in ONSET (7b), repeated here:

(33) **ONSET:** Assign a violation * for each onsetless syllable. (*Have an onset!*)

• This constraint will penalize the *PCR-driven alternative pattern, helping motivate C_1-copying in the general case (32a).

⋆ The other thing we need to do is make a claim about the reduplicative vowel:
→ It must be an underlying "**fixed segment**", rather than a copy.

2.5.1 Types of vocalism

• The patterns of reduplicant vocalism in the IE languages vacillate between two descriptive types:

(34) Type of reduplicant vocalism
a. **Copy vocalism**: the reduplicative vowel is always (partially) identical to the base vowel.
∗ Sanskrit, Anatolian (mostly), Latin (to some extent)
b. **Fixed vocalism**: the reduplicative vowel has a consistent value (doesn't co-vary with base vowel).
∗ More typical, including Ancient Greek, Gothic, etc.

• Following Alderete et al. (1999), fixed vocalism (and consonantism) comes in two types:

(35) Types of fixed vocalism
a. **Phonologically fixed**: the reduplicative vowel copies the base vowel but is consistently reduced to satisfy markedness constraints (McCarthy & Prince 1994, 1995).
b. **Morphologically fixed**: the reduplicative vowel is specified in the underlying representation, and thus not a "copy" at all.

⋆ The Ancient Greek-type STVX– non-copying pattern requires a *morphological* fixed segmentism analysis, because of the way that BR-correspondence works (see Zukoff 2017a:Ch. 2).

2.5.2 The Ancient Greek analysis

• The ranking that generates the Ancient Greek pattern is the following:

(36) **Ancient Greek ranking:** *PCR, ANCHOR-L-BR, *CC ≫ ONSET[6]

• ONSET enforces C_1-copying for TRVX– bases (37b) because non-copying (37d) confers no benefit:

(37) Generating C_1-copying (w/ morphologically fixed /e/): A. Greek κέκριμαι [k-e-kri-mai]

/RED, e, prako/		*PCR	ANCHOR-L-BR	*CC	ONSET
a.	pr-e-prako			**!	
b. ☞	p-e-prako			*	
c.	r-e-prako		*!	*	
d.	_-e-prako			*	*!

[6] CONTIGUITY-BR is not relevant because the reduplicative vowel isn't a copy.

- But given the ranking in (36), when *PCR blocks C_1-copying for STVX– (38b), non-copying (38d) is the optimal repair because it violates only low-ranked ONSET:

(38) Generating STVX– C_2-copying alongside TRVX– C_1-copying: A. Greek ἔσταλκα [e-stal-k-a]

/RED, e, stako/	*PCR	ANCHOR-L-BR	*CC	ONSET
a. st-e-stako			**!	
b. s-e-stako	*!		*	
c. t-e-stako		*!	*	
d. ☞ _-e-stako			*	*

- The reason why we require a morphological (as opposed to phonological) fixed segmentism account is that, if the vowel were a copy (phonological fixed segmentism), winning candidate (38d) would violate ANCHOR-L-BR.
- This violation would be equivalent to that of the C_2-copying candidate, which lacks (38d)'s ONSET violation, and thus would be selected: compare (39.i) vs. (39.ii).

(39) ANCHOR-L-BR violations by vocalism type

i. *Copy vocalism* or *phonologically-fixed vocalism*

/RED, stako/	ANCHOR-L-BR	ONSET
a. 💣 te-stako	*	
b. ☹ e-stako	*	*!

ii. *Morphologically-fixed vocalism*

/RED, e, stako/	ANCHOR-L-BR	ONSET
a. t-e-stako	*!	
b. ☞ _-e-stako		*

2.6 Latin infixing perfect reduplication for STVX– bases

- The last *PCR-driven reduplicative repair we will consider is infixal reduplication to ST-initial bases in Latin (Fleischhacker 2005, DeLisi 2015).
  - In this pattern, the reduplicant retains its target shape *CV*, but deviates from its target position at the left edge by placing the reduplicant *after* the root-initial *s*, as shown in (40).

(40) **Latin infixing perfect reduplication to STVX– bases** (forms from Weiss 2009:410)

Root		Perfect		
√*spond*	'promise'	*s-po-pond-ī*	(not ***so-spond-ī*)	
√*scid*	'cut'	*s-ci-cid-ī*	(not ***si-scid-ī*)	
√*st*	'stand/stop'	*s-te-t-ī*	(not ***se-st-ī*)	[but present *si-st-ō*]

- Infixation is triggered by *PCR, because it again penalizes prefixal C_1-copying (e.g. ***si-scid-ī*).
- The primary constraint violated by infixation is ALIGN-RED-L (41), which wants the reduplicant to be as close to the left edge as possible.[7]

(41) **ALIGN-RED-L:** Assign one violation * for each segment intervening between the left edge of the reduplicant and the left edge of the word. (*Prefix the reduplicant!*)

[7] Infixation inside the root also violates CONTIGUITY-IO: *Assign one violation * for each pair of segments which are adjacent in the input that have non-adjacent correspondents in the output.*

→ If ALIGN-RED-L is the lowest-ranked constraint, infixation will be selected as the optimal pattern for STVX– bases, as shown in (42).

- ∗ This alignment approach correctly predicts that infixation is minimal: (42d) ≻ (42e).
- ∗ The base of reduplication must be the string to the right of the reduplicant.

(42) Infixing reduplication in Latin STVX– bases to avoid *PCR violation

/RED, scid, ī/		*PCR	ANCHOR-L-BR	*CC	ALIGN-RED-L
a.	si-scid-ī	*!		*	
b.	ci-scid-ī		*!	*	
c.	sci-scid-ī			**!	
d. ☞	s-ci-cid-ī			*	*
e.	sc-id-id-ī			*	**!

(43) **Latin Ranking:** *PCR, ANCHOR-L-BR, *CC ≫ ALIGN-RED-L

- This analysis predicts that TRVX– roots should exhibit C_1-copying pattern, because infixation is triggered by *PCR-violating repetitions: hypothetical $\sqrt{}$*plen-* → *pe-plen-*, not *p-le-len-*.
- Unfortunately, Latin doesn't have any reduplicated forms to TRVX– roots (Cser 2009), so we can't test this prediction.

∗ **N.B.:** To avoid selecting infixation as an optimal output in the other systems considered above, ALIGN-RED-L must outrank (at least) CONTIGUITY-BR.

2.7 A brief look at Tocharian

- I have not yet fully assessed the evidence, but Pan (yesterday) (drawing on Krause 1952 and Malzahn 2010) has collected the Tocharian cluster-initial reduplicated verbal forms.
- The table in (44) gives the evidence from Tocharian A.
  - ○ These forms appear to all attest C_1-copying, as in Old Irish.

(44) Tocharian A cluster-initial partial reduplication

Root			**Reduplicated**
C-sonorant clusters			
krop(ā)-	'to assemble'	→	*kākropu/kākrupu*
prutk(ā)-	caus. 'to fill up'	→	*paprutku*
plānt(ā)-	'to rejoice'	→	*pāpläntu*
mrosk(ā)-	'to feel disgust'	→	*māmrosku*
kärs(ā)-	caus. 'to make know(n)'	→	*śaśärsu*
sp-clusters			
spārtw(ā)-	'to behave'	→	*sāspärtwu*
spärk(ā)-	caus. 'to destroy'	→	*ṣaṣpärku*
st-clusters			
ṣtäm(ā)-	caus. 'to put'	→	*śaśmu*

- The table in (45) gives the evidence from Tocharian B, which appears substantially more complex.
  - Clusters ending in a sonorant all display C_1-copying, as with most of the other IE languages.
  - ST-clusters where the stop is [p] appear to show C_2-copying, as in Sanskrit.
  - ST-clusters where the stop is [t] appear to show cluster-copying, as in Gothic.

(45) Tocharian B cluster-initial partial reduplication

Root			**Reduplicated**
C-sonorant clusters			
kraup(ā)-	'to assemble'	→	*kakraupau*
klutk(ā)-	caus. 'to make'	→	*keklyutku*
prutk(ā)-	caus. 'to fill up'	→	*peprutku*
plānt(ā)-	'to rejoice'	→	*paplāntau*
mrausk(ā)-	'to feel disgust'	→	*mamrauskau*
wlāwā-	'to control'	→	*wawlāwau*
sp-clusters			
spārtt(ā)-	'to behave'	→	*paspārttau*
spārtt(ā)-	caus. 'to turn'	→	*peṣpirttu*
spänt(ā)-	caus. 'to make trust'	→	*peṣpiṃtu*
st-clusters			
staukk(ā)-	'to swell'	→	*stastaukkauwa*
stäm(ā)-	caus. 'to put'	→	*śceścamoṣ, śeśśamu*

- Assuming this is the correct interpretation, we likely will need to identify an additional markedness constraint that can distinguish between the different *PCR-driven repairs within the same language.

3 Reconstruction of Proto-Indo-European Reduplication

- We have now assembled minimally different constraint grammars for at least 6 of the IE languages.

(46) Constraint rankings

a. **Hittite:** Contiguity-BR, Anchor-L-BR ≫ *CC
b. **Old Irish:** Anchor-L-BR, *CC ≫ Contiguity-BR, *PCR
c. **Gothic:** *PCR, Anchor-L-BR ≫ *CC ≫ Contiguity-BR
d. **Sanskrit:** *PCR, *CC ≫ Anchor-L-BR ≫ Contiguity-BR
e. **Ancient Greek:** *PCR, Anchor-L-BR, *CC ≫ Onset
f. **Latin:** *PCR, Anchor-L-BR, *CC ≫ Align-Red-L

- While there is a substantial amount of cross-linguistic variation, we can make a number of clear generalizations:

Generalizations

1. With the exception of Hittite (and Latin, where the data is lacking), all languages exhibit prefixal C_1-copying as their default behavior for cluster-initial roots.
   - This essentially matches the behavior of single-consonant-initial roots.
2. While many of the languages display *PCR effects, clearly not all do:
   - Old Irish very clearly doesn't: *PCR is violated in C_1-copying for ST-initial bases.
   - From the evidence adduced earlier, *PCR does not play a role in Hittite reduplication.

   → In fact, evidence from vowel-initial roots (Yates & Zukoff 2018) demonstrates that Hittite (and Luwian) also freely violates *PCR in reduplication.
3. Furthermore, among the languages that display *PCR effects, the specific patterns that result are all different.

⋆ Having viewed these patterns not just as collections of forms but as dynamic grammatical systems, we can address the question of reconstruction from a more holistic perspective:

→ We want to reconstruct not just the forms of the proto-language, but also the *grammar* of the proto-language.

- When considering the reconstruction of the PIE reduplicative system[8] as a whole from this perspective, it may be fruitful to frame the questions as in (47):

(47) a. Did PIE exhibit *PCR effects in reduplication? If so, then:
b. What was the alternative reduplication pattern induced by *PCR?

- The answer that many scholars working with traditional reconstruction methods (e.g. Rix 1992: 202–203) have arrived at is that PIE *did* exhibit *PCR effects, and that the repair was cluster-copying, as in Gothic:

(48) Traditional PIE reconstruction
a. C_1-copying for TR-bases: /RED, TRVX–/ → [TV-TRVX–]
b. Cluster-copying for ST-bases: /RED, STVX–/ → [STV-STVX–]

- This reconstruction allows for all of the attested patterns to be derived from the proto-language via various reductions/"dissimilations" (cf. Kim 2020), though not by otherwise regular sound changes.
- If diachronic changes happen exclusively by the application of sound changes or analogical extensions, then we would be hard pressed to find any other cogent explanation.

∗ However, if we view diachronic changes as changes in constraint grammars — i.e. the increasing or decreasing priority of a given constraint — then such an explanation is available, and indeed will be preferable.

⋆ What I want to argue today is that the answer to (47a) is *no* (which renders (47b) moot):

→ PIE exhibited across-the-board C_1-copying (following essentially Keydana 2006, Byrd 2010: 100–105), equivalent to Old Irish:

[8] See McIntyre (1992), Niepokuj (1997), Keydana (2006, 2012), Kim (2020) for recent work on the reconstruction of reduplication in Proto-Indo-European. (Consult Katz 2000 for a critique of some of Niepokuj 1997.)

(49) Alternative PIE reconstruction (to be argued for)
   a. C_1-copying for TR-bases: /RED, TRVX–/ → [TV-TRVX–]
   b. C_1-copying for ST-bases: /RED, STVX–/ → [SV-STVX–]

- In this section, I will review evidence both from traditional internal and comparative reconstruction and from constraint-grammar comparison for this reconstruction.

3.1 Evidence from internal and comparative reconstruction

- The primary evidence for across-the-board C_1-copying is straightforward: we observe **cognate archaisms** across the family that run counter to the (semi-)productive patterns represented above.

- There are a number of reflexes of a PIE reduplicated present to the root $\sqrt{}$*$steh_2$ 'stand':

(50) Reduplicated presents of PIE $\sqrt{}$*$steh_2$ 'stand' (Brugmann & Delbrück 1897:40–41; see Byrd 2010:103–104)
   a. A. Greek ἵστημι [hí-stɛ̄-mi] (< Proto-Greek *si-stā-mi) cf. perfect ἕσταλκα [é-stal-k-a]
   b. Latin *sistō* ([si-st-ō]) cf. perfect *stetī* [s-te-t-ī]
   c. Avestan *hi-štaiti*, *vi-ša-star*^{ə}
   d. Old Persian *a-hi-štatā*

Greek

- The productive pattern for ST-initial roots observed in the Ancient Greek perfect (the only productive reduplicative category) is non-copying, as in ἕσταλκα [e-stal-k-a] (**[s-e-stal-k-a]).
- Yet, the unproductive reduplicated present ἵστημι [h-i-stɛ̄-mi] (< Proto-Greek *si-stā-mi) shows C_1-copying.
- And so does its corresponding perfect, ἕστηκα [h-e-stɛ̄-k-a] (< Proto-Greek *se-stā-k-a), which has been retained due to the influence of the reduplicated present (Zukoff 2017a:50–53).

→ This shows that Ancient Greek's *PCR effect is an innovation, and that a prior stage must have had across-the-board C_1-copying.

Latin

- The unproductive but categorical pattern for Latin ST perfects is infixation: *stetī* [s-te-t-ī].
- Yet, Latin attests a corresponding reduplicated present with C_1-copying: *sistō* [si-st-ō].
- Like in Greek, present reduplication is a less productive process than perfect reduplication, making it highly likely that *sistō* predates *stetī*.

→ Given that it perfectly matches the Greek form, this strongly suggests that it is a retained archaism, and thus points to across-the-board C_1-copying in PIE.

Indo-Iranian

- This is further strengthened by the fact that the Latin and Greek forms agree with Iranian, but *not* Sanskrit, which has *tiṣṭ^{h}ati*.
- This should lead us to conclude that Sanskrit's C_2-copying pattern is an innovation against Proto-Indo-Iranian. (To my knowledge, C_2-copying is not attested in Iranian.)
- Therefore, we should treat Sanskrit *tiṣṭ^{h}ati* as an Indic innovation, *not* evidence for a PIE form/pattern.

⋆ Thus, internal reconstruction, coupled with comparative evidence, points strongly toward reconstructing C_1-copying for ST-initial roots in PIE.

- Reconstructing C_1-copying for TR-initial roots in PIE is nearly trivial based on the evidence presented above, since all languages but Hittite show this pattern.
  - ◦ According to Yates & Zukoff (2018), Hittite's cluster-copying for TR bases is innovative against Proto-Anatolian (and Luwian).
  - ◦ That is, Proto-Anatolian ought to be reconstructed as having the same pattern as Gothic, ST cluster-copying driven by *PCR.

  → This makes the reconstruction in fact trivial.

3.2 Constraint ranking change

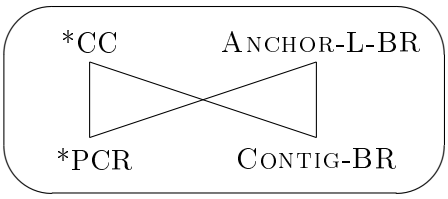
- Reconstructing across-the-board C_1-copying precludes a "dissimilation" analysis of the changes into the daughter languages, demanding a new explanation.
- The evidence just presented for across-the-board C_1-copying is anything but new.

⋆ The reason why it has not been determinative to this point is that it was not feasible to come up with an explanation for the changes into the daughter languages.

→ Thinking about the problem from the perspective of constraint ranking change provides a solution.

- The PIE ranking would be equivalent to Old Irish:

(51) **Ranking for ATB C_1-copying in PIE:**
ANCHOR-L-BR, *CC ≫ CONTIGUITY-BR, *PCR



- Here again are the constraint grammars of the attested systems, leaving out Hittite, which Yates & Zukoff (2018) argue to be innovative against Proto-Anatolian's Gothic-like system.

(52) Constraint grammars of the attested languages

	~~**Hittite:**~~	~~CONTIGUITY-BR, ANCHOR-L-BR ≫ *CC~~
a.	**Old Irish:**	ANCHOR-L-BR, *CC ≫ CONTIGUITY-BR, *PCR
b.	**Gothic:**	*PCR, ANCHOR-L-BR ≫ *CC ≫ CONTIGUITY-BR
c.	**Sanskrit:**	*PCR, *CC ≫ ANCHOR-L-BR ≫ CONTIGUITY-BR
d.	**Ancient Greek:**	*PCR, ANCHOR-L-BR, *CC ≫ ONSET
e.	**Latin:**	*PCR, ANCHOR-L-BR, *CC ≫ ALIGN-RED-L

- The change from PIE to each respective innovative system can be characterized in the same way:
  → *PCR is *promoted* over one other constraint.

(53)
a. PIE C_1-copying → Old Irish C_1-copying — *no change*
b. PIE C_1-copying → Gothic cluster-copying — ***PCR ≫ *CC**
c. PIE C_1-copying → Sanskrit C_2-copying — ***PCR ≫ ANCHOR-L-BR**
d. PIE C_1-copying → Ancient Greek non-copying — ***PCR ≫ ONSET**
e. PIE C_1-copying → Latin infixation — ***PCR ≫ ALIGN-RED-L**

- In a certain sense, then, the changes in reduplication patterns all arise from the *same change*:
  → Increased sensitivity to the repetition avoidance constraint *PCR

- But it is clear that we cannot treat this as a "shared innovation" *per se*, because the results differ so dramatically across the languages.

∗ *How then can we fit all the pieces together?* I propose that we can and should understand it in the following way:

1. During the stage of PIE itself, *PCR was still not strong enough to condition large-scale categorical effects.
2. Nevertheless, the linguistic conditions inherited by the daughter languages were leading learners to become more and more sensitive to *PCR.
3. Independently, each of these branches eventually promotes *PCR high enough that a repair must be initiated.
   - However, since there are multiple ways of fixing the *PCR problem in reduplication, the pre-existing conditions did not deterministically select a single repair across the languages.
   - Instead, each was free to "choose" which constraint *PCR would crucially outrank. (In doing so, some of the languages would have to solidify additional rankings parasitically.)

⋆ Reconstructing this sort of scenario circumvents the problem of their being no obvious phonological precursor to some of the patterns.
  ◦ For example, a change from C_1-copying to C_2-copying is unlikely to have been driven by misperception (cf., e.g., Ohala 1981).

→ The language is forced to innovate as a response to the constraint promotion.

- This approach also makes sense of the fact that the languages differ somewhat in exactly which repetition types are targeted by *PCR (see Zukoff 2017a:Ch. 6 for extensive discussion).
  ◦ While all of these languages make a consistent distinction between TR-initial roots and ST-initial roots, they show substantial differences in the treatment of the other cluster types.
  ◦ This seems a likely state of affairs if the *PCR effects represent parallel developments driven by similar inherited conditions, but not a true shared innovation.

4 Conclusion

- In this talk, I've argued that the central issue in PIE reduplicative phonology is the behavior of *PCR, whose (simplified) definition is repeated in (54):

(54) **No Poorly-Cued Repetitions (*PCR)** [≈ *$C_\alpha VC_\alpha$/_$C_{[-\text{sonorant}]}$]
For each sequence of repeated identical consonants separated by a vowel ($C_\alpha VC_\alpha$), assign a violation * if that sequence immediately precedes an obstruent.

- I've argued that thinking about the (Proto-)Indo-European reduplicative system in terms of constraints and rankings, rather than purely in terms of forms, allows us to integrate the internal and comparative evidence with a sensible account of the changes between PIE and the daughter languages.

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