Poorly-Cued Repetition Avoidance in Indo-European Reduplication*

[*formerly* "Syllable-Level OCP Effects in Indo-European Reduplication"]

Sam Zukoff, szukoff@mit.edu
January 9th, 2015

1. Introduction

- In the reduplicative systems of Ancient Greek, Gothic, and Sanskrit, we see differences in copying pattern dependent on the shape of the root-initial sequence.
  - Roots with an initial *consonant-vowel* (CV) sequence show C_1-copying.
    - $\surd C_1V$- → reduplicated $\underline{C_1V}$-C_1V-
  - Roots with initial *stop-sonorant* (TR) clusters tend to follow this default C_1-copying pattern.
    - $\surd T_1R_2V$- → reduplicated $\underline{T_1V}$-T_1R_2V-
  - However, roots with other initial clusters, notably *s-stop* (ST), display some other, distinct pattern:

(1) Non-default copying patterns in the Indo-European languages

	Copying Pattern	Base	Reduplicated form
Ancient Greek	non-copying	$\surd S_1T_2V$-	$\underline{V}$-S_1T_2V-
Gothic	cluster-copying	$\surd S_1T_2V$-	$\underline{S_1T_2V}$-S_1T_2V-
Sanskrit (cluster-initial roots)	C_2-copying	$\surd S_1T_2V$-	$\underline{T_2V}$-S_1T_2V-
Sanskrit (zero-grade bases)	"$C_1\bar{e}C_2$" pattern	S_1T_2-	$S_1\bar{e}T_2$-

- In addition to differing in the nature of the non-default pattern, the languages also vary in which types of clusters pattern with TR and which pattern with ST.

❖ In this paper, I propose that these effects are all avoidance strategies for a single problem:

  ➢ **C_1-copying is blocked when it is *too difficult* to perceive the presence of root-C_1.**

- This will be formalized as the interaction between the (non-)availability of phonetic cues (cf. Wright 2004) and the principle of *repetition avoidance* (cf. Walter 2007).

* Special thanks to Donca Steriade, Adam Albridge, Edward Flemming, and Tony Yates. Thanks also to Michael Kenstowicz, Jesse Lundquist, Ryan Sandell, Juliet Stanton, Suyeon Yun, and audiences at MIT. All mistakes are, of course, my own.

2. (Im)perceptibility in $C_\alpha VC_\alpha C_\beta$ sequences

- It is well-known that there are biases against repetition in human language, and human cognition more generally (e.g., Walter 2007, and citations therein).
  - Walter 2007 demonstrates that, in phonology, there are both articulatory and perceptual biases against repetition, particularly against repetition of consonants in a local domain.
  - One specific bias in perception is "repetition blindness," originally proposed by Kanwisher (1987) based on evidence from non-linguistic perception tasks, whereby subjects are unable to perceive repeated tokens as being separate entities (Walter 2007: Ch. 5).
- It is also well-known that consonants are dispreferred in contexts where they are less perceptible ("Licensing by Cue"; Steriade 1997).

- A logical extension is that the union of these two principles is especially dispreferred:

(2) THE POORLY-CUED REPETITION PRINCIPLE (PCR):

A CVC sequence containing identical consonants ($C_\alpha VC_\alpha$) is dispreferred, due to repetition blindness; it is especially dispreferred if one or both of the consonants lack phonetic cues which are important for the perception of its presence (in contrast to zero) in the speech signal.

- The intuition is the following:
  - Listeners are biased by *repetition blindness* to fail to identify the presence of a locally-repeated segment.
  - Listeners have difficulty recovering the presence of a consonant when it lacks robust phonetic cues to its presence.
  - When both of these conditions hold, accurate perception of the speech signal is especially difficult.
- I propose that this can project a constraint in the phonological grammar, such that these sequences may be actively avoided:

(3) POORLY-CUED REPETITION (PCR):

Assign a violation mark * to any $C_\alpha VC_\alpha$ sequence where the second consonant[1] lacks the **requisite cues** to its presence.

➢ This constraint can begin deriving the differences between TR and ST clusters.

[1] Because we are dealing with a $\#C_\alpha VC_\alpha C_\beta$ sequence, the first consonant will always be maximally-cued; the #_V context is the optimal context for perception of a consonant (see Wright 2004). Therefore, only perception of the second of the repeated consonant is at stake here.

- Among the cues which are most significant to perceiving the **presence** of a consonant (not necessarily the **place** of the consonant) are *burst, intensity rise,* and *consonant-to-sonorant* (*CR*) *transitions*[2] (see Wright 2004).
    - All of these cues are present for a stop (T) before a sonorant (R).
    - None of them are present for a fricative (S), which inherently has no *burst*, before a stop, which can host neither an *intensity rise* nor *transitions*.
        - The *frication noise* of the fricative is normally a strong cue to its presence, particularly the high-intensity frication of sibilants.
        - It seems likely that *repetition blindness* may decrease the efficacy of this cue more than others; this will be discussed below.
    - Each of these cues (including *frication noise*) benefits from the "boost at onset" (Wright 2004: 43-35), a property of the auditory system which amplifies cues at the beginning of a (high-amplitude) speech signal.
        - *VC transitions* (the mirror image of *CV / CR transitions*), on the other hand, do not benefit from this property, and are therefore comparatively less robust.

- Focusing first just on the TR vs. ST distinction, we can say that a consonant is *requisitely-cued* if it has all of the following cues: *burst, intensity rise,* and *CR transitions*.

(4) PCR [*for TR vs. ST*]:

Assign a violation mark * to any $C_\alpha V C_\alpha$ sequence where the second consonant lacks the requisite cues to its presence.

►**REQUISITE CUES**: *burst, intensity rise,* and *CR transitions*

3. Indo-European partial reduplication: TR vs. ST

3.1. Non-copying ST perfects in Ancient Greek

- Ancient Greek shows default C_1-copying when the root begins in a *stop-sonorant* (TR) cluster (shown in (5)), but "non-copying" in roots with initial *s-stop* (ST) (shown in (6)).

(5) C_1-copying perfects to TR roots in Ancient Greek[3]

Root		Perfect Tense	
kri-	'decide'	k-e-kri-mai	not **e-kri-mai
tla-	'suffer, dare'	t-e-tlɛ̄-mai	not **e-tlɛ̄-mai
pneu-	'breathe'	p-e-pnū-mai	not **e-pnū-mai

[2] I intend "CR transitions" to name the set of CV, CL, and CN transitions, which stand in a stringency relationship: CV > CL > CN.

[3] There are three stop series: *plain voiceless* (p,t,k), *plain voiced* (b,d,g), and *voiceless aspirated* (p^h,t^h,k^h). All of these freely occur before all of the sonorant consonants (m,n,r,l), with the exception of /gn/, which surfaces as [ŋg].

(6) Non-copying perfects to ST roots in Ancient Greek

Root	Perfect Tense	
stel- 'prepare'	e-stal-ka	not **s-e-stal-ka
strateu- 'wage war'	e-strateu-mai	not **s-e-strateu-mai

- With the current definition of the PCR from (4), we can motivate a difference between TR and ST roots.
  - The actual repair is dependent on the ranking of a number of other constraints.

(7) Constraints modulating potential repairs for PCR

a. ONSET:
Assign a violation mark * for each onsetless syllable.
Potential PCR Repair: V-C_1C_2V- (candidates (b))

b. C/V (≈ *COMPLEX):
Assign a violation mark * for every consonant which does not precede a vowel.
Potential PCR Repair: C_1C_2V-C_1C_2V- (candidates (c))

c. ANCHOR-L-BR:
Assign a violation mark * 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.[4]
Potential PCR Repair: C_2V-C_1C_2V- (candidates (d))

- To specifically generate the non-copying repair in Greek, ONSET must be the lowest ranked of these constraints, and it must also be dominated by PCR.[5]

(8) Non-copying in ST roots in Greek (PCR violation): √*stal-* → *e-stal-ka* 'I have made ready'

/RED, e, stal, a/	ANCHOR-L-BR	C/V	PCR	ONSET
a. s-e-stal-ka		*	*!	
b. ☞ e-stal-ka		*		*
c. st-e-stal-ka		**!		
d. t-e-stal-ka	*!	*		

- Candidate (a) is the default C_1-copy form – it is blocked from surfacing by PCR.

[4] I assume that this constraint is not violated (i.e. vacuously satisfied) if no segments have been copied, as in the "non-copying" forms of Ancient Greek (e.g. candidate (8b)). In Sanskrit, ANCHOR-L-BR will not be vacuously satisfied by the non-copying candidates, because their patterns involve copying of a root-vowel (see Steriade 1988 for arguments regarding copying in Sanskrit). If we follow Sandell & Zukoff's (2014) synchronic analysis of the Gothic preterite system, then it must be the case that Gothic also copies a root vowel, with consistent phonological reduction to [e] (i.e. phonological fixed segmentism).
[5] I omit MAX- and DEP-violating candidates for reasons of space. These constraints necessarily dominate C/V, as word-initial clusters are obviously permitted in all these languages.

- The alternative candidates (b-d) each obviate PCR by avoiding the creation of the problematic repetition.
    - Candidate (d) does so by copying C_2, but fatally violates ANCHOR-L-BR.
    - Candidate (c) does so by copying the entirety of the root-initial cluster, interrupting the repetition with C_2, but this results in an extra C/V violation.
- The optimal candidate (b) copies nothing, at the expense only of low-ranked ONSET, whose violation is tolerable in service of PCR.

- When the repetition caused by copying C_1 is well-enough cued to satisfy PCR, the ONSET violation incurred by the non-copying candidate becomes unnecessary, and so C_1-copying is permitted, as shown in (9):

(9) C_1-copying in TR roots in Greek (no PCR violation): √*kri-* → *k-e-kri-mai* 'I have been judged'

/RED, e, kri, mai/	PCR	ONSET
a. ☞ k-e-kri-mai		
b. e-kri-mai		*!

3.2. Cluster-copying reduplicated preterites in Gothic

- In Gothic there not many relevant examples, but they again point to a distinction between TR and ST roots.
    - TR roots follow the default C_1-copying pattern (as seen in (10)).
    - ST roots display cluster-copying, i.e. a reduplicant in *STe*- (as seen in (11)).

(10) C_1-copying preterites to TR roots in Gothic (forms from Lambdin, 2006: 115)

	Infinitive	Preterite	
'to weep'	grēt-an	gɛ-grōt	not **grɛ-grōt

(11) Cluster-copying preterites to ST roots in Gothic

	Infinitive	Preterite	
'to possess'	stald-an	stɛ-stald	not **sɛ-stald
'to divide'	skaið-an	skɛ-skaiθ	not **sɛ-skaiθ

- This pattern falls out if we take the constraints and rankings proposed for Ancient Greek and simply swap ONSET and C/V:

(12) Cluster-copying in ST roots in Gothic (PCR violation): √*stald*- → *ste-stald* 'he possessed'

/RED, stald/	ANCHOR-L-BR	ONSET	PCR	C/V
a. se-stald			*!	*
b. e-stald	*!	*		*
c. ☞ ste-stald				**
d. te-stald	*!			*

- Here, the viable alternative to the PCR-violating C_1-copy candidate is the cluster-copying candidate (c).
    - When copying C_2 in addition to C_1 can avoid a poorly-cued repetition, a cluster in the reduplicant is tolerated.
- In all other cases, however, it is not:

(13) Copying in TR roots in Gothic (no PCR violation): √*grēt*- → *ge-grōt* 'he wept'

/RED, grōt/	PCR	C/V
a. ☞ ge-grōt		*
b. gre-grōt		**!

- In §4, we will see that there are certain cases which do not satisfy all the conditions of the current definition of the PCR. This will lead us to refine the definition.

3.3. TR-initial vs. ST-initial bases in Sanskrit

- The situation in Sanskrit is a bit more complicated.
    - There are two distinct non-default treatments, depending on the morpho-phonological origin of the base-initial cluster.
    - But the distribution of default vs. non-default treatment in both categories adheres to the principles of the PCR.

3.3.1. The behavior of cluster-initial roots in Sanskrit

- The division between TR and ST clusters for cluster-initial roots is illustrated in (14) & (15):

(14) C_1-copying perfects to TR-initial roots in Sanskrit (forms from Whitney 1885 [1988])

Root	Perfect Tense	
b^hraj- 'shine'	ba-b^hrāj-a	not **ra-b^hrāj-a
drā- 'sleep'	da-drā-u	not **ra-drā-u
prac^h- 'make'	pa-prāc^h-a	not **ra-prāc^h-a

(15) C_2-copying perfects to ST-initial roots in Sanskrit

Root	Perfect Tense	
st^{h}ā- ‘stand’	ta-st^{h}ā-u	not **sa-st^{h}ā-u
stamb^h- ‘prop’	ta-stamb^h-a	not **sa-stamb^h-a
sparç- ‘touch’	pa-spṛç-ē	not **sa-spṛç-ē

- To derive the C_2-copying pattern for the ST-initial roots in Sanskrit, we again only need to permute the rankings proposed earlier for Greek and Gothic.
    - If ANCHOR-L-BR is the uniquely lowest-ranked relevant constraint, we predict C_2-copying as the repair for a PCR violation.

(16) C_2-copying in ST-initial roots in Sanskrit (PCR violation):

√*stamb^h*- → *ta-stamb^h-a* ‘he has propped’

/RED, stamb^h, a/	ONSET	C/V	PCR	ANCHOR-L-BR
a. sa-stamb^h-a		*	*!	
b. a-stamb^h-a	*!	*		*
c. sta-stamb^h-a		**!		
d. ☞ ta-stamb^h-a		*		*

(17) C_1-copying in TR-initial roots in Sanskrit (no PCR violation):

√*prac^h*- → *pa-prāc^h-a* ‘he has made’

/RED, prāc^h, a/	PCR	ANCHOR-L-BR
a. ☞ pa-prāc^h-a		
b. ra-prāc^h-a		*!

3.3.2. The behavior of cluster-initial “zero-grade” bases in Sanskrit

- In certain morphological categories (notably the active plural, and the middle), Sanskrit displays a process of vowel deletion (“zero-grade” ablaut).
    - When this applies to roots of the shape /C_1aC_2/, it creates a cluster which was not present underlyingly: /C_1aC_2/ → //-C_1C_2-//.
- If this new cluster would yield a PCR violation when accompanied by C_1-copying, C_1-copying is blocked as expected, but the non-default treatment is not C_2-copying.
- Instead we see selection of a different allomorph, the “$C_1ēC_2$ pattern”: /C_1aC_2/ → [$C_1ēC_2$-].

(18) C_1-copying perfects to -TR- zero-grade bases in Sanskrit[6]

Root	Perfect Tense	
b^{h}ar- ‘bear’	ba-b^{h}r-ē	not **b^{h}ēr-ē
d^{h}ar- ‘hold’	da-d^{h}r-ē	not **d^{h}ēr-ē
par- ‘fill’	pa-pr-ur	not **pēr-ur

[6] There are three *stop-liquid* roots which take the $C_1ēC_2$ pattern: *tērur* ← √*tar* ‘pass’, *p^{h}ēlire* ← √*p^{h}al* ‘fruit’, *p^{h}ēlur* ← √*p^{h}al* ‘burst’. See Appendix B for discussion.

(19) <u>$C_1\bar{e}C_2$ perfects to -ST- zero-grade bases in Sanskrit</u>

Root		Perfect Tense	
sap-	'serve'	sēp-ur	not **<u>sa</u>-sp-ur, **<u>pa</u>-sp-ur
sad-	'sit'	sēd-ur	not **<u>sa</u>-sd-ur,[7] **<u>da</u>-sd-ur
çak-	'be able'	çēk-ur	not **<u>ça</u>-çk-ur, **<u>ca</u>-çk-ur
çap-	'curse'	çēp-ur	not **<u>ça</u>-çp-ur, **<u>pa</u>-çp-ur

- The unavailability to these roots of the C_2-copying pattern is explainable using Input-Reduplicant (IR) faithfulness (McCarthy & Prince 1995), specifically LINEARITY-IR.

(20) LINEARITY-IR:

For every pair of segments in the reduplicant *x'*, *y'*, such that *x'* precedes *y'*, assign a violation mark * if they have correspondents in the underlying root *x*, *y*, and *x* does not precede *y*.

- I assume that the reduplicant vowel corresponds to a segment in the underlying root,[8] such that LINEARITY violations are assigned as in (21):

(21) <u>LINEARITY-IR violations: cluster-initial root vs. CaC root</u>

	ZERO-GRADE CATEGORY (underlying vowel is deleted in root)	LINEARITY-IR
Cluster-initial roots:	/RED, $s_1t^h{}_2\bar{a}_3$, ur/ → $\underline{t_2a_3}$-$s_1t^h{}_2$-ur	
CaC roots:	/RED, $s_1a_2p_3$, ur/ → **$\underline{p_3a_2}$-s_1p_3-ur	*

- LINEARITY-IR therefore blocks C_2-copying for these bases, and forces the use of a secondary repair strategy for the PCR, namely the $C_1\bar{e}C_2$ allomorph.
- I will treat this as morphological (following Sandell 2014a), and allow the choice between reduplication and the $C_1\bar{e}C_2$ allomorph to be modulated by "USE X" constraints: USE REDUPLICATION » USE CēC.
  - These constraints are integrated into the phonological constraint ranking such that phonological constraints can force the use of the dispreferred morphological pattern.
- With these constraints in place, we can derive the four-part distribution shown in (22) with the tableaux in (23).

(22) <u>Distribution of stem-formation patterns in the Sanskrit perfect</u>

	ST cluster	TR cluster
Zero-grade base	$C_1\bar{e}C_2$	C_1-copying
Cluster-initial root	C_2-copying	C_1-copying

[7] This form, as well all three examples with /ç/, can be ruled out independently on phonotactic grounds. Nonetheless, there are many other cluster types which undergo the $C_1\bar{e}C_2$ pattern despite being phonotactically licit.
[8] See Steriade 1988 for arguments in favor of this approach.

(23) Reduplication in Sanskrit: TR vs. ST

			LINEARITY-IR	PCR	USE RED	C/V	ANCHOR-L-BR	USE CēC
Zero-grade	ST	/RED, s<a>p, ur/						
		a. sa-sp-ur		*!		*		*
		b. pa-sp-ur	*!			*	*	*
		c. ☞ sēp-ur			*			
	TR	/RED, p<a>r, ur/						
		a. ☞ pa-pr-ur				*		*
		b. ra-pr-ur	*!			*	*	*
		c. pēr-ur			*!			
Cluster-initial	ST	/RED, stamb^{h}, a/						
		a. sa-stamb^{h}-a		*!		*		*
		b. ☞ ta-stamb^{h}-a				*	*	*
		c. stēmb^{h}-a			*!	*		
	TR	/RED, prāc^{h}, a/						
		a. ☞ pa-prāc^{h}-a				*		*
		b. ra-prāc^{h}-a				*	*!	*
		c. prēc^{h}-a			*!	*		

(24) Total Ranking for Sanskrit TR vs. ST

LINEARITY-IR   PCR

USE RED

|

C/V

|

ANCHOR-L-BR

|

USE CēC

4. Refining the PCR: the behavior of other cluster types

- Ancient Greek, Gothic, and Sanskrit all allow other types of root-initial clusters beside just TR and ST.
- In this section, we will evaluate which of these clusters pattern with TR and which pattern with ST in the respective languages, and how the PCR can be defined to capture these distinctions.

4.1. Greek vs. Gothic

- While Ancient Greek and Gothic differ significantly in their cluster inventory, they differ minimally in their distribution of default vs. non-default treatment for various cluster types.
- The tables in (25) illustrate these distributions.
  - ❖ Attested initial clusters are marked with ✓; non-occurring initial clusters are marked with × and dark grey.
  - ❖ White cells are those which display default C_1-copying; light grey cells are those occurring clusters with non-default treatment.

(25) Initial clusters and reduplicative behavior (see Appendix A for complete data)

Greek

C_2 / C_1	Stop	Fricative	Nasal	Liquid
Stop	✓	✓	✓	✓
Fricative	✓	(✓)[10]	✓	✓
Nasal	×	×	✓	×

Gothic[9]

C_2 / C_1	Stop	Fricative	Nasal	Liquid
Stop	×	×	×	✓
Fricative	✓	×	×	✓
Nasal	×	×	×	×

- In Gothic, the only attested cluster with non-default treatment is indeed ST.
  - o There are two other attested cluster types, both of which show C_1-copying:
    - ▪ *stop-liquid* (TL) and *fricative-liquid* (SL, S = {f,s})
- Greek has a more robust cluster inventory, but a very restricted distribution of C_1-copying.
  - o TR (i.e. TL & TN) clusters copy C_1, whereas all other types show non-copying.

(26) Attested clusters and their behavior in Greek and Gothic

C_2 / C_1	**Stop**	**Nasal**	**Liquid**
Stop	Greek: ×	Greek: ✓	Greek: ✓
	Gothic: Ø	Gothic: Ø	Gothic: ✓
Fricative	Greek: ×	Greek: ×	Greek: ×
	Gothic: ×	Gothic: Ø	Gothic: ✓

✓ = C_1-copying
× = non-default treatment
Ø = unattested cluster type

❖ The most notable difference between Greek and Gothic in this respect is that Greek *does not* show default behavior for SL clusters (nor SN clusters), whereas Gothic *does*.

[9] A few additional root shapes, including *sm-*, *sn-*, *sw-*, exist more generally in the language, but are not attested among reduplicating roots.
[10] Greek permits root-initial geminates in *-ss-* and (more frequently) *-rr-*. (They are simplified to their corresponding singleton when they do not follow a vowel.) These roots show non-copying in the perfect: e.g. √*sseu* 'chase' → perfect *e-ssu-mai*. Whether this should be taken as a PCR effect remains a question.

- In order to see how this relates to the PCR, we must consider what cues are available in each cluster:

(27) Availability of cues to presence of root-C_1 in root-initial clusters

C_1 \ C_2	**Stop**	**Nasal**	**Liquid**
Stop	TT · burst	TN · burst · intensity rise · CR transitions	TL · burst · intensity rise · CR transitions
Fricative	ST · frication noise	SN · frication noise · intensity rise · CR transitions	SL · frication noise · intensity rise · CR transitions

❖ **Question**: Can we refine the PCR's "requisite cues" clause to capture the distinct distributions in the two languages?

- For Gothic, the "requisite cues" clause must pick out TL and SL to the exclusion of ST.
    - Two cues independently satisfy this condition: *intensity rise* and *CR transitions*.

(28) PCR [*for Gothic*]:

Assign a violation mark * to any $C_\alpha VC_\alpha$ sequence where the second consonant lacks the requisite cues to its presence.

►**REQUISITE CUES**: *intensity rise* and/or *CR transitions*

- For Greek, on the other hand, we must distinguish TR, which shows C_1-copy, from SR, which does not.
    - We must also pick out TR to the exclusion of ST, TT, and NN (*nasal-nasal*), all of which are attested (with non-copying) in Greek.
- The major difference between TR and SR sequences with respect to cues is that TR sequences have *burst* but SR sequences have *frication noise*.
    - While both of these are robust cues to the presence of a consonant (see Wright 2004), *frication noise* might be more apt to suffer from *repetition blindness*.
        - *Repetition blindness* might bias listeners towards disregarding the *frication*-less gap in a *fricative-vowel-fricative* sequence, and instead interpret the entirety of the frication noise as belonging to a single articulation.
        - Since the *burst* cue does not extend over a duration, it would be impossible for speakers to hear a second burst yet attribute it to the first.
    - Therefore, *burst* would seem to be a better cue in the repetition context than *frication noise*. This seems to be necessary for Greek.

- *Intensity rise* must also be a necessary cue, since *burst* alone would include TT and NN, neither of which permit C_1-copying.
    - o Therefore, *burst* <u>and</u> *intensity rise* must both be requisite cues.[11]
- We must also separately include *CV transitions* (distinct from *CR transitions*).
    - o Roots with initial *liquid-vowel* sequences copy C_1, yet they have neither *burst* nor *intensity rise*.

(29) PCR [*for Greek*]:

Assign a violation mark * to any $C_\alpha VC_\alpha$ sequence where the second consonant lacks the requisite cues to its presence.

►**REQUISITE CUES**: (i) *burst* and *intensity rise*; and/or (ii) *CV transitions*

➢ Greek and Gothic thus have different sets of "requisite cues" for the purpose of the PCR.
- o The ramifications of this will be taken up in the conclusion.

4.2. Sanskrit

- Sanskrit seems to be the most permissive of the three languages with respect to the PCR.

(30) <u>Attested clusters and reduplicative behavior in Sanskrit cluster-initial roots</u>

(see Appendix A for complete data)

C_1 \ C_2	Stop	Affricate	Fricative	Nasal	Liquid	Glide
Stop	×	×	✓(?)	✓	✓	✓
Affricate	×	×	×	✓	✓	✓
Fricative	✓	✓	×	✓	✓	✓
Nasal	×	×	×	✓	✓	✓

- Sanskrit permits C_1-copying to all *consonant-sonorant* (CR) root-initial clusters.
    - o This implies that *CR transitions* are sufficient for PCR satisfaction in Sanskrit, as long as we assume that (non-homorganic) NN sequences have *CR transitions*.[12]
- Additionally, it also seems to permit C_1-copying to *stop-fricative* (TS) clusters (*ps*, *ts*, *ks*).
    - o This is surprising, given that, before a fricative, a stop will have none of the cues available in TR clusters, i.e. *burst*, *intensity rise*, or *CR transitions*.
    - o The data here is minimal and questionably relevant,[13] so it is unclear how much weight we should place on this pattern. I will not pursue it further here.

[11] Yun (2014) has identified these two cues (together termed "acoustic disjuncture") as being significant for the typology of epenthesis site. However, more recently Yun (p.c.) thinks that intensity rise on its own may be sufficient to explain the epenthesis typology, possibly with intensity rise defined such that release bursts create intensity rises.

[12] There is a single data point for NN roots: √*mnā* 'note' → *mamnāu*. This form is not found in naturally-occurring texts, but rather only cited by grammarians. If this data point is legitimate and NN clusters do not have *CR transitions*, then it is not immediately clear what licenses C_1-copy for this type; possibly *burst*, but this may run into problems with the behavior of *stop-stop* zero-grade bases (see Appendix B).

- The facts regarding zero-grade bases are harder to pin down, but follow the same general shape: CR clusters tend to show C_1-copying and other clusters tend to show non-default treatment (i.e. the $C_1\bar{e}C_2$ pattern).
  - o There are though a number of cases on the borderline which contradict this statement.
  - o But phonotactics and diachrony interfere significantly, such that it is difficult to tease apart what is directly applicable to the PCR.
- ❖ See Appendix B for further discussion.

5. Conclusion

- In the reduplicative systems of the Indo-European languages, there are a number of cases in which default C_1-copying is blocked.
- In this paper, I have argued that these cases can be unified as repair strategies for the Poorly-Cued Repetition Principle (PCR):

(31) THE POORLY-CUED REPETITION PRINCIPLE (PCR):

A CVC sequence containing identical consonants ($C_\alpha VC_\alpha$) is dispreferred, due to repetition blindness; it is especially dispreferred if one or both of the consonants lack phonetic cues which are important for the perception of its presence (in contrast to zero) in the speech signal.

- The proposal centers around the logical union of *repetition avoidance* (cf. Walter 2007) and the availability and robustness of phonetic cues (cf. Wright 2004).
- The PCR can induce avoidance of C_1-copying in reduplication, contrary to the normal pattern of the Indo-European languages.
  - o Non-copying in Ancient Greek
  - o Cluster-copying in Gothic
  - o C_2-copying in Sanskrit cluster-initial roots
  - o $C_1\bar{e}C_2$ allomorphy in Sanskrit zero-grade bases
- The PCR unites these patterns in ways which were not possible under previous approaches.
  - o Fleischhacker's (2005) similarity-based analysis and Keydana's (2012) proposal regarding non-linear phonological structure cannot extend to the $C_1\bar{e}C_2$ pattern.
  - ❖ A virtue of Fleischhacker's account, which cannot be replicated with the current proposal, is the connection between partial reduplication and other cluster-sensitive processes (epenthesis, alliteration, infixation).

[13] There are only two examples of this type where the stop is not velar: (i) √*tsar*- 'approach stealthily' → perfect *tatsāra*, which is attested only in the earliest stage of the language, the Rig-Veda (Whitney 1885 [1988]: 68), which may have been more permissive generally (see discussion in Appendix B); and (ii) √*psā*- 'devour' → perfect *papsāu*, which is only cited by grammarians, rather than occurring in actual texts (Ibid.: 104). Velars do not provide relevant evidence here, because they independently undergo a process of palatalization, which exempts them from identical repetition.

- The PCR is likely also responsible for a number of other patterns of the Indo-European languages:
  - The phonological origin of the Sanskrit $C_1\bar{e}C_2$ pattern (Sandell 2014a)
  - The Germanic $C_1\bar{e}C_2$ preterite plurals (see Appendix C; Sandell & Zukoff 2014)
  - The "Narten" long-vowel formations of PIE (cf. Sandell 2014b)
  - The origin of the "Attic Reduplication" pattern in Pre-Greek (Zukoff 2014)
  - The treatment of *s-stop* roots in Latin: *spondeō* → perf. *<u>spo</u>-pondī* (cf. Keydana 2012)

❖ A remaining question is whether the PCR can be defined as a singular constraint, or it must be parametrized by language?

- At this point, the PCR must remain a constraint schema / constraint family, since what counts as a "requisite cue" clearly does vary by language:
  - Greek: *CV transitions* and/or *burst + intensity rise*
  - Gothic: *CR transitions* and/or *intensity rise*
  - Sanskrit: *CR transitions* (and maybe whatever picks out *stop-sibilant*)

➢ But it appears to be the case that these requirements are not distributed randomly.
  - Assume there are two distinct means of identifying the presence of a consonant: (i) *transitions*, and (ii) the combination of *burst* and *intensity rise*.[14]
  - The three languages form a sliding scale along both of these dimensions, going from requiring the least robust option in each category (Sanskrit) to the most robust (Greek), with Gothic falling somewhere in the middle.[15]

(32) <u>Stringency relations among the "requisite cues"</u>

least strict ↔ most strict				
Sanskrit	<	Gothic	<	Greek
CR transitions	=	*CR transitions*	<	*CV transitions*
Ø	<	*intensity rise*	<	*burst + intensity rise*

- If we can ascertain the relative strength of the points along the two scales, we may be able to make typological predictions about the cluster-wise distribution of PCR repairs cross-linguistically.

[14] Again see Yun (2014) on "acoustic disjuncture" as defined by these two cues.
[15] There is no cluster type in Gothic in which one of the two requisite cues is present but the other is not; therefore, it might not be appropriate to say that the two are separate for Gothic.

6. References

Fleischhacker, Heidi Anne. 2005. Similarity in Phonology: Evidence from Reduplication and Loan Adaptation. PhD Dissertation, University of California, Los Angeles.

Kanwisher, Nancy. 1987. Repetition Blindness: Type Recognition without Token Individuation. *Cognition* 27: 117–43.

Keydana, Götz. 2012. Evidence for Non-Linear Phonological Structure in Indo-European: The Case of Fricative Clusters. In *The Sound of Indo-European: Phonetics, Phonemics, and Morphophonemics*, edited by Benedicte Nielsen Whitehead, Thomas Olander, and Birgit Anette Olsen, 99–117. Denmark: Museum Tusculanum Press.

van de Laar, Henri M. F. M. 2000. *Description of the Greek Individual Verbal Systems*. Amsterdam: Rodopi.

Lambdin, Thomas O. 2006. *An Introduction to the Gothic Language*. Eugene, Oregon: Wipf & Stock Publishers.

McCarthy, John J., & Alan Prince. 1995. Faithfulness and Reduplicative Identity. In *University of Massachusetts Occasional Papers in Linguistics 18: Papers in Optimality Theory*, edited by Jill Beckman, Suzanne Urbanczyk, and Laura Walsh Dickey, 249–384. Amherst, MA: GLSA, University of Massachusetts. http://works.bepress.com/john_j_mccarthy/44.

Niepokuj, Mary. 1997. *The Development of Verbal Reduplication in Indo-European*. Washington, D.C.: Institute for the Study of Man.

Sandell, Ryan. 2014a. Vedic Perfect Weak Stems of the Form C_1eC_2. In *Proceedings of the 25th UCLA Indo-European Conference*. Bremen: Hempen.

Sandell, Ryan. 2014b. The Phonological Origins of Indo-European Long-Vowel (“Narten”) Presents. Paper presented at the *26th Annual UCLA Indo-European Conference*, Los Angeles, October 25. Available at: https://ucla.academia.edu/RyanSandell.

Sandell, Ryan, & Sam Zukoff. 2014. A New Approach to the Origin of Germanic Strong Preterites. Poster presented at *NELS 45*, November 1, MIT. Available at https://mit.academia.edu/SamZukoff.

Steriade, Donca. 1982. Greek Prosodies and the Nature of Syllabification. PhD Dissertation, MIT.

Steriade, Donca. 1988. Reduplication and Syllable Transfer in Sanskrit and Elsewhere. *Phonology Yearbook* 5: 73–155.

Steriade, Donca. 1997. Phonetics in Phonology: The Case of Laryngeal Neutralization. Ms., UCLA.

Struijke, Carolina Maria. 2000. Reduplication, Feature Displacement, and Existential Faithfulness. PhD Dissertation, University of Maryland.

Thurneysen, Rudolph. 1966. *A Grammar of Old Irish*. Translated by D. Binchy and O. Bergin. Dublin: Dublin Institue for Advanced Studies.

Walter, Mary Ann. 2007. Repetition Avoidance in Human Language. PhD Dissertation, MIT.

Whitney, William Dwight. 1885 [1988]. *The Roots, Verb-Forms, and Primary Derivatives of the Sanskrit Language: A Supplement to his Sanskrit Grammar*. Reprinted 1945 as American Oriental Series 30. New Haven: American Oriental Society.

Wright, Richard. 2004. A Review of Perceptual Cues and Cue Robustness. In *Phonetically Based Phonology*, edited by Bruce Hayes, Robert Kirchner, and Donca Steriade, 34–57. Cambridge: Cambridge University Press.

Yun, Suyeon. 2014. The Role of Acoustic Cues in Nonnative Cluster Repairs. In *Proceedings of the 31st West Coast Conference on Formal Linguistics*, edited by Robert E. Santana-LaBarge, 514–23. Somerville, MA: Cascadilla Proceedings Project. www.lingref.com, document #3055.

Zukoff, Sam. 2014. On the Origins of Attic Reduplication. In *Proceedings of the 25th UCLA Indo-European Conference*. Bremen: Hempen.

7. Appendix A: The data

7.1. Ancient Greek (see, e.g., Van de Laar 2000)

(33) C_1-copying root-shapes in Ancient Greek

❖ (a) Roots with initial singleton consonants

	Root		Present Tense	Perfect Tense
(i)	pemp-	‘send’	pemp-ō	p-e-pemp-tai
	dō-	‘give’	d-i-dō-mi	d-e-dō-ka
(ii)	sōs-	‘save’	sōzd-ō	s-e-sōs-mai
	lu-	‘loosen’	lu-ō	l-e-lu-ka

❖ (b) Roots with initial *stop* + *sonorant* (TR) clusters

Root		Present Tense	Perfect Tense
kri-	‘decide’	krī-n-ō	k-e-kri-mai
tla-	‘suffer, dare’	tla-ō	t-e-tlē-mai
pneu-	‘breathe’	pne-ō	p-e-pnū-mai

(34) Non-copying root-shapes in Ancient Greek

❖ (a) Roots with initial *stop* + *obstruent* clusters

	Root		Perfect Tense	
(i)	kten-	‘kill’	e-kton-a	not **k-e-kton-a
	$p^{h}t^{h}i$-	‘decay’	e-$p^{h}t^{h}i$-ka	not **p-e-$p^{h}t^{h}i$-ka
(ii)	pseud-	‘lie’	e-pseus-mai	not **p-e-pseus-mai

❖ (b) Roots with initial *s* + *consonant* clusters

	Root		Perfect Tense	
(i)	stel-	‘prepare’	e-stal-ka	not **s-e-stal-ka
	strateu-	‘wage war’	e-strateu-mai	not **s-e-strateu-mai
(ii)	smēk^{h}-	‘wipe’	e-smēg-menos	not **s-e-smēg-menos

❖ (c) Roots with initial geminates

Root		Perfect Tense	
rreu-	'flow'	e-rru-ēka	not **r-e-rru-ēka
sseu-	'hasten'	e-ssu-mai	not **s-e-ssu-mai

7.2. Gothic (see Lambdin 2006: 115)

(35) C$_1$-copying root-shapes in Gothic

❖ (a) Roots with initial singleton consonants

	Infinitive	Preterite (1/3SG.)
'to fold'	falθ-an	fɛ-falθ
'to tend'	hald-an	hɛ-hald
'to boast'	h^{w}ōp-an	h^{w}ɛ-h^{w}ōp
'to touch'	tēk-an	tɛ-tōk
'to play'	laik-an	lɛ-laik

❖ (b) Roots with initial *stop* + *liquid* clusters

	Infinitive	Preterite (1/3SG.)
'to weep'	grēt-an	gɛ-grōt

❖ (c) Roots with initial *fricative* + *liquid* clusters

	Infinitive	Preterite (1/3SG.)
'to sleep'	slēp-an	sɛ-slēp (also sɛ-zlēp)
'to bewail'	flōk-an	fɛ-flōk
'to tempt'	frais-an	fɛ-frais

(36) Cluster-copying root-shapes in Gothic

❖ Roots with *fricative* + *stop* clusters

	Infinitive	Preterite (1/3SG.)	
'to possess'	stald-an	stɛ-stald	not **sɛ-stald
'to divide'	skaið-an	skɛ-skaiθ	not **sɛ-skaiθ

7.3. Sanskrit cluster-initial roots (see Whitney 1885 [1988])

- White cells are those which show C_1-copying; light grey cells are those with C_2-copying; dark grey cells are unattested clusters.
  - Forms marked with brackets [ ] are those Whitney reports as being cited only in grammatical texts rather than in naturally-occurring texts.
  - *Italicized* forms are those in which the reduplicated consonant is a palatal affricate corresponding to a root-initial velar stop or *h*.
    - These would be expected to escape PCR violations by virtue of their (significant) non-identity.
- Transcription conventions:
  - < c, j > are palatal affricates IPA [ʧ,ʤ]
  - < y > is palatal glide IPA [j]
  - < v > likely represents labial glide [w], but might have a higher degree of constriction (i.e. a fricative)

C_1 \ C_2	Stop	Affricate	Sibilant	Nasal	Liquid	*w*	*y*
Stop			tatsāra [papsāu] *cakʂamē* *cakʂadē*	dad^{h}māu[16]	bab^{h}rāja dadrāu paprāc^{h}a tatrē pupluvē *jagrab^{h}a* *cakranda*	didvēʂa tatvarē [*cakvātha*]	dad^{h}yāu cak^{h}yāu tatyāja didyota
h				[*juhnuvē*]	*jihrāya*	[*jahvāla*]	
Affricate				jajɲāu	[jijrāya]	jajvāla [jajvāra]	cucyuvē jijyāu
s	tast^{h}āu tastamb^{h}a tastāra *caskanda* *cask^{h}āla* paspr̥çē paspaçē			sasmāra sismāya sasnur	susrāva sasransur	sasvadē sasvajē sasvanur	sasyandē
ʂ, ç	tiʂʈ^{h}ēva tuʂʈ^{h}āva	cuçcota		[çaçnāt^{h}a]	çaçrāma çaçrat^{h}ē çaçlāg^{h}irē	çaçvāsa [çiçvāya]	siʂyanda suʂvāpa [çaçyē]
Nasal				[mamnāu]	mumloca mamlāu		mimyakʂa
w					vavrāja		vivyāca vivyād^{h}a

[16] It is unclear whether this should be treated as a cluster-initial form or a zero-grade form.

8. Appendix B: Sanskrit zero-grade bases

- Because there are few (relevant) co-occurrence restrictions between root-C_1 and root-C_2 in CaC roots, zero-grade ablaut can in theory bring just about any two consonants into contact.
  - ➢ Many of these sequences are not phonotactically licit.
  - o Copying either consonant would not change the illegality of the zero-grade sequence.
  - o The $C_1\bar{e}C_2$ pattern circumvents this problem altogether by replacing the would-be zero-grade allomorph with one with a vowel between the consonants.
  - o Therefore, any would-be cluster type which is not phonotactically legal that shows the $C_1\bar{e}C_2$ pattern cannot be used as direct evidence for the PCR.
- There may also be diachronic interference, as the $C_1\bar{e}C_2$ pattern seems to expand its scope of applicability over time (cf. Sandell 2014a).
  - o Among roots which attest both a C_1-copying form and a $C_1\bar{e}C_2$ form, the C_1-copying form is almost always older, and usually ceases to be attested in the later periods, implying that there has been grammatical change between the earliest period and the later periods.
  - o Furthermore, the $C_1\bar{e}C_2$ pattern even eventually spreads beyond CaC roots to some CRaC / CaRC roots.[17]
  - ➢ Therefore, it is in principle possible that, in the later language, some factor other than the PCR could be conditioning the selection of the $C_1\bar{e}C_2$ allomorph.
- Although much is left to interpretation, the data which will be presented below suggests that Sanskrit has undergone a (gradual) change in the strictness of the PCR and the scope of the repair (i.e. the $C_1\bar{e}C_2$ pattern) for zero-grade bases.
  - o The earliest (possibly pre-historic) stage is one in which the PCR was very permissive (or inactive) and repair was dispreferred.
  - o The latest stage, on the other hand, is one in which the PCR was more strict and the repair was not dispreferred at all (rather it may have come to be preferable to actual zero-grade ablaut).

8.1. The data

- The following chart shows all the attested perfect forms to CaC roots which have either (i) C_1-copying with zero-grade of the root[18] (white cells) or (ii) $C_1\bar{e}C_2$ allomorphy (grey cells).[19] (Dark grey cells are unattested clusters.)
- *Italicized* forms are those in which the reduplicated consonant is non-identical to root-C_1, either due to velar palatalization in the reduplicant or place assimilation of root-C_1 to root-C_2.

---

[17] For example: √*tras* ‘be terrified’ → perf active singular *tatrāsa*, but perf middle plural *trēsur* (not ***tatṛsur*); √*b^h^ram* ‘wander’ → perf. active singular *bab^h^rāma*, but perf. middle plural *b^h^rēmatur* (not ***bab^h^ṛmatur*)

[18] There are other CaC roots with C_1-copying in zero-grade categories but with an unexpected full-grade of the root. This seems to be another avoidance strategy for bad clusters (whether phonotactic or PCR), but I have not yet examined these systematically.

[19] There are additional examples of *stop-liquid* roots; all other cells are virtually exhaustive to the best of my knowledge.

- Forms marked with brackets [ ] are those Whitney reports as being cited only in grammatical texts rather than in naturally-occurring texts; he does not report which grammarian(s) cites such forms, and thus I do not know their chronology.
- Forms marked in parentheses ( ) are presents or other derivatives which appear to have (or clearly do have) reduplication.
- Each C_1ēC_2 form is accompanied by a ✓ (indicating that the cluster resulting from zero-grade would be phonotactically **legal**) or a ✗ (indicating that the cluster would be phonotactically **illegal**, assuming no assimilations took place). Those in parentheses are those which I am unsure of in this regard.
- The solid vertical line separates clusters where C_2 is an obstruent (left) from those where C_2 is a sonorant (right).

(37) Treatment of zero-grade clusters in reduplication (data from Whitney 1885 [1988])

C_2 / C_1	Stop	Affricate	*h*	Sibilant	Nasal	Liquid	Glide
Stop	paptur pētur ✓ pēdur ✗ dēb^{h}ur ✓ tēpē ✓	pēcur ✗	dēhē ✗	*jakṣur* (*bapsati*)	dad^{h}mirē tatnē papnē *cak^{h}nur* *jagmur* tēnē ✓ [pēṇē] ✗ [p^{h}ēṇur] ✗	bab^{h}rē dad^{h}rē dadrē paprur *cakrē* tērur ✓ p^{h}ēlirē ✗ [p^{h}ēlur] ✗	bib^{h}yur *cikyur* *jigyē* *jig^{h}yur*
Sibilant	sēdur ✗ sēpur ✓ çēkur ✗ çēpur ✗	*saçcur* sēcirē ✗ sējur ✗	sēhur ✗		(sasni) (siṣṇu) [sēnē] ✓ çēmur (✓)	sasrē çaçrē [çēlē] (✗)	*suṣvāṇa* çiçyē
Nasal	(*mant^h*-) (nandati) mēthur ✗ nēdur ✓ [nēbhē] ✗		[nēhē] ✗	nēçur (✓)	mamnāt^{h}ē mēnē ✓ nēmē ✓	mamrur	ninyē mimyur
Liquid	lēb^{h}ē ✗ lēpur (✓) rēb^{h}ē ✓ [rēdur] ✓ [rēṭur] ✓	rējur ✓	rēhur (✗)	lēṣur (✓) rēsur ✓	rēmē ✓		lilyē
Glide	yētē ✗	yējē(?) ✗			vavnē vēmur (✗) yēmur ✗	vavrē	vivyē

8.2. Interpretation

- In the cells to the left of the dividing line, the vast majority of forms show C_1ēC_2.
  - This follows the pattern seen for cluster-initial roots.
- The exceptions all date to the earliest attested period of Sanskrit (the Rig-Veda).
  - For all of the roots with doublets, the C_1-copying form is older:
  - *paptur* > *pētur*, *mant^h^-* > *mēt^h^ur*, *nandati* > *nēdur*, *saçcur* > *sēcire*
- Four of the exceptions show non-identity between reduplicated consonant and surface root-C_1 (they are italicized in the table):
  - √*mat^h^* → *mant^h^-*, √*sac* → *saçcur*, √*g^h^as* → *jakṣur*, √*b^h^as* → *bapsati*
  - Velar palatalization certainly escapes a PCR violation (there are no velar-initial roots that take the C_1ēC_2 pattern).
  - Whether the other types of non-identity are significant enough to escape a PCR violation is unclear, but this may point to that being the case.
    - A difference in aspiration is not enough to satisfy PCR, as Grassmann's Law deaspirates all reduplicated aspirates.
- If we take seriously the examples mentioned in 3.3.1 (fn.13), *stop-sibilant* is expected to show C_1-copying, so *jakṣur* and *bapsati* would not be counterexamples to begin with.

- To the right of the line, most of the examples show C_1-copying, as expected relative to the cluster-initial roots.
  - Some of the counterexamples can be ruled out independently by phonotactics.
  - e.g., √*p^h^al* → *p^h^ēlirē* because ***pa-p^h^l-ire* would have an illegal **-*p^h^l-* sequence.
  - Here again, for roots with doublets, the C_1-copying form is older:
    - *tatnē* > *tēnē*, *sasni* / *siṣṇu* > [*sēnē*], *mamnāt^h^ē* > *mēnē*
  - Even for those C_1ēC_2 forms without doublets, they are mostly not attested until the later language (an exception being *tēnē*, which is already attested in the Atharva-Veda).

- While this leaves much up to interpretation, it seems likely that this picture represents one of transition, with approximately three major stages:
  (i) In the (prehistoric) stage that precedes Vedic Sanskrit, it might have been the case that all clusters which were phonotactically licit (or made phonotactically licit through assimilation) copied C_1 (i.e. default behavior).
    - This explains archaic forms like *paptur* and *saçcur*.
  (ii) In the Vedic (or at least post-Rig-Vedic) period, any cluster which did not have *CR transitions* (with the possible exception of *stop-sibilant*) took on the C_1ēC_2 allomorph.
  (iii) In Classical/Epic Sanskrit, there is some variation in *consonant-nasal* clusters, with the trend seeming to be moving towards C_1ēC_2, except when C_1 is a stop, in which case C_1-copying still predominates.

- If this characterization of Classical/Epic Sanskrit is correct, and the distribution at that point is still governed by some version of the PCR, then it seems that it is possible for there to be distinctions made between *CN transitions* and *CL transitions*.
  - The retention of C_1-copying for *stop-nasal* sequences indicates that *burst* and/or *intensity rise* could have become significant factors in the PCR of this stage.
- But since there does not seem to be any equivalent change in cluster-initial roots, it might be preferable to not attribute this to PCR, but rather to the general morphological / morpho-phonological change that is expanding the scope of the $C_1\bar{e}C_2$ pattern to include even non-CaC roots (see Sandell 2014a).

8.3. A few more data points

- The following shows the behavior of *h*- and *affricate*-initial zero-grade bases.

(38) Treatment of *h*- and *affricate*-initial zero-grade clusters in reduplication

C1 \ C2	Stop	Nasal	Liquid	Glide
h			*jahrur*	*juhve* [20]
Affricate	jepur × [cete] ×	jajɲur cemur ×	celur × cerur × jerur (×)	

- The *h*-initial roots will always be exempted from PCR effects, because *h* reduplicates as *j* (for historical reasons).
- The only potential zero-grade cluster among these roots which is phonotactically licit is the *-jɲ-* of *jajɲur* (← √*jan*).
  - *-jr-* seems to be marginally permitted in the later language.
- Therefore, it is very difficult to tell what the "expected" behavior of affricate-initial clusters should be.

9. Appendix C: The $C_1\bar{e}C_2$ pattern in Germanic and Indic (and elsewhere)

- The $C_1\bar{e}C_2$ pattern of Sanskrit undoubtedly has phonological origins (cf. Sandell 2014 and citations therein), but it is difficult to ascertain if and to what extent PCR played a role in those origins (see Appendix B).
- However, there is a virtually identical pattern in the Germanic languages, which almost certainly is to be analyzed as a PCR effect.
  - The preterite plurals of CeT / CeS roots in Gothic (Strong Class V) unexpectedly show a long vowel [ē].[21]

[20] This may belong with the cluster-initial root forms.

[21] CeR roots (Class IV) also have long [ē] in their preterite plurals. It is unclear whether these should be attributed to the same period as the origin of the Class V forms, or seen as later secondary developments.

(39) Gothic CeT & CeS preterite plurals (forms from Lambdin 2006:51)

	Infinitive	Preterite Plural (1PL.)	
'to give'	*gib-an* [gib-an]	*geb-um* [gēb-um]	(as if from *ge-gb-um)
'to say'	*qiþ-an* [k^wiθ-an]	*qeþ-um* [k^wēθ-um]	(as if from *k^we-k^wθ-um)

- From a historical/derivational perspective, this can be viewed as reduplication followed by deletion of root-C_1 + compensatory lengthening:

(40) Deriving $C_1\bar{e}C_2$ in *Pre-Germanic*[22]

	/RED, C_1eC_2, um/
Reduplicate: copy CV	C_1e-C_1eC_2-um
Zero-grade: delete root vowel[23]	C_1e-C_1C_2-um
Deletion + compensatory lengthening: $eC_\alpha \rightarrow \bar{e}$ / C_α_C	$C_1\bar{e}C_2$-um

- This reflex is not seen in roots of the shape CeRC (Strong Class I-III), because they had a sonorant which could vocalize and provide a well-cued repetition.
    - "Zero-grade" vowel deletion did cause PCR violation, on the other hand, for CeT / CeS roots, just as it did synchronically for Sanskrit (§3.3.2).
- The distribution of $C_1\bar{e}C_2$ forms in Pre-Germanic can thus be identified as a PCR effect:
    - Default treatment (C_1-copying) when *CR transitions* are available.
    - Non-default treatment (deletion + compensatory lengthening) otherwise.

- A similar grammar could be used to generate the $C_1\bar{e}C_2$ pattern in early Sanskrit, although the version of the PCR is likely slightly different.
    - Equivalent forms also exist in Old Irish (Thurneysen 1966: 429; cf. Niepokuj 1997: 151-152).
- The similarity of repair between these languages suggests that the pattern could be projected even farther back to Proto-Indo-European.
    - Sandell 2014 argues that some of the "Narten" roots/formations in PIE, i.e. present stems with unexpected long-vowels, could be examples of exactly this pattern.

[22] This is not how the pattern is encoded in the synchronic grammar of Gothic (cf. Sandell & Zukoff 2014), so it must be attributed to an earlier stage. This is necessary anyway, since the reflexes of this pattern are seen across the Germanic languages, even those which lack reduplication in the reflexes of Class VII verbs.
[23] This deletion was likely originally conditioned by accent, which surfaced on the suffix in the plural.

- To model this particular repair in parallel OT, we will need to make use *existential faithfulness* (Struijke 2000).

(41) ∃-MAX-C-IO:

Assign one violation mark * for every consonant in the input which does not have *at least one* correspondent in the output.

- In Struijke's theory, the reduplicant is subject to Input-Output correspondence; therefore, ∃-MAX-C-IO will be satisfied under any one of three circumstances:
  (i) There is a single output correspondent of the consonant, and it is in the root.
  (ii) There is a single output correspondent of the consonant, and it is in the reduplicant.
  (iii) There are multiple output correspondents of the consonant.

- We will also need:

(42) ANCHOR-L-IR:

Assign one violation mark * if the segment at the left edge of the reduplicant does not stand in correspondence with the segment at the left edge of the *underlying root in the input*.

- In order to generate the pattern, both of these constraints must dominate ANCHOR-L-BR.

DISCLAIMER: I have not yet figured out a satisfactory way to derive the long vowel non-derivationally, so I'm just aiming to get the segmental makeup of the form correct here.

(43) Gothic Class V preterite plurals in $C_1\bar{e}C_2$

/RED, e, $\mathbf{g_1b_2}$, um/	DEP-IO	∃-MAX-C-IO	ANCHOR-L-IR	PCR (Pre-Gmc)	C/V	ANCHOR-L-BR
a. $\underline{g_1\text{-}e}$-$\mathbf{g_1b_2}$-um				*!	*	
b. ☞ $\underline{g_1\text{-}e}$-$\mathbf{b_2}$-um						*
c. $\underline{e}$-$\mathbf{g_1b_2}$-um			(*!)		*!	(*)
d. $\underline{g_1\text{-}e}$-$\mathbf{g_1}$-um		*!				
e. $\underline{b_2\text{-}e}$-$\mathbf{b_2}$-um		*!	*			
f. $\underline{b_2\text{-}e}$-$\mathbf{g_1}$-um			*!			*
g. $\underline{b_2\text{-}e}$-$\mathbf{g_1b_2}$-um			*!		*	*
h. $\underline{g_1b_2\text{-}e}$-$\mathbf{g_1b_2}$-um					*!*	
i. $\underline{g_1eb_2\text{-}e}$-$\mathbf{g_1b_2}$-um	*!				*	