

The Reduplicative System of Ancient Greek and a New Analysis of Attic Reduplication

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The Ancient Greek perfect tense poses an interesting empirical puzzle involving reduplication. While consonant-initial roots display a phonologically regular alternation based on cluster type, vowel-initial roots display two distinct patterns whose distribution is not phonologically predictable. The reduplicative grammar that generates the consonant-initial patterns is directly compatible with the productive vowel-initial pattern, vowel lengthening. The minority vowel-initial pattern, “Attic reduplication,” both its shape and its distribution, can be explained as a phonotactic repair that operated at a prior stage of the language. This pattern was later reanalyzed, such that Attic reduplication is retained not as a phonotactic repair but through lexical indexation.

Keywords: Attic reduplication, Ancient Greek, Indo-European, Optimality Theory, constraint indexation, language change

1 Introduction

The distribution of stem formation patterns in the Ancient Greek perfect tense poses an interesting empirical puzzle involving the analysis of reduplication. Consonant-initial roots display a phonologically regular alternation between two patterns, determined by the type of initial cluster; vowel-initial roots also display two distinct patterns, but this variation is not predictable from phonological properties. While most vowel-initial roots show lengthening of the root-initial vowel, a small set of roots instead displays “Attic reduplication,” VC-copying plus lengthening of the root-initial vowel.

The reduplicative grammar necessary to generate the patterns for consonant-initial roots is directly compatible with the more productive vowel-lengthening pattern. Attic reduplication, both its shape and its distribution, can be explained through careful consideration of diachrony. The pattern arises as the result of laryngeal-related phonotactics in Pre-Greek, which force an alternative reduplication strategy. The pattern itself is constrained by the normal reduplicative grammar and other laryngeal-related repairs, namely, “laryngeal vocalization.” The loss of the laryngeals

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forces reanalysis, such that Attic reduplication is retained in Ancient Greek by a more complicated mechanism, namely, constraint indexation.

The account developed in this article yields three primary results. First, it provides a comprehensive analysis of the synchronic system of perfect-stem formation in Ancient Greek, integrating the minority pattern—Attic reduplication—with the productive majority patterns. Second, it synthesizes previous, relatively informal proposals regarding the origin of the Attic reduplication pattern into a full-fledged formal synchronic analysis, located at the Pre-Greek stage. And third, more generally, it addresses the problem of how to deal with residual morphophonological patterns within a language’s morphological and phonological grammar. Minority patterns of the sort represented by Attic reduplication are omnipresent crosslinguistically, yet analysts often overlook their value. This account not only demonstrates that such patterns can reveal significant insights about the larger systems in which they are embedded, but also illustrates diachronic pathways by which they arise and the diachronic tools that can be employed to yield a meaningful analysis of this kind.

1.1 Data

In the Ancient Greek perfect tense, consonant-initial roots display a phonologically regular alternation between two stem formation patterns, determined by the type of initial cluster. Roots with an initial singleton consonant or an initial stop-sonorant cluster show the overtly reduplicative pattern in (1a): a prefixed copy of the root-initial consonant followed by a fixed vowel [e]. Roots with all other types of initial clusters lack reduplicative copying and show just the prefixed [e], the “noncopying” pattern in (1b).¹

(1) *Distribution of stems in the perfect: Consonant-initial roots*

a. C₁-copying

Singleton roots: √CV- → Ce-CV-
 (e.g., √d5 ‘give’ → perf. de-d5-)
 Stop-sonorant roots: √TRV- → Te-TRV-
 (e.g., √kri ‘judge’ → perf. ke-kri-)

b. Noncopying

Other cluster roots: √CCV- → e-CCV-
 (e.g., √kten ‘kill’ → perf. e-kton-)

Vowel-initial roots likewise show a dichotomy of patterns. However, unlike among the consonant-initial roots, there is no clear phonological conditioning that regulates the variation; it simply varies by lexeme. Most vowel-initial roots form their perfect stem by lengthening the root-initial vowel, as in (2a). However, a small set of roots, illustrated in (2b), instead displays

¹ I will use the following notations: “>” indicates a diachronic development; “→” indicates a synchronic input-output (IO) mapping; “***” indicates a form that never occurred; “**” indicates a reconstructed form.

copying of the root-initial VC- sequence while simultaneously lengthening the root-initial vowel, a pattern referred to as Attic reduplication (AR).²

(2) *Distribution of stems in the perfect: Vowel-initial roots*

a. Vowel lengthening: $\sqrt{VC-} \rightarrow \check{V}C-$

(e.g., \sqrt{ag} ‘lead’ \rightarrow perf. $\bar{a}g-$, \sqrt{onoma} ‘name’ \rightarrow perf. $\bar{o}noma-$)

b. Attic reduplication: $\sqrt{VC-} \rightarrow VC-\check{V}C-$

(e.g., \sqrt{ager} ‘gather’ \rightarrow perf. $ag-\bar{a}ger-$, \sqrt{ol} ‘destroy’ \rightarrow perf. $ol-\bar{o}l-$)

AR’s distribution within the synchronic grammar is seemingly arbitrary; the roots that undergo AR have no discernible phonological characteristics that set them apart from roots that undergo the default pattern.

1.2 Outline

This article will provide a comprehensive account of the historical development of the AR pattern set within the larger reduplicative system of Greek. In exploring the synchronic reduplicative system of attested Ancient Greek in section 2, I will show that the grammar that generates the pattern displayed by consonant-initial roots also directly generates the productive vowel-lengthening pattern for vowel-initial roots. This reveals that it is indeed AR that requires further attention.

I will first answer the question of how the AR pattern came into being, in section 3. Virtually all roots that display AR are reconstructed with an initial laryngeal consonant (e.g., Winter 1950: 368–369, Beekes 1969:113–126); for example, Ancient Greek $\sqrt{ol} <$ Proto-Indo-European $*\sqrt{h_3elh_1}$ (Rix et al. 2001:298, Beekes and Van Beek 2010:1069–1070). With this in mind, I will propose that the historical source of AR (henceforth ‘Pre-AR’) arose at a stage of the language in which the laryngeal consonants were still present (‘Pre-Greek’), such that an AR form like Ancient Greek $ol-\bar{o}l-$ derives historically from a Pre-AR form $*h_3el-e-h_3l-$. Pre-AR is a deviation from the normal reduplication pattern, restricted to laryngeal-initial roots, induced by the unique phonetic and phonological properties of the laryngeals. The exact nature of Pre-AR is determined in large part by the interaction of the default reduplicative grammar with another laryngeal-related phonological process known as ‘laryngeal vocalization.’ The distribution of default reduplication vs. the Pre-AR pattern in Pre-Greek is schematized in (3).

(3) *Default reduplication vs. Pre-AR in Pre-Greek (H = laryngeal consonant)*

a. Default reduplication preforms: $*\underline{C^iV}-C^iC^kVC-$ or $*\underline{C^iV}-C^iC^k-$

b. AR preforms: $*\underline{H^iVC^kV}-H^iC^kVC-$ or $*\underline{H^iVC^kV}-H^iC^k-$

² For forms involving /a/, I use non-Attic-Ionic forms, such that the lengthened correspondent of /a/ is [ā]. In the Attic-Ionic dialect group, [ā] has become [ē] (see, e.g., Sihler 1995:48–52), such that the relationship between short and long vowel is slightly less transparent. It may not be the case that all forms with [ā] are actually attested outside of Attic-Ionic (i.e., in Doric or other [ā] dialects), but all are at least attested in their [ē] forms in Attic-Ionic. When necessary, I will refer to [ā]-forms as belonging to ‘Common Greek.’

Having accounted for the origin of AR, in section 4 I will address the question of how the pattern could be retained as a minority pattern into attested Ancient Greek and how it was represented by speakers in the synchronic grammar. Subsequent to the initial development of Pre-AR, the laryngeals were lost in Greek, and thus the phonotactics driving the pattern were no longer recoverable. In order to retain the pattern, learners formulated a new analysis, whereby copying in these forms is motivated by the operation of a lexically restricted REALIZE MORPHEME constraint (Kurisu 2001). Additional evidence for the special activity of this constraint comes from a set of exceptions to the generalizations regarding cluster-type-dependent copying in (1), namely, the reduplicated presents and their associated perfects. Incorporating lexically restricted REALIZE MORPHEME into the grammar thus provides a principled way of generating the entire synchronic distribution of reduplicative forms in the Ancient Greek perfect.

2 Reduplication in Ancient Greek

This section presents the analysis of the productive reduplicative system of Ancient Greek.³ The three productive patterns of perfect-tense stem formation ((1a), (1b), and (2a)) are generated from a single, consistent constraint ranking, without appeal to reduplicative templates, under an analysis where two morphemes, RED and /e/, compete for position at the left edge of the word. The analysis will be framed in terms of Base-Reduplicant Correspondence Theory (McCarthy and Prince 1995), though little of the formal apparatus employed in the analysis is dependent on this.⁴ Section 2.1 begins by analyzing the two patterns found in the consonant-initial roots and includes a discussion of the underlying morphemic structure of the perfect (section 2.1.2). Section 2.2 examines the behavior of vowel-initial roots, showing that the analysis developed for the consonant-initial roots is compatible with the productive vowel-lengthening pattern. When projected back to the earlier stage of the language in which laryngeal consonants were still present, the grammar developed here, adjusted only slightly and supplemented by an independently motivated phonotactic constraint, will generate the Pre-AR pattern.

2.1 Consonant-Initial Roots

2.1.1 Data and Generalizations As introduced in (1), the perfect of Ancient Greek shows two distinct stem formation patterns for consonant-initial roots: C₁-copying and noncopying, exemplified further in tables 1 and 2, respectively.⁵ The distribution is determined by the composition of the root-initial string. If the root begins with a single consonant or a stop-sonorant cluster, the perfect is formed via C₁-copying. All other consonant-initial roots show noncopying.⁶

³ For the facts of Ancient Greek reduplication, see, for example, Schwyzer 1939:646–650. For recent theoretical analyses, see Steriade 1982:195–208, 304–312, 1988:135–136, Fleischhacker 2005, Keydana 2006:83–91, Halle 2008:333–336.

⁴ For recent alternative theoretical approaches to reduplication, consult Raimy 2000, 2009, Inkelas and Zoll 2005, Idsardi and Raimy 2008, Frampton 2009, Kiparsky 2010, McCarthy, Kimper, and Mullin 2012.

⁵ The Ancient Greek data in this article are drawn primarily from the survey of verbal forms conducted by van de Laar (2000). All generalizations comport with traditional descriptions, for example, those of Smyth 1920 [1984], Schwyzer 1939, Sihler 1995.

⁶ There is a systematic set of exceptions where roots with other cluster types unexpectedly show C₁-copying. These will be discussed in section 4.4.

Table 1C₁-copying reduplication

Root		Present tense		Perfect tense	
a. Roots with initial singleton consonants					
d5-	'give'	δίδωμι	[di-d5-]	δέδωκα	[de-d5-]
pemp-	'send'	πέμπω	[pemp-]	πέπεμπται	[pe-pemp-]
lu-	'loosen'	λύω	[lu-]	λέλυκα	[le-lu-]
b. Roots with initial <i>stop-sonorant</i> clusters					
kri(n)-	'decide'	κρίνω	[kri-n-]	κέκριμαι	[ke-kri-]
tla-	'suffer'	τλάω	[tla-]	τέτλακα	[te-tla-]
pneu-	'breathe'	πνέω	[pne-]	πέπνυμαι	[pe-pnu-]

When reduplication is successfully carried out in forms like those in table 1, the string proposed to the root takes the shape *CV*. In such cases, *C* is always identical to the root-initial consonant. This can be captured using the constraint ANCHOR-L-BR (McCarthy and Prince 1995: 123), which penalizes copying from non-root-initial position. (The function of ANCHOR could equally well be taken up by LOCALITY; see Nelson 2003, et seq.) In the overtly copying pattern in table 1, and indeed also in those cases where copying fails to occur (as in table 2), *V* is always [e], regardless of the identity of the root vowel.

2.1.2 Perfect Reduplication: One Morpheme or Two? The [e] vowel that precedes the root in the perfect does not covary with a segment in the base. A priori, cases where a fixed segment occurs in a reduplicative context admit two analytical options (see Alderete et al. 1999): a phonological analysis or a morphological analysis. Under the phonological approach, the segment is taken to be copied from the base as part of the reduplicant, but markedness constraints induce phonological reduction (a case of *the emergence of the unmarked*; McCarthy and Prince 1994).⁷

Table 2

Noncopying 'reduplication'

Root		Perfect tense		
a. Roots with other initial clusters				
kten-	'kill'	ἔκτονα	[e-kton-]	not **[ke-kton-]
pseud-	'lie'	ἔψευσμαι	[e-pseus-]	not **[pe-pseus-]
stel-	'prepare'	ἔσταλκα	[e-stal-]	not **[se-stal-]
smēk ^h -	'wipe'	ἔσμηλένοζ	[e-smēg-]	not **[se-smēg-]
b. Roots with initial geminates				
rreu-	'flow'	ἔρρήκα	[e-rru-]	not **[re-rru-]
sseu-	'hasten'	ἔσσυμαι	[e-ssu-]	not **[se-ssu-]

⁷ Alderete et al. (1999) also entertain an analysis in which the fixed segment is not copied, but epenthetic.

As I will show in sections 2.1.3 and 2.1.4, such an analysis is unworkable for Ancient Greek, as it would lead to a ranking paradox.

Therefore, I will proceed with the alternative, morphological analysis. Rather than identifying the fixed segment as belonging to the reduplicant proper (i.e., arising via ‘copying’), we can view it as an independent morpheme, bound to cooccur with the reduplicative morpheme. This situation resembles, for example, that of *schm*-reduplication in English (Alderete et al. 1999: 355–357; cf. Nevins and Vaux 2003).⁸ Under this approach, a typical reduplicated form like perfect κέκριμαι [kékrimai] will be decomposed as in (4).

(4) *Morphological decomposition of the perfect*

k-	e-	kri	-mai
REDUPLICANT	FIXED-SEGMENT	AFFIX	ROOT INFLECTION

With the fixed *e* identified as an independent morpheme, two questions remain to be answered in order to complete an analysis of the consonant-initial roots: (a) How does the reduplicant come to take the shape of a single consonant in the pattern in table 1? and (b) How do we derive the $C \sim \emptyset$ alternation that distinguishes the C_1 -copying pattern in table 1 from the noncopying pattern in table 2? These two questions are taken up immediately below.

2.1.3 The C_1 -Copying Pattern Since the noncopying pattern exists, the constraints that motivate having segments in the reduplicant must be violable in Ancient Greek. As will be shown in sections 2.1.4 and 2.2, violation of these constraints can be forced by higher-ranked phonotactic considerations. When these constraints are not in danger of being violated, the constraints that enforce copying are satisfied. This is the case for the roots with C_1 -copying.

REALIZE MORPHEME (RM; Kurisu 2001) is a constraint that can motivate reduplicative copying. RM demands that morphemes that are present in the underlying representation have surface exponents in the phonology. If no reduplicative copying were undertaken, the RM constraint on the reduplicative morpheme—RM(RED)—would incur a violation.

The phonotactics provide a motivation for copying, as well. If the /e/ were to surface without a preceding consonant, a violation of ONSET (Prince and Smolensky 1993/2004) would be incurred, since this would create an onsetless syllable. Onsetless syllables are permitted in Ancient Greek, but actively disfavored. This can be seen from a number of processes, including vowel contraction, cross-word elision (‘crasis’), and ‘*nu* movable’ (see Golston 2014). Therefore, ONSET will specifically militate for the presence of a consonant-final (and also consonant-initial) reduplicant, to accommodate the fixed *e* morpheme.

RM(RED) and ONSET thus prefer an overt reduplicant of the shape $\#(C \dots)C$ - (followed immediately by the fixed *e*), but make no further demands regarding reduplicant shape. McCarthy and Prince (1986/1996, et seq.) demonstrate that ‘reduplicative templates’ must take the shape of ‘genuine units of prosody’ (syllable, foot, prosodic word). In the Ancient Greek perfect, neither of the two overtly reduplicative patterns takes on such a shape: the C_1 -copying pattern

⁸ As with *schm*-reduplication and similar cases, it is unclear if these two morphs have distinct functions.

currently under discussion is a single consonant; the AR pattern is a necessarily heterosyllabic VC sequence. Therefore, it seems unsuitable to pursue an analysis of reduplicant shape based on templates of any sort. Furthermore, the fact that such different reduplicant shapes result from roots of different shapes would make such an analysis difficult.

Instead, this section will develop an ‘‘a-templatic’’ analysis (see Gafos 1998, Hendricks 1999, among many others). A-templatic accounts of minimal reduplication patterns such as these rely on the activity of a ‘‘size restrictor’’ constraint (e.g., Spaelti 1997, Hendricks 1999, Riggle 2006). A size restrictor constraint will in some way penalize the reduplicant for having excessive length (or indeed any length at all). When the size restrictor outranks MAX-BR (the constraint that advocates copying each segment of the base into the reduplicant; see McCarthy and Prince 1995), the minimal reduplicant shape emerges as optimal.

Following Hendricks (1999), I use an ALIGNMENT constraint (McCarthy and Prince 1993, Prince and Smolensky 1993/2004) as the size restrictor. Given that the fixed *e* has been identified as a distinct morpheme, it can have an alignment constraint defined for it, as in (5).⁹

- (5) ALIGN-/e/-L: Assign one violation * for every segment that intervenes between the left edge of the prosodic word and the left edge of the fixed-segment affix *e*.¹⁰

When ranked above MAX-BR, this constraint will induce the desired minimization effect, since increasing the length of the reduplicant will necessarily increase the number of violations of this constraint, as illustrated in (6).¹¹

- (6) *Minimizing the reduplicant*

√*pemp-* → πέπεμπται [p-é-pemp-tai] ‘he has (been) sent’

/RED, e, pemp-/	ALIGN-/e/-L	MAX-BR
a. $\sqrt{\text{p-e-pemp-}}$	*	***
b. $\sqrt{\text{pem-e-pemp-}}$	***!	*

Given that we do see copying in the general case, ALIGN-/e/-L must be ranked below ONSET and/or RM(RED), since failure to copy anything will satisfy ALIGN-/e/-L but violate ONSET and RM(RED).¹²

⁹ For ease of exposition, in this article I employ gradient alignment constraints. McCarthy (2003) argues that alignment constraints (and indeed all Optimality Theory constraints) should be defined categorically, not gradually. However, Yu (2007:38–42) demonstrates that McCarthy’s restriction to categorical alignment constraints does not actually avoid the typological overgeneration problem it seeks to solve. The facts here are compatible with a categorical analysis, in which the single gradient constraint is separated into two categorical constraints: one alignment constraint defined with reference to an intervening *segment*, and another defined with reference to an intervening *syllable*.

¹⁰ In cases where the underlying /e/ morpheme coalesces with a root-initial vowel, this constraint is evaluated with respect to that coalesced vowel.

¹¹ To ensure that this constraint does not have the effect of placing the [e] to the left of the reduplicant, we may also need to include an alignment constraint on the reduplicant (ALIGN-RED-L), ranked above it. However, such an ordering would generally be disfavored anyway by higher-ranked ONSET.

¹² I will show in section 2.2 that ONSET >> ALIGN-/e/-L >> RM(RED).

(7) *Ensuring consonant copying*

√*pemp*- → πέπεμππται [p-é-pemp-tai] 'he has (been) sent'

/RED, e, pemp-/	RM(RED)	ONSET	ALIGN-/e/-L
a. p^{e} -e-pemp-			*
b. __-e-pemp-	*!	*!	

ALIGN-/e/-L would also be capable of selecting the minimal C_1 reduplicant for roots with initial clusters. However, in accounting for the noncopying pattern in section 2.1.4, we will see that the ranking of ONSET and/or RM(RED) over ALIGN-/e/-L will in that case prefer extending the reduplicant to include the whole cluster. To avoid this outcome, we must supplement the ranking with a constraint against consonant clusters: *CLUSTER (*CC). We can view this as another case of the emergence of the unmarked in reduplication; while consonant clusters are permitted generally, they are prevented from occurring in the reduplicant, even in the reduplicant to roots beginning in consonant clusters. Therefore, MAX-IO and DEP-IO dominate *CC, but *CC dominates MAX-BR (see McCarthy and Prince 1994, 1995), as shown in (8). This ranking prefers the C_1 -copying candidate (9a) to the cluster-copying candidate (9b) and the cluster-simplifying candidate (9c).

(8) *Ranking*

MAX-IO, DEP-IO \gg *CC \gg MAX-BR

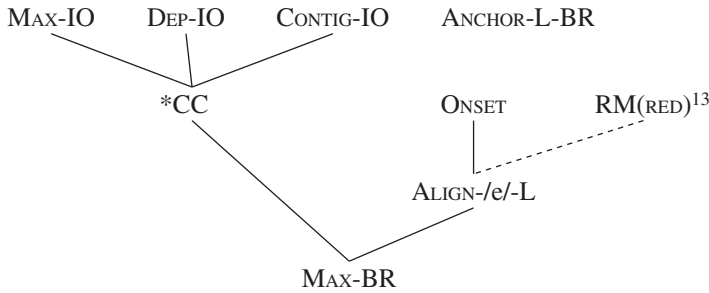
(9) *C_1 -copying reduplication*

√*kri*- → κέκριμαι [k-é-kri-mai] 'I have (been) judged'

/RED, e, kri-/	MAX-IO	*CC	ALIGN-/e/-L
a. k^{e} -e-kri-		*	*
b. <u>kr</u> -e-kri-		**!	**
c. <u>k</u> -e-ki-	*!		*

These size-minimizing constraints show why reduplication cannot be larger than a single consonant; however, they do not specify which consonant should be copied into this position. The constraint that will enforce copying of root- C_1 , as opposed to, for example, root- C_2 (as in a candidate like [r-e-kri-]) has already been mentioned, ANCHOR-L-BR. (Nothing yet fixes this constraint's relative ranking.) Candidates in which the *e* is infix, like [-k-e-ri-] or [ke-k-e-ri-], would alleviate the root's *CC violation, but these are ruled out if the constraint CONTIGUITY-IO (CONTIG-IO; Kenstowicz 1994, McCarthy and Prince 1995) dominates *CC.

This analysis generates the basic C_1 -copying reduplication pattern. The ranking of the constraints employed thus far is summarized in (10).

(10) *Ranking summary*

2.1.4 Noncopying to Other Cluster-Initial Roots The C_1 -copying pattern is blocked for cluster-initial roots *not* of the shape stop-sonorant: for example, *kten-* ‘kill’ → perfect *e-kton-*, not ***ke-kton-* (see again table 2). There are many avenues we might pursue in accounting for these facts (see the end of this section for discussion of a few alternatives). Here, I follow the approach I introduced in Zukoff 2015a regarding the motivation for differential treatment of different cluster types in reduplication, namely, that there is a dispreference for the surface sequence that would result from C_1 -copying to certain types of cluster-initial roots. C_1 -copying results in a sequence of repeated consonants separated only by a short vowel. Sequences of repeated consonants are dispreferred crosslinguistically (see, e.g., Walter 2007, Graff and Jaeger 2009). In Zukoff 2015a, I showed that the types of clusters that display noncopying in Ancient Greek (and other nondefault behaviors in the reduplicative systems of related languages) are unified by their absence of robust phonetic cues to root- C_1 . Put another way, consonant repetitions are dispreferred if one (or both) of the copies appears in a context where robust phonetic cues are lacking. Different combinations of phonetic cues license different sets of consonant repetitions. Avoidance strategies targeting these different sets are borne out in the reduplicative systems of a number of other ancient Indo-European languages, including Sanskrit, Gothic, and Latin. Similar effects are found outside of reduplication in these languages, as well (Zukoff 2015b).

While I must forego a fuller exposition of the proposal here for reasons of space, the basic facts of Ancient Greek can be captured by positing the antirepetition constraint in (11), which militates against the repetition of consonants in preobstruent position.¹⁴ This comports with the

¹³ We currently have evidence only that one of ONSET or RM(RED) dominates ALIGN-/e/-L.

¹⁴ The only noncopying cluster type that this constraint will not cover is *s*-nasal: for example, $\sqrt{sm\bar{e}k^h}$ → perfect $\acute{\epsilon}\sigma\mu\eta\gamma\mu\acute{\epsilon}\nu\omicron\varsigma$ [esmēg-], not ***[sesmēg-]*. (Roots of the shape *s* + sonorant are very infrequent in Ancient Greek because of prior sound change. No other such clusters attest perfects.) To ban this configuration, we will need one additional antirepetition constraint.

(i) $*S_\alpha VS_\alpha / _C$: Assign a violation * to any *s*-vowel-*s* sequence that immediately precedes a consonant.

Notice that this constraint will assign violations also to *SVST* sequences, which are additionally penalized by the constraint in (11).

phonetic fact that robust cues such as steep intensity rise and consonant-to-sonorant transitions are absent in this context (see Wright 2004).

- (11) $*C_\alpha VC_\alpha / _[-son]$: Assign a violation $*$ to any sequence of identical consonants separated by a vowel ($C_\alpha VC_\alpha$) that immediately precedes an obstruent.

This antirepetition constraint penalizes C_1 -copying candidates for roots with initial consonant-obstruent clusters, such as (12b). When ranked above ONSET and RM(RED), this constraint rules out the default pattern in favor of the noncopying candidate (12a). Besides noncopying, tableau (12) shows two additional ways of avoiding the problematic repetition: copying the entire root-initial cluster (candidate (12c)) and copying root- C_2 (candidate (12d)). Since these are not the preferred solutions to the $*C_\alpha VC_\alpha / _[-son]$ problem, this shows that $*CC$ and ANCHOR-L-BR must outrank ONSET and RM(RED).

- (12) *Noncopying perfects*

$\sqrt{kt\bar{e}n-} \rightarrow \xi\kappa\tau\omicron\nu\alpha$ [é-kton-a] ‘I have killed’

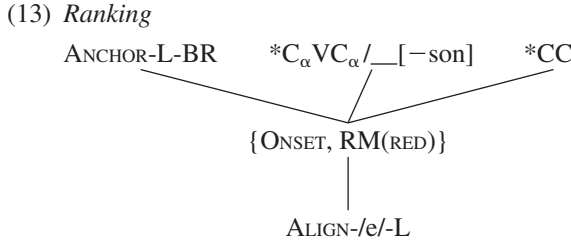
/RED, e, kton-/	$*C_\alpha VC_\alpha / _[-son]$	ANCHOR-L-BR	$*CC$	ONSET	RM(RED)
a. $\xi\kappa$ ___-e-kton-			*	*	*
b. \underline{k} -e-kton-	*!		*		
c. \underline{kt} -e-kton-			**!		
d. \underline{t} -e-kton-		*!	*		

For the noncopying candidate (12a) to be selected over the C_2 -copying candidate (12d), candidate (12d)'s ANCHOR-L-BR violation must be fatal. If it were the case that (12a) also suffered from an ANCHOR violation, (12d) would be selected, as it avoids the ONSET and RM(RED) violations. Therefore, it is necessary that a candidate like (12a) not violate ANCHOR. This informs both the analysis of the fixed *e* and the abstract phonological representation of the noncopying form. If we had pursued a *phonological* fixed-segmentism analysis of the fixed *e*, (12a) necessarily would violate ANCHOR, since its leftmost reduplicant segment ([e]) would be in correspondence with a segment not at the left edge of the base (i.e., the root vowel). Therefore, the fixed *e* must indeed be analyzed morphologically.

But the ANCHOR question does remain even under the current morphological analysis, since it is conceivable that an empty reduplicant is still evaluated for ANCHOR-L-BR. Yet the notion that this candidate violates RM(RED) requires that there is, in a deep sense, *no reduplicant* in the output. Without a reduplicant, there is nothing to instantiate the ‘R’ in the BR (base-reduplicant) correspondence relation.¹⁵ This implies that BR-faithfulness constraints are *vacuously satisfied*

¹⁵ Consult McCarthy and Prince 1995 for definition and discussion of correspondence and the relevant correspondence constraints.

when no reduplicative copying takes place, as the string(s) necessary to establish the correspondence relation is (are) undefined.¹⁶ By this reasoning, (12a) vacuously satisfies ANCHOR-L-BR and is selected as the winner under the ranking shown in (12), schematized in the Hasse diagram in (13).



The antirepetition constraint cannot explain the behavior of the geminate-initial roots in line b. of table 2, because geminates are not clusters, per se. Instead, the answer here lies in BR faithfulness. A high-ranking constraint demanding identity for consonant length between base and reduplicant (IDENT[long]-C-BR¹⁷) would prevent copying a root-initial geminate as a reduplicant singleton. Initial geminates are disallowed, as evidenced by the initial degemination observed for these roots in isolation: for example, /sseu-/ → [seu-] (*#C: >> IDENT[long]-C-IO). These two factors interact to make any sort of copying impossible for these roots.

(14) *Noncopying perfects*

√sseu- → ἔσσομαι [é-ssu-mai] ‘I have hastened’

/RED, e, ssu-/	*#C:	IDENT[long]-C-BR	IDENT[long]-C-IO	ONSET	RM(RED)
a. $\underline{\quad}$ -e-ssu-				*	*
b. \underline{ss} -e-ssu-	*!				
c. \underline{s} -e-ssu-		*!			
d. \underline{s} -e-su-			*!		

While I have pursued an analysis of the noncopying pattern based on antirepetition constraints, a number of other approaches to these facts have previously been proposed. Several of these derive the distinction through differences in syllabification. If stop-sonorant clusters formed complex onsets but other clusters were heterosyllabic (Steriade 1982, 1988, Devine and Stephens

¹⁶ We could also consider a candidate that is surface-identical to (12a), but phonologically *does* have a “reduplicant” in the output, just one that lacks any substantive content. This candidate would satisfy RM(RED), instantiating the BR-correspondence relation. This triggers evaluation of the BR-faithfulness constraints and thus induces violation of ANCHOR-L-BR. Since ANCHOR >> RM(RED), this candidate will always be inferior in Greek to the one that leaves the reduplicant phonologically unrealized.

¹⁷ This constraint must be limited to consonant length, because BR alternations in vowel length are present in AR forms.

1994), we could ascribe the distribution to a ban on copying root-initial consonants that were syllabified as codas. This could be effected within the current analysis by a markedness constraint that penalizes identical consonants within the same syllable (as I proposed in Zukoff 2014). However, recent work (Steriade 2015; cf. Saussure 1884) demonstrates that the weight-sensitive phonological processes of Ancient Greek treated all (word-internal) cluster types identically. Assuming that prosodic weight is determined by syllabic constituency, this indicates that all cluster types had equivalent syllabification (see also Hermann 1923).¹⁸ This casts doubt on a syllable-based analysis of the reduplication facts.

Fleischhacker (2005) proposes an analysis of these facts—along with similar cluster-dependent reduplication patterns in Sanskrit, Gothic, and elsewhere—within a theory of similarity-based cluster reduction. Fleischhacker’s analysis does not rely on syllabification, so it is not contingent on the answers to the above questions of syllabification. However, Fleischhacker presents no analysis of the behavior of vowel-initial roots, including the AR pattern. While her system may be capable of handling these facts to the same extent as the one proposed here, it is unclear whether it can be extended to capture the Pre-AR pattern that will be discussed in section 3. Her analysis may likewise be insufficient to capture the full range of data in the similar systems of closely related Indo-European languages (see Zukoff 2015a). I leave a fuller comparison of the two systems as a direction for further inquiry.

2.2 *Vowel-Lengthening Perfects*

The productive pattern for perfect-stem formation for vowel-initial roots is lengthening of the root-initial vowel. Some examples of this pattern are given in table 3. The grammar developed thus far is consistent with vowel-initial roots forming their perfects through vowel lengthening. The length derives from the underlying mora contributed by the fixed-segment affix *e*. The output long vowel is the result of coalescence of the root-initial vowel with the underlying /e/. This analysis requires that the constraint militating against coalescence, UNIFORMITY-IO (McCarthy

Table 3

Vowel-lengthening perfects (forms from Smyth 1920 [1984]:147, Schwyzer 1939:650)

Root	Present tense	Perfect tense
onoma-	‘name, call’ ὄνομάζω [onoma-]	ὄνόμακα [ɔ̄noma-]
ort ^h o-	‘set upright’ ὀρθόω [ort ^h o-]	ὄρθωκα [ɔ̄rt ^h o-]
et ^h el-	‘wish’ ἐθέλω [et ^h el-]	ἤθελυκα [ē ^h el-]
elpid-	‘hope’ ἐλπίζω [elpizd-]	ἤλυκα [ēlpi-]
angel-	‘announce’ ἀγγέλλω [angel-]	ἄγγελυκα [āngel-]
ag-	‘lead’ ἄγω [ag-]	ἄγυκα [āg-]

¹⁸ Recent studies of Indo-European syllabification (Byrd 2010, 2015, Cooper 2012, 2014) reach similar conclusions.

and Prince 1995:123), is not highly ranked. There is independent evidence for this, as Ancient Greek has an extensive process of mora-preserving ‘vowel contraction’ (see Smyth 1920 [1984]: 20–21, De Haas 1988). To generate vowel coalescence/contraction, we can employ the ranking in (15), which is illustrated in (16). The activity of MAX-μ-IO selects candidate (16d) over (16c), but there is no evidence for its relative ranking.

(15) *Ranking*

MAX-IO >> ONSET >> UNIFORMITY-IO¹⁹

(16) *Vowel contraction*

/...Ce-o.../ → [...Cō...]

/...Ce ₁ -o ₂ .../	MAX-IO	ONSET	UNIFORMITY-IO	MAX-μ-IO
a. ...Ce ₁ -o ₂ ...		*!		
b. ...Co ₂ ...	*!			*
c. ...Co _{1,2} ...			*	*!
d. [⊖] ...Cō _{1,2} ...			*	

Vowel lengthening in the perfect, as well as the vowel lengthening that occurs in the affixation of the past tense indicative ‘augment’ prefix (see Smyth 1920 [1984]:145–146), which is also underlyingly /e/, results in coalescence outputs different from those generally found in vowel contraction. For vowel-lengthening perfects and augmented forms, coalescence of /e/ + /e,o/ generally produces *lax* [ē,ō] (orthographic <η, ω>);²⁰ yet, in vowel contraction, coalescence produces *tense* [ē,ō] (orthographic <ει, ου>). These distributions are straightforward when viewed from the diachronic perspective, as the lengthening pattern arises in a period of Greek prior to the first appearance of the tense long mid vowels.²¹

When the vowel contraction facts are integrated with the evidence from consonant-initial reduplication, we derive the vowel-lengthening forms, subject to one adjustment to the ranking. In the preceding discussion, there was no way to disambiguate ONSET violations from RM(RED) violations. This is because properly anchored copying always alleviated the ONSET violation that would be incurred by leaving the fixed *e* without an onset consonant. However, in the case of vowel-initial roots, properly anchored copying itself induces a new ONSET violation, since the leftmost copied element will be a vowel in word-initial position. Inspection of the ranking under

¹⁹ The ranking of MAX-IO over ONSET follows from transitivity relative to *CC (cf. (10) and (13)).

²⁰ There is some variation on this point, with some vowel-lengthening perfects and augmented forms attesting the contraction outputs [ē,ō].

²¹ Once the tense vowels become the normal result of contraction, the lax vowels of the perfect must be relegated to irregular morphophonology. This can be represented by a markedness constraint specific to the perfect that bans tense long mid vowels: *[ē,ō]_{PERF} (see, e.g., Pater 2009 on constraint indexation). A higher-ranked IDENT constraint would protect *underlying* tense long mid vowels. Therefore, *[ē,ō]_{PERF} would only prohibit [ē,ō] from arising in the course of derivation, such as in perfect-tense vowel lengthening.

these circumstances reveals that RM(RED) must in fact be ranked below ALIGN-/e/-L, while ONSET remains relatively highly ranked.

(17) *Vowel-lengthening perfects*

$\sqrt{ag-} \rightarrow \bar{\alpha}\gamma\mu\alpha\iota$ [ǎ́g-mai] ‘I have (been) led’

/RED, e ₁ , a ₂ g-/	ANCHOR-L-BR	ONSET	ALIGN-/e/-L	RM(RED)	UNIFORMITY-IO
a. <u>a</u> -e ₁ -a ₂ g-		**!*	*		
b. <u>—</u> -ā _{1,2} g-		*		*	*
c. <u>ag</u> -ā _{1,2} g-		*	*!*		*
d. <u>g</u> -ā _{1,2} g-	*!		*		*

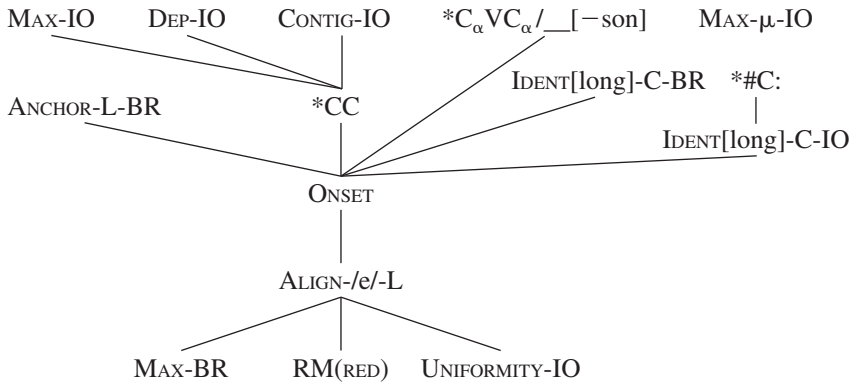
Owing to the high ranking of MAX-IO and MAX-μ-IO (omitted for reasons of space), candidates that delete a vowel (e.g., [g-e₁-g-]) or coalesce as a short vowel (e.g., [—-a_{1,2}g-]) are suboptimal. ONSET eliminates all candidates that display hiatus, here represented by candidate (17a). Since ANCHOR ≫ ONSET, the word-initial ONSET violation cannot be avoided, as in candidate (17d). Only two candidates avoid hiatus and improper anchoring: the vowel-lengthening candidate (17b) [—-ā_{1,2}g-], and candidate (17c) [ag-ā_{1,2}g-], which is the potential output corresponding to the AR pattern. Both candidates receive a single ONSET violation. Candidate (17b)’s violation is for the coalesced fixed /e/ + root /a/. Candidate (17c), on the other hand, repaired that particular ONSET violation by copying both the root-initial vowel and the root-second consonant, which serves as the onset for the coalesced vowel. The two candidates thus have equivalent violation profiles, but from different loci of violation. The choice comes down to the relative ranking of ALIGN-/e/-L and RM(RED). When the resolution of an ONSET violation is not at stake, the system prefers to leave the RED morpheme unrealized than to displace the /e/ from the left edge, selecting the vowel-lengthening candidate (17b). Nonetheless, the observation that the AR candidate survives this deep into the evaluation will serve as the starting point for an explanation of the AR pattern’s survival in the language.

2.3 Interim Summary

This section has developed a grammar that generates the productive distribution of stem formation patterns in the Ancient Greek perfect tense, both overtly reduplicative (as in the case of C₁-copying) and nonreduplicative (as in the noncopying pattern for consonant-initial roots and the basic vowel-lengthening pattern for vowel-initial roots). For consonant-initial roots, C₁-copying is the preferred pattern, applying to roots with an initial singleton consonant or an initial stop-sonorant cluster. This pattern is blocked for roots with other types of initial clusters by markedness constraints disfavoring consonant repetitions in certain environments, namely, in preobstruent position. It is also blocked for roots with initial geminates by constraints on consonant length. To avoid such violations, copying is eschewed altogether for these roots. The same strategy is ultimately employed for vowel-initial roots. Since, in such cases, it is impossible to completely alleviate ONSET violations without deletion or improper anchoring, the minimal reduplicant

shape—null—is preferred, despite the violation of RM(RED). The total ranking of the constraints posited in section 2 is summarized in (18).

(18) *Total ranking for Ancient Greek reduplication*



The constraint set and ranking thus far motivated leaves AR, the alternative pattern for vowel-initial roots, completely unexplained. Why should this complicated pattern exist at all, and how could it subsist in a grammar that generates a simpler pattern? Section 3 will bring to bear insights from historical and comparative linguistics to establish a phonologically motivated origin for the pattern in a prior stage of the language. Section 4 will track the development from this prior stage into attested Ancient Greek and propose that the pattern can actually be straightforwardly generated by the introduction of a single additional constraint.

3 Attic Reduplication

In investigating the productive reduplicative behavior of vowel-initial roots in the synchronic grammar of attested Ancient Greek, we saw that there is no obvious synchronic motivation for the presence of the AR pattern. Given that it also has a very restricted distribution, the best explanation is that it is a retained archaism. This section shows that the origin of this archaic pattern can be generated directly in the phonology of an earlier stage of the language.

3.1 Attic Reduplication and the Laryngeals

Within the synchronic grammar of Ancient Greek, there are no obvious phonological properties that distinguish the vowel-initial roots that exhibit AR from the vowel-initial roots that exhibit vowel lengthening. However, there is a clear distinction when we consider their etymologies. Virtually all of the roots that display AR can be reconstructed as having an initial laryngeal consonant in Proto-Indo-European (PIE) (see the reconstructions and evidence in Rix et al. 2001).²² This connection between AR and the laryngeals has long been recognized in the Indo-European literature (Kuryłowicz 1927, Winter 1950:368–369, Beekes 1969:113–126, Suzuki

²² Only 2 of at least 20 AR roots are definitively not laryngeal-initial, and both are structurally similar (or, in the case of \sqrt{or} ‘keep watch’, identical) to roots that are historically laryngeal-initial.

Table 4

Some Attic reduplication perfects and likely etymologies (see appendix)

Root (Greek < *PIE)		Present tense		Perfect tense		
#*h ₁	(en-)εηκ < *h ₁ nek̑	‘bring’	not applicable	ἐνήνοχα	[enēnok ^h -]	
	ελευτ ^h < *h ₁ lewd ^h	‘go, come’	not applicable	ἐλήλουθα	[elēlout ^h -]	
#*h ₂	ager < *h ₂ ger	‘gather together’	ἀγείρω	[agēr-]	ἄγαγερμαι	[agāger-]
	ar < *h ₂ er	‘join, fit together’	ἀραρίσκω	[arar-]	ἄραρα	[arār-]
#*h ₃	od < *h ₃ ed	‘smell’	ὄζω	[ozd-]	ὄδωδα	[odōd-]
	or < *h ₃ er	‘incite’	ὄρνυμι	[or-]	ὄρωρα	[orōr-]

1994, Sihler 1995:489, Keydana 2006:90–91, 2012:107–108).²³ Some illustrative examples, together with their etymologies, are shown in table 4.

The laryngeals are a set of consonants reconstructed for PIE on the basis of internal and comparative evidence (Saussure 1879).²⁴ They are partially attested in the Anatolian languages, but have been lost in all other Indo-European branches. Their exact phonetic characteristics are unknown, but they are generally identified as fricatives with constriction in the rear of the vocal tract. The most commonly recognized phonemic inventory of PIE includes three laryngeals (which will be represented here as *h*₁, *h*₂, and *h*₃, *H* collectively), based in large part on the “triple reflex” in Greek. As represented in table 5, in each of several environments where we can reconstruct a laryngeal, each of the three different (nonhigh) vowel qualities is found in Greek.

Table 5

Laryngeal outcomes in Greek

	Laryngeal contexts		
	Vocalization *H/{C,#}__C	Coloration *He/#__	Coloration and lengthening *eH/___{C,#}
<i>h</i> ₁	e	e	ē
<i>h</i> ₂	a	a	ā ~ ē [†]
<i>h</i> ₃	o	o	ō

[†] In Attic-Ionic, there is a sound change that changes /ā/ to /ē/. [ā] is attested in other dialects. See footnote 2.

²³ Cowgill (1965:153) takes the opposing view: “It seems also that the Attic Reduplication in Greek perfects must have started from roots which had a prothetic vowel of *nonlaryngeal origin*” (my emphasis).

²⁴ For an introduction to laryngeal theory, consult, for example, Mayrhofer 1986:121–145, Fortson 2010:62–64, 81–83, Byrd to appear. For further discussion of laryngeal behavior in Greek, see Cowgill 1965, Beekes 1969, Rix 1992: 68–76, among others.

We find exactly this triple reflex in the AR forms. Of the approximately 20 vowel-initial roots that have AR perfects, none have an initial high vowel; all begin in [e,a,o], the outcomes of laryngeals in word-initial position (“vocalization”/“coloration”). The long vowels of the second syllables of the AR forms are limited to [ē,ā,ō], the outcomes of tautosyllabic *-eH-* sequences (“coloration and lengthening”). The vowels associated with the AR pattern are thus exactly those vowels associated with laryngeal reflexes. When these facts about the distribution of vowel qualities and quantities are coupled with the comparative etymological evidence for initial laryngeals in these roots, it is safe to assert a connection between AR and laryngeals.

Prior to Proto-Greek (the stage reconstructible by means of comparing the Greek dialects), the laryngeals were lost, leaving only indirect effects such as those listed above. Therefore, in order to bring the laryngeals to bear on AR, the origin of the pattern must be localized in a stage of Greek that precedes their loss. Since evidence of this stage comes from internal reconstruction of Common Greek or Proto-Greek, this stage will be identified as “Pre-Greek.” I proceed under the conservative assumption that, in the absence of evidence to the contrary, the reduplicative grammar of Pre-Greek is minimally different from the directly observable grammar of Ancient Greek.²⁵

3.2 Previous Approaches

With the connection between laryngeals and AR established, the null hypothesis would be that the AR pattern was generated by running the laryngeal-initial roots through the basic reduplicative grammar, as we have it still in Ancient Greek. Since the laryngeals were consonantal segments, the default C_1 -copying reduplication pattern for consonantal roots would yield a preform of the shape $H^i-e-H^iC^k(VC)$ -. For a root $\sqrt{*h_2ger}$ ‘gather together’, this would predict the following derivation:

- (19) *If laryngeal roots reduplicated normally*
- a. Pre-Greek IO mapping: $\sqrt{*h_2ger} \rightarrow$ perfect $*h_2e-h_2ger-mai$
 - b. Diachrony: Pre-Greek $*h_2eh_2germai >$ Common Greek $**āgermai$

The actual form, which does display the AR pattern, is ἀγᾶγερμαι [agāgermai] (Attic-Ionic ἀγήγερμαι [agēgermai]). This form is clearly incompatible with such a derivation.

To fix this problem, most accounts have asserted that roots with initial $*HC$ clusters exceptionally copied both elements to create a reduplicant of the shape $*HCV$ - (Winter 1950:368–369, Beekes 1969:113–126, Rix 1992:204–205, Keydana 2006:90–91, 2012:107–108).²⁶ Once the forms are fixed in such a way, they would derive correctly into Greek.

²⁵ On the behavior of nonlaryngeal cluster-initial roots in Pre-Greek, see section 4.4.

²⁶ Suzuki (1994) also asserts an exceptional copying pattern for laryngeal-initial roots, based on a rule of “laryngeal resyllabification.” Under his account, $*HC$ clusters employed single-consonant copy, but of C_2 rather than C_1 , equivalent to what we find in Sanskrit *jāgāra* < $*g^w_e-h_1g^w_or-e$, and also synchronically in Sanskrit *ST*-initial roots. This generates a preform in $*C_2V-HC_2VC$ -, but still requires “analogical” reintroduction of the initial vowel, perhaps through a sort of base-derivative faithfulness (though Suzuki does not use exactly those terms).

(20) Copying root-initial HC

- a. Pre-Greek IO mapping: $\sqrt{*h_2ger} \rightarrow$ perfect $*h_2g-e-h_2ger-$
 b. Diachrony: Pre-Greek $*h_2geh_2ger-$ ($>$ $*h_2geh_2ger-$) $>$ Common Greek $agāger-$

However, these accounts rarely consider what the motivation for such exceptional behavior (i.e., copying as $C_1C_2V-C_1C_2V-$ rather than $C_1V-C_1C_2V-$) might have been, and simply announce it as stipulation.

While some have tried to connect this cluster copying for laryngeals to the behavior of *s*-stop-initial roots (Keydana 2012), it is demonstrably the case that such roots did indeed follow the normal C_1 -copying pattern, at least among the reduplicated presents. As was pointed out already by Brugmann and Delbrück (1897–1916:40–41; via Byrd 2010:103–104), the exact correspondence between the archaic reduplicated present forms of the PIE root $\sqrt{*steh_2}$ ‘stand’ in Ancient Greek $\iota\sigma\tau\eta\mu$ [hí-stē-mi] ($<$ Proto-Greek $*si-stā-mi$) and Latin *sistō* ([si-st-ō]), neither of which conforms to the languages’ productive patterns for reduplication, requires that we reconstruct this pattern for PIE, and thus Pre-Greek, as well. Under the assumption that reduplication operated in the same way in both present and perfect at the periods in which both were productive, and thus that evidence from the present bears on the behavior of the perfect, we can infer that $*ST$ -initial roots copied C_1 (i.e., *s*) in Pre-Greek. This leaves $*HC$ -initial roots as the only type not to follow the CV reduplication pattern.

But it is not necessary to stipulate that this one particular root shape should copy in an exceptional way. Appealing to the process of laryngeal vocalization, and considering the underlying motivation behind it, provides a recourse for deriving the divergent pattern directly through constraint interaction. Once markedness constraints targeting laryngeals are integrated into the reduplicative grammar, Pre-AR will emerge as the optimal resolution. This resolution yields a preform similar to that of the cluster-copying approaches, but with a phonological motivation for the exceptional behavior of laryngeal-initial roots. The proposed distribution of reduplicant shapes in Pre-Greek is shown in (21), slightly modified from (3).

(21) Default reduplication vs. Pre-AR in Pre-Greek

- a. Default reduplication preforms: $*\underline{C}^i-e-C^iC^kVC-$ or $*\underline{C}^i-e-C^iC^k-$
 b. AR preforms: $*\underline{H}^iVC^k-e-H^iC^kVC-$ or $*\underline{H}^iVC^k-e-H^iC^k-$

3.3 Vowel Prothesis and Laryngeal Vocalization in Greek

In Ancient Greek, as well as in Armenian and Phrygian, reconstructed PIE word-initial HC sequences ultimately surface as the sequence VC (see, e.g., Cowgill 1965, Clackson 1994). In Greek, the quality of the vowel corresponds to the quality of the laryngeal (see table 5); for example, Greek $\acute{\alpha}\nu\eta\rho$ [anḗr] ‘man’ $<$ PIE $*h_2nēr$ (cf. Sanskrit *nar-*). This sound change is traditionally referred to as ‘vowel prothesis’ and can be described with the following diachronic correspondence:

(22) Vowel prothesis

PIE $*\#HCV >$ Ancient Greek $\#VCV$ ($*H > V/\#_CV$)

Vowel prothesis, however, is really just a special case of the more general process of laryngeal vocalization, whereby a reconstructed PIE laryngeal consonant displays a vocalic reflex in the

daughter language. Laryngeal vocalization in Greek occurred when a laryngeal consonant would have occurred word-medially between consonants in a **-VCHCV-* sequence.

(23) *Examples of laryngeal vocalization in Greek*

- a. PIE **h₂enh₁-mos* > Ancient Greek ἄνεμος [ánemos] ‘breath’
(Rix 1992:71)
- b. PIE **ǵenh₁-tōr* > Ancient Greek γενέτωρ [genétōr] ‘begetter’
(Sihler 1995:99)

In terms of diachronic correspondence, the development can be stated as follows:

(24) *Laryngeal vocalization*

PIE **CHC* > Ancient Greek *CVC* (*H > V/C__C)

The only difference in conditioning environment between vowel prothesis and traditional laryngeal vocalization is the preceding context: word boundary in the first case and consonant in the second. The two contexts are unified by the fact that the laryngeal is *not adjacent to a vowel* in either case.

Requiring adjacency to a vowel would be a means of ensuring that the laryngeal consonant has transitional cues. Given that the laryngeals were on their way toward complete loss (presumably by way of a gradual lenition process), it is likely that they were relatively difficult to perceive at this stage. Maximizing what phonetic cues they had would have improved the laryngeals’ perceptibility, both in terms of perceiving their presence and in terms of perceiving their contrastive place. The constraint demanding that laryngeals be adjacent to vowels, which was active in the grammar of Pre-Greek, is defined in (25).

(25) H//V: Assign one violation * for each laryngeal that is not adjacent to a vowel.

This constraint describes the conditioning environment for laryngeal vocalization, but not the change itself. I will be following the view in which laryngeal vocalization is seen not as direct vocalization of the consonantal segment but as epenthesis of a vowel adjacent to the laryngeal (see Mayrhofer 1986:138, Byrd 2010, 2011). The alternative view involving direct laryngeal vocalization is not compatible with the analysis developed here, as it cannot make use of H//V and requires an optimal output at the Pre-Greek stage that violates ONSET. This means that the previous examples have the historical derivations in (26).

(26) *Derivations of laryngeal vocalization in Greek*²⁷

- a. Pre-Greek IO mapping: **/h₂nēr/* → **h₂ənēr*
Diachrony: Pre-Greek **h₂ənēr* > Ancient Greek ἀνήρ [anḗr]
- b. Pre-Greek IO mapping: **/h₂enh₁-mos/* → **h₂enh₁amos/*h₂enəh₁mos*
Diachrony: Pre-Greek **h₂enh₁amos/*h₂enəh₁mos*
> Ancient Greek ἄνεμος [ánemos]

²⁷ I will not attempt to adjudicate the position of the epenthetic vowel relative to the laryngeal for all cases, as it is likely to vary depending on the specific phonotactics and morphological composition of any given string. However, consistency with the proposed analysis of Pre-AR (section 3.4) requires cluster-internal (as opposed to cluster-preceding) epenthesis in cases of word-initial **HC* clusters.

- c. Pre-Greek IO mapping: $*/\acute{g}enh_1-t\ddot{o}r/ \rightarrow *g\acute{e}nh_1\acute{o}t\ddot{o}r/*g\acute{e}n\acute{a}h_1t\ddot{o}r$
 Diachrony: Pre-Greek $*g\acute{e}nh_1\acute{o}t\ddot{o}r/*g\acute{e}n\acute{a}h_1t\ddot{o}r$
 > Ancient Greek γενέτωρ [genétōr]

The synchronic mappings in Pre-Greek are generated by the ranking in (27). The ranking $ONSET \gg CONTIG-IO$ is responsible for cluster-internal epenthesis in word-initial position.

(27) *Ranking (Pre-Greek)*

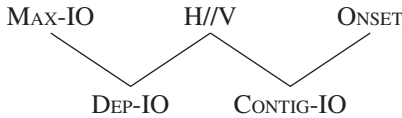


Tableau (28) illustrates how this ranking selects the cluster-internal epenthesis candidate. In this and all subsequent tableaux in this section, each candidate (in the leftmost column) is followed by the form that such a candidate would evolve into in Common Greek. If a candidate would yield the attested outcome, it is accompanied by a “✓”; if it would yield an unattested outcome, it is marked by “*!”. (In (28), “>>” means ‘becomes, possibly via multiple sound changes’.) I make the following two assumptions about the diachrony of laryngeals: (a) the synchronic process of laryngeal vocalization does not involve deletion of the laryngeal consonant; (b) the sound change that eliminates laryngeals occurs after laryngeal vocalization has already run its course, leaving behind the epenthetic vowel as part of the (underlying) phonological representation.

(28) *Laryngeal vocalization*

PIE $\sqrt{*h_2ger}$ ‘gather’ > Ancient Greek ἀγερ- [ager-]

/h ₂ ger/		H//V	MAX-IO	DEP-IO	ONSET	CONTIG-IO
a.	h ₂ ger- >> **ger-	*!				
b.	ger- >> **ger-		*!			
c.	h ₂ er- >> **ar-		*!			*
d.	$\sqrt{*}h_2\acute{a}ger-$ >> ✓ager-			*		*
e.	əh ₂ ger- >> ✓ager-			*	*!	

3.4 Generating (Pre-)Attic Reduplication in Pre-Greek

When the rankings just motivated for laryngeal vocalization are integrated with the grammar previously developed for reduplication in Ancient Greek, the grammar selects an output that will evolve into the AR pattern. Ultimately, the Pre-AR output that the Pre-Greek grammar will produce is [h₂əg-e-h₂ger-]. This form copies both members of the root-initial cluster, with an epenthetic vowel inserted between the copied segments in the reduplicant. This divergence from the normal C₁-copying pattern emerges as a repair for two high-ranking laryngeal-related

markedness constraints in the system: H//V and an antirepetition constraint specifically targeting laryngeals.

3.4.1 *Motivating the Pattern* Prior to the initiation of the Pre-AR pattern (i.e., in PIE and early Pre-Greek), all root shapes displayed C₁-copying, regardless of cluster type (see the discussion in section 3.2, and evidence from archaisms in Greek in section 4.4; see also Niepokuj 1997 for a general survey of Indo-European reduplication). This means that laryngeal-initial roots would have had a CV reduplicant (i.e., HV). This is likely reflected in the Vedic Sanskrit perfect stem [ānáś-] < *h_{1/2}e-h_{1/2}noók- (for *h₁, see Cowgill 1965:151; for *h₂, see Kümmel 2000:289), which is directly cognate with the Old Irish preterite -ánaic. Since neither of these forms is synchronically regular, they are evidence for HV-reduplication to *HC roots in PIE. Applying this pattern to our example root √*h₂ger, these grammars select a candidate [h₂-e-h₂ger-], which copies just C₁. Such a form would have derived into Common Greek as **āger-, which is clearly not the AR pattern.

What, then, changes such that [h₂-e-h₂ger-] is no longer an acceptable output? The antirepetition constraint *C_αVC_α/___[-son] proposed in (11) in order to induce the Ancient Greek noncopying pattern gives us a point of departure. This constraint encoded a dispreference for certain types of repeated consonants in certain contexts. If we posit a constraint of this nature that targets the repetition of laryngeals in the preconsonantal context, then we have a reason why the default C₁-copying candidate would be disfavored in just this case.

- (29) *H_αVH_α/___C: Assign a violation * to any sequence of identical laryngeals separated by a vowel (H_αVH_α) that immediately precedes a consonant.

The presence and activity in the grammar of exactly this repetition constraint likely correlates with the factors that led to laryngeal vocalization. Given that laryngeals required epenthesis of an adjacent prop vowel to license their presence, likely as a means of maximizing their phonetic cues, it is reasonable that they would be specially targeted in the repetition context, as well, if indeed repetition avoidance is sensitive to phonetic cues. Conversely, the lack of epenthesis of this sort for other consonants correlates with tolerance of their repetition.

When *H_αVH_α/___C comes to be active in the grammar (i.e., is promoted to a position in the ranking high enough to induce repairs), the default C₁-copying pattern is prevented from surfacing, since the previously optimal C₁-copying form [h₂-e-h₂ger-] violates this constraint. The new form that will ultimately be chosen as optimal, [h₂əg-e-h₂ger-] (> Common Greek [agāger-]), satisfies *H_αVH_α/___C, as illustrated in (30).

- (30) *Ruling out C₁-copying reduplication*

/RED, e, h ₂ ger-/		*H _α VH _α /___C
a.	h ₂ -e-h ₂ ger- > **āger-	*!
b.	h ₂ əg-e-h ₂ ger- > ✓agāger-	

Table 6

Potential repairs and their associated constraints

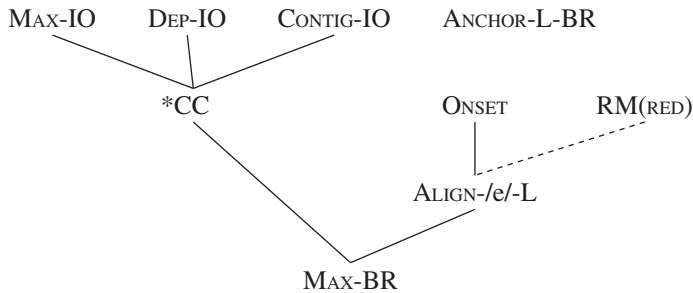
Repair	Candidate output	Constraint(s) violated
a. Reduplication-internal epenthesis	[h ₂ əg-e-h ₂ ger-]	DEP-IO & CONTIG-BR
b. Root-internal epenthesis	[h ₂ e-h ₂ əger-]	DEP-IO & CONTIG-IO
c. Infixation with copying	[h ₂ e-h ₂ e-ger-]	CONTIG-IO
d. Infixation without copying	[__-h ₂ e-ger-]	CONTIG-IO & RM(RED)
e. Unfilled onset	[__-e-h ₂ ger-]	ONSET & RM(RED)
f. Cluster copying	[h ₂ g-e-h ₂ ger-]	H//V
g. Deletion of root-C ₁	[g-e-ger-]	MAX-IO
h. Deletion of root-C ₂	[h ₂ e-h ₂ er-]	MAX-IO & CONTIG-IO
i. Improper anchoring	[g-e-h ₂ ger-]	ANCHOR-L-BR

With the C₁-copying candidate blocked, an alternative copying pattern must take over. The characteristics of this alternative pattern (i.e., (30b)) are determined by the relative ranking of the remaining constraints, which has in large part already been determined.

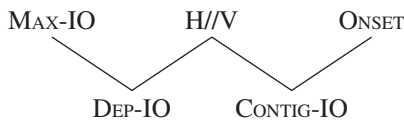
3.4.2 The Alternative Pattern There are a number of ways in which the *H_αVH_α/__C problem might be avoided. Viable repairs are listed in table 6. The Pre-AR form is the *reduplicant-internal epenthesis* candidate (a) [h₂əg-e-h₂ger-], which violates DEP-IO (+CONTIG-BR and ALIGN-/e/-L).

These repairs coincide with operations modulated by the constraints introduced previously in order to account for the basic reduplication pattern and for laryngeal vocalization, respectively. These rankings are repeated here, from (10) and (27).

(31) a. *Ranking for C₁-copying reduplication*



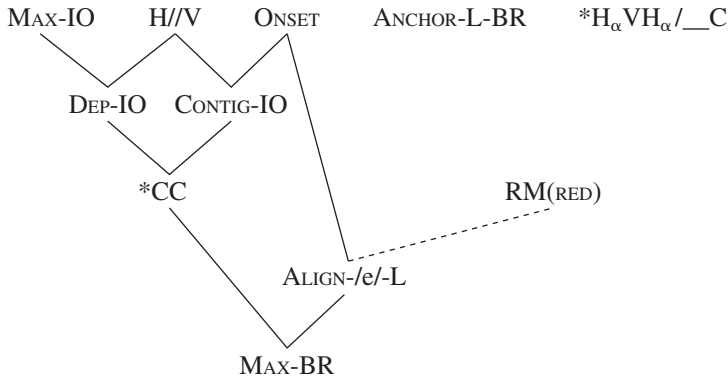
b. *Ranking for laryngeal vocalization*



When we compare these rankings, we find that there are no ranking contradictions. The two rankings can therefore be reconciled without changing the results of either process independently.

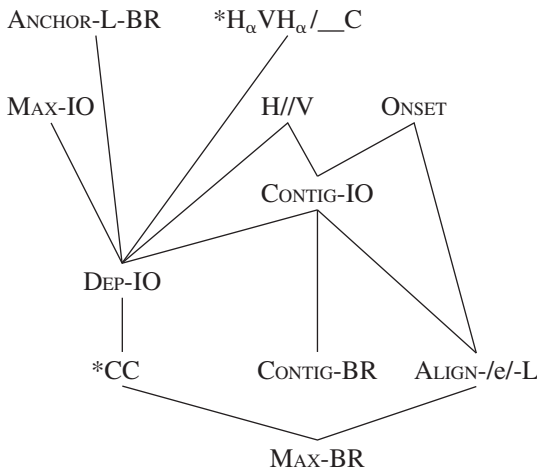
The result of integrating the two rankings without asserting any additional rankings that do not follow from transitivity—other than the addition of undominated $*H_\alpha VH_\alpha / _C$ —is shown in the Hasse diagram in (32).

(32) *Integrated ranking*



The critical rankings contained in (32) successfully eliminate a majority of the candidates listed in table 6 (assuming that the undominated constraints ANCHOR-L-BR and $*H_\alpha VH_\alpha / _C$ cannot become dominated by otherwise dominated constraints). Among the candidates not eliminated is the presumed Pre-AR candidate in line a. of table 6. However, a unique winner cannot be determined with these critical rankings alone. To select the Pre-AR candidate, all that is necessary is to fix CONTIG-IO above DEP-IO, ALIGN-/e/-L, and CONTIG-BR. These additional rankings are shown in the Hasse diagram in (33).²⁸ Tableau (34) demonstrates that these rankings properly select the desired Pre-AR candidate from among the remaining candidates.

(33) *Reconciled total ranking for Pre-AR*



²⁸ RM(RED) is omitted, as there is neither evidence nor need for its ranking.

(34) *The alternative repair: Cluster copying + reduplicant-internal epenthesis*

/RED, e, h ₂ ger-/		CONTIG-IO	DEP-IO	ALIGN-/e/-L	CONTIG-BR
a. $\text{h}_2\text{əg-e-h}_2\text{ger-}$	> ✓ agāger-		*	***	*
b. $\text{h}_2\text{-e-h}_2\text{ger-}$	> **āger-	*!	*	*	
c. $\text{h}_2\text{e-h}_2\text{-e-ger-}$	> **āger-	*!		***	
d. $\text{__-h}_2\text{-e-ger-}$	> **ager-	*!		*	

Before we move on, let us consider what this example in particular may be demonstrating about language change. The catalyst for grammatical reorganization (i.e., the creation of the Pre-AR pattern) is the new activity/high ranking of markedness constraints relating to laryngeals: H//V in laryngeal vocalization; *H_αVH_α/__C in reduplication. These processes are basically *sound changes* and may, as proposed above, derive from the low-level phonetic changes affecting the laryngeals. When the sound change occurs—that is, speakers “decide” that they will not violate the new markedness constraint—they are forced to impose rankings among faithfulness constraints that may not have previously interacted. This in some ways may mirror a standard assumption about phonological learning: *markedness* trumps *faithfulness*. Preliminary investigation has indicated that Biased Constraint Demotion (Prince and Tesar 2004) may be able to generate some or all of the additional critical rankings that turn (32) into (33), assuming that alignment constraints are not afforded the bias given to standard markedness constraints. It is probable then that the AR total ranking is to some extent *predetermined* from a learning perspective. Verifying this fully is left to later work.

Finally, the generalizations captured by the ranking in (33) are summarized in (35). A full summary tableau of the candidates from table 6 is shown in (36).

(35) *Generalizations and ranking arguments*

- a. Laryngeals must be adjacent to a vowel: H//V is active
- b. H//V violations are repaired by epenthesis: H//V, MAX-IO ≫ DEP-IO
- c. Consonant-initial roots reduplicate with C₁-copying:
ANCHOR-L-BR is active; ONSET ≫ ALIGN-/e/-L ≫ MAX-BR
- d. This is interrupted for laryngeal-initial roots because of a dispreference for laryngeal repetitions: *H_αVH_α/__C is active
- e. *H_αVH_α/__C violations are avoided by epenthesis + extra copying:
*H_αVH_α/__C, MAX-IO, ANCHOR-L-BR, ONSET ≫ DEP-IO, ALIGN-/e/-L
- f. Reduplicant-internal epenthesis is preferred to root-internal epenthesis:
CONTIG-IO ≫ CONTIG-BR, ALIGN-/e/-L

(36) *The alternative repair: Cluster copying + reduplicant-internal epenthesis*

/RED, e, h ₂ ger-/	*H _α VH _α /__C	ANCHOR-L-BR	MAX-IO	H//V	ONSET	CONTIG-IO	DEP-IO	ALIGN-/e/-L	CONTIG-BR
a. $\text{h}_2\text{ag-e-h}_2\text{ger-}$ > $\checkmark\text{agäger-}$							*	***	*
b. $\text{h}_2\text{-e-h}_2\text{äger-}$ > **äger-						*!	*	*	
c. $\text{h}_2\text{e-h}_2\text{-e-ger-}$ > **äger-						*!		**	
d. $\text{__-h}_2\text{-e-ger-}$ > **äger-						*!		*	
e. $\text{__-e-h}_2\text{ger-}$ > **äger-					*!				
f. $\text{h}_2\text{g-e-h}_2\text{ger-}$ > **gäger-				*!				**	
g. g-e-ger- > **geger-			*!					*	
h. $\text{h}_2\text{-e-h}_2\text{er-}$ > **är-			*!			*		*	
i. $\text{g-e-h}_2\text{ger-}$ > **gäger-	*!							*	
j. $\text{h}_2\text{-e-h}_2\text{ger-}$ > **äger-	*!							*	

3.5 Attic Reduplication for *HeC roots

While the solution proposed above derives the Pre-AR pattern for roots of the shape *HCeC without problem, a complication arises for *HeC roots with respect to the operation of ablaut.²⁹ The expected ablaut grade for the perfect active singular is the “o-grade.” Therefore, for an *HeC root like $\checkmark\text{h}_1\text{ed}$ ‘eat’ (> Ancient Greek $\checkmark\text{ed}$ ‘eat’), the root allomorph that should be entered into the derivation (for the perfect active singular) is /h₁od/. Since the normal pattern for reduplication is C₁-copying, the default candidate for this allomorph would be [h₁-e-h₁od-]. In this output, the laryngeal is intervocalic and thus not in violation of *H_αVH_α/__C or H//V. Therefore, there would be nothing to rule out this candidate, and it should be chosen as the winner. A Pre-Greek form *h₁-e-h₁od- would yield Ancient Greek **ōd-, which is not the attested perfect stem for this root; instead, this root attests a perfect stem edēd- that shows AR. While the ō- outcome is not attested for this particular root, it is seen in the lexicalized perfect stem ἄνωγα [án-ōg-a] ‘I command’,³⁰ which is typically identified as belonging to the PIE root $\checkmark\text{h}_2\text{eg}$ ‘say’ (Rix et al. 2001:256) (the an sequence is the preverb an(a)- ‘up, on, upon’): Pre-Greek *an(a)-h₂-e-h₂og- > Ancient Greek anōg-. Thus, the system developed to account for reduplica-

²⁹ For an introduction to Indo-European ablaut, see, for example, Mayrhofer 1986, Fortson 2010.

³⁰ Thank you to an anonymous LI reviewer for pointing out the relevance of this form.

tion in Pre-Greek does generate attested outcomes for *o*-grade perfects of Pre-Greek **HeC* roots, just not AR outcomes. This means that the Pre-AR pattern in **HeC* roots cannot come from the *o*-grade.

In order to generate Pre-AR to the **HeC* roots that display it, we must instead start with a formation that takes “zero-grade” ablaut. For $\sqrt{*h_1ed}$, the best and oldest attested perfect form is the participle ἐδηδώς [edēd-ōs]. Since the participle is indeed a zero-grade formation, the input would be /RED, e, h₁d, wōs/. Plugging in the default C₁-copying candidate, we do encounter our *H_αVH_α/___C violation: [h₁-e-h₁d-wōs]. This leads us down the same road as with the **HCeC* roots, ultimately choosing the candidate [h₁əd-e-h₁d-wōs], which directly yields the attested AR form ἐδηδώς [edēd-ōs]. Therefore, while AR should not arise in *o*-grade (or indeed *e*-grade) formations for **HeC* roots, it should arise in zero-grade formations, which include all categories in the perfect other than the active singular.

This predicts that, for a time, **HeC* roots would have had normal C₁-copying reduplication in *e/o*-grade categories, as is reflected in *anōg-* (< **an(a)-h₂-e-h₂og-*), but Pre-AR reduplication in zero-grade categories, as is reflected in *edēd-* (< **h₁əd-e-h₁d-*). As ablaut distinctions collapsed, and as the transparency of the relationship between the two reduplicative allomorphs was eroded by the loss of the laryngeals, speakers could have easily generalized one or the other of the stem forms throughout the perfect paradigm.

3.6 Interim Conclusions

In this section, we have seen how the phonological properties of the laryngeals, likely deriving from the weakness of their phonetic cues, had major effects on Pre-Greek. In the general case, laryngeals required epenthesis of a prop vowel when not otherwise vowel-adjacent (i.e., laryngeal vocalization). In reduplication, the desire to avoid the local repetition of laryngeals in preconsonantal position made it impossible for laryngeal-initial roots to reduplicate according to the default C₁-copying pattern of the language. This led to the precursor of the AR pattern of attested Ancient Greek. The constraint ranking needed to generate this pattern, which ultimately selects cluster copying and reduplicant-internal epenthesis as the optimal alternative reduplication pattern, is in large part independently motivated by the default C₁-copying reduplication pattern and laryngeal vocalization. The independent activity of these two parts of the grammar may, in a certain sense, have predestined this particular resolution of the laryngeal markedness problem. The Pre-AR pattern, generated productively and transparently in Pre-Greek, is maintained in Ancient Greek as AR. In the following section, we will consider how this pattern came to persist into Ancient Greek despite the loss of its original conditioning factors.

4 Attic Reduplication in the Synchronic Grammar of Ancient Greek

4.1 Compositionality in Greek Reduplication

The synchronic analysis of AR presented above hinges crucially on the presence of laryngeals in the phonemic/phonetic inventory. However, the AR forms clearly survive beyond the period at which laryngeals are lost from the inventory (if they had not, we would have no trace of the

pattern). If the perfects built to these roots had been productively generated throughout their history, they would have fallen together with the outcomes of other vowel-initial roots³¹—and thus come to display vowel lengthening (see again section 2.2)—rather than retaining AR. The retention of AR thus requires special explanation.

The simplest account would be that AR forms are retained as noncompositional listed allomorphs to particular roots. However, there is clear evidence for compositionality in reduplication in Greek. The best such evidence comes from the treatment of reconstructed root-initial labiovelar consonants in the unproductive reduplicated present.

While Ancient Greek productively/obligatorily displays reduplication only in the perfect tense, it does show remnants of reduplicative processes in its two other tense stems: the present and the aorist.³² In PIE and Pre-Greek, we can reconstruct reduplication of a form virtually identical to that of the perfect (*Ci-* in the present, *Ce-* in the aorist) that was used as an optional derivational process of stem formation in these two tense categories. By the time of attested Ancient Greek, it appears that new forms could not be generated in this way, but many relics remain (particularly in the present). The unproductiveness of present reduplication gives us a window into the nature of reduplication in the system, *vis-à-vis* its interaction with sound change.

PIE contained a series of consonants reconstructed as labiovelar stops. These sounds are retained as such in Mycenaean, the earliest attested dialect of Greek. Subsequently, they undergo a series of conditioned partial mergers with the other stop series (see, e.g., Schwyzler 1939: 293–296, Rix 1992, Sihler 1995), and they have completely merged with the other stops by the period of Common Greek. The laryngeals have already been lost by the Mycenaean period. Therefore, any process relating to the conditioned outcomes of the labiovelars necessarily postdates any processes affecting the laryngeals.

Of interest here are two particular outcomes of the labiovelars: labiovelars became coronals before a front vowel (/e,i/), but, for the most part, they became labials elsewhere. When a root-initial labiovelar entered into reduplication, the possibility arose that the copied consonant and the root-initial consonant might surface in contexts that would condition different outcomes. Specifically, the reduplicated consonant would be in the coronalizing context even if the root-initial consonant was in the default (i.e., labializing) context. If such a form surfaces in Greek with a coronal in the reduplicant but a labial in the root, we can be sure that the form was “frozen” prior to the application of the labiovelar sound changes. If, on the other hand, the reduplicant consonant matches the outcome in the root, we can surmise that the form was generated compositionally later than the application of the sound change. Since we know that reduplication is fully productive in the perfect, perfect forms are all expected to display the latter behavior (and they

³¹ Note that there were no (or extremely few) vowel-initial roots in PIE (see Rix et al. 2001). They come about in Greek (and elsewhere) primarily because of loss of certain consonants in initial position, namely, the laryngeals, glides, and *s*. Chronologically, the laryngeals are lost first. Therefore, there is no preexisting pattern for vowel-initial roots in the perfect.

³² See van de Laar 2000 for a catalogue of Greek verbal forms; see Giannakis 1992 for a study of the reduplicated presents in Greek.

do); this question is therefore only probative when asked about reduplication in the present or the aorist.

The root $\sqrt{*g^w er(h_3)}$ ‘eat’ gives us exactly the desired test case. This root has a reduplicated present, which takes the form $\beta\iota\beta\rho\acute{\omega}\sigma\kappa\omega$ [\underline{b} -i-br⁵-sk- $\bar{\sigma}$], not $**\delta\iota\beta\rho\acute{\omega}\sigma\kappa\omega$ $**[\underline{d}$ -i-br⁵-sk- $\bar{\sigma}]$, which would be the outcome predicted by regular sound change (as if from $*g^w$ -i-g^wr(e)h₃-sk- $\bar{\sigma}$). The fact that such forms do not show the outcomes of regular sound change demonstrates that they were subject to compositional production past the stage at which the labiovelars changed (Schwyzer 1939:649). That is to say, if they had come to be stored noncompositionally, BR identity would not have protected the copied consonant from undergoing the expected sound change. If the unproductive reduplicated presents were being generated compositionally at this stage, it seems extremely likely that all *perfect* forms—including AR perfects—were being generated compositionally as well, since reduplication was fully productive in the perfect tense well beyond that point. This strongly indicates that AR forms were being generated compositionally past the point at which the laryngeals were lost. This should lead us to eschew the noncompositional analysis, and explore an analysis in which the AR pattern is generated in the phonology. This section develops such an account.

4.2 Attic Reduplication and REALIZE MORPHEME

As discussed in section 2.2, the productive perfect-stem formation pattern for vowel-initial roots in Ancient Greek is initial-vowel lengthening: for example, present $\acute{\alpha}\gamma\gamma\acute{\epsilon}\lambda\lambda\omega$ [aŋgél- $\bar{\sigma}$] ‘I announce’ → Common Greek perfect $\acute{\alpha}\gamma\gamma\acute{\epsilon}\lambda\kappa\alpha$ [āŋgel-k-a]. Some roots that originally had laryngeals do indeed follow this pattern: for example, present $\acute{\alpha}\gamma\omega$ [ág- $\bar{\sigma}$] (< PIE $*h_2eg\acute{-}\bar{\sigma}$) ‘I lead’ → Common Greek perfect $\acute{\alpha}\gamma\mu\alpha\iota$ [ág-mai]. Left unamended, the grammar we have reconstructed in section 3 will cease to generate AR forms once laryngeals are lost and instead will predict that they should display vowel-lengthening perfects. This is illustrated in tableau (37), which is equivalent to tableau (17) but now showing a root that in reality does display AR: \sqrt{ager} (< Pre-Greek $\sqrt{*h_2ger}$) → $\acute{\alpha}\gamma\acute{\alpha}\gamma\epsilon\rho$ - [agāger-], not $**\acute{\alpha}\gamma\epsilon\rho$ - [āger-].

(37) *The predictions of the synchronic grammar, after laryngeal loss*

/RED, e ₁ , a ₂ ger-/	ANCHOR-L-BR	ONSET	ALIGN-/e/-L	RM(RED)	UNIFORMITY-IO
a. \underline{a} .-e ₁ .-a ₂ ger-		**!*	*		
b. \bullet $\underline{\bar{a}}$ _{1,2} ger-		*		*	*
c. \odot \underline{ag} .- \bar{a} _{1,2} ger-		*	*!*		*
d. \underline{g} .- \bar{a} _{1,2} ger-	*!		*		*

While still superior to all other possibilities, the AR candidate (37c) loses to the vowel-lengthening candidate (37b), because of the ranking ALIGN-/e/-L \ggg RM(RED). The system thus prefers maximal left-edge alignment to overt realization of the reduplicative morpheme. What is necessary to generate AR forms is a reversal of this preference, just in the case of roots that

actually display AR. This can be accomplished using a lexically indexed constraint (see Kraska-Szlenk 1999, Fukazawa 1999, Itô and Mester 1999, 2001, Pater 2000, 2009) that favors overt realization of the reduplicative morpheme.

- (38) REALIZE MORPHEME(RED)_{lex}: If a root has the index *lex*, assign a violation * if there is an underlying RED morpheme that has no phonological content in the output.

When RM(RED)_{lex} is ranked above ALIGN-/e/-L, and all and only the AR roots come with the lexical index *lex*, we derive the distinction between AR forms and vowel-lengthening forms within the synchronic grammar.³³ In tableau (39), we generate copying for a root indexed with *lex*: √ager_{lex} → perfect [ag-āger-]. In tableau (40), we generate just vowel lengthening for a root not indexed with *lex*: √ag → perfect [___āger-].

- (39) RM(RED)_{lex} with lexical indexation selects Attic reduplication

/RED, e ₁ , a ⁱ ₂ g ^k er _{lex} -/	RM(RED) _{lex}	ONSET	ALIGN-/e/-L	RM(RED)
a. ___-ā _{1,2} ger-	*!	*		*
b. a ⁱ g ^k -ā ⁱ _{1,2} g ^k er-		*	**	

- (40) RM(RED)_{lex} without lexical indexation selects vowel lengthening

/RED, e ₁ , a ⁱ ₂ g ^k -/	RM(RED) _{lex}	ONSET	ALIGN-/e/-L	RM(RED)
a. ___-ā _{1,2} g-	not applicable	*		*
b. a ⁱ g ^k -ā ⁱ _{1,2} g ^k -		*	*!*	

The crucial difference between the two derivations arises from the relationship between RM(RED)_{lex} and ALIGN-/e/-L. When RM(RED)_{lex} is not activated through the requisite indexation (as in (40)), there is nothing to differentiate the vowel-lengthening candidate (40a) from the AR candidate (40b) until ALIGN-/e/-L enters the evaluation. Since the AR candidate has extra copying, ALIGN-/e/-L selects vowel lengthening. When RM(RED)_{lex} is activated (as in (39)), ALIGN-/e/-L never gets to exert its force, because RM(RED)_{lex} has already eliminated the vowel-lengthening candidate. This allows ONSET to adjudicate between the various copying candidates, ultimately selecting the AR output.

4.3 Whence Lexical Indexation?

Adopting the RM(RED)_{lex} approach, we can begin to provide a coherent sketch of the diachronic development of AR. It first develops when laryngeal-related phonotactics induce the *cluster-copying + reduplicant-internal epenthesis* pattern for laryngeal-initial roots (Pre-AR): √*h₂ger

³³ The same result could be achieved by lexically indexing the constraint ranking, such that those roots bearing the index *lex* were evaluated by a ranking where RM(RED) >> ALIGN-/e/-L.

→ perfect $*[h_2\partial g\text{-}e\text{-}h_2ger\text{-}]$. When the laryngeals are lost, the motivation for the pattern (i.e., the application of the laryngeal-related phonotactics) is also lost; that is to say, $\sqrt{ager} \rightarrow$ perfect [agāger-] now lacks phonotactic motivation. Learners had two options. One option would have been to fail to learn the pattern altogether and instead regenerate the forms using the productive grammar without further modifications. This would mean a diversion to the mapping $\sqrt{ager} \rightarrow$ perfect [āger-], namely, the vowel-lengthening pattern. This is indeed attested for some roots of laryngeal origin: for example, $\sqrt{*h_2e\acute{g}}$ ‘lead’ → perfect ἄγμου [āg-]. The other option was to attempt to retain the $\sqrt{ager} \rightarrow$ perfect [agāger-] mapping by hook or by crook. To do so required amending the grammar such that it included a new impetus for generating the AR mapping, namely, $RM(RED)_{lex}$ coupled with lexical indexation for only those roots that originally, genuinely displayed AR.³⁴

When considering why speakers might have chosen the second option over the first, we could speculate about a circumstance like the following. The laryngeals would not have been lost overnight (just as no sound change occurs immediately). At some point while this change was in progress, there would have been some members of the speech community who produced laryngeals, and others who did not. Those who produced laryngeals would have been able to construct the grammar with $*H_\alpha VH_\alpha / __C$ and $H//V$, directly motivating AR in the relevant cases. Those without laryngeals would not have been able to generate the forms by means of phonotactics; still, they would have been cognizant of such forms’ existence through contact with laryngeal speakers. (The AR pattern must have been quite striking, considering how divergent it is from the normal reduplication pattern.) To accommodate to the laryngeal speakers, the laryngeal-less speakers would have adduced a new constraint— $RM(RED)_{lex}$ —that could allow them to keep producing AR forms despite a lack of phonotactic motivation.

4.4 $RM(RED)_{lex}$, Reduplicated Presents, and Their Associated Perfects

Independent evidence for the activity of $RM(RED)_{lex}$ can be found elsewhere in the reduplicative system. This progression from phonological productivity to lexical restriction via $RM(RED)_{lex}$ can be seen to repeat itself in the development of the reduplicated presents and the perfects associated with them. As discussed briefly in section 4.1, Ancient Greek possesses a relatively small set of

Table 7

Present reduplication (see Giannakis 1992)

Root		Present		Perfect	
d5-	‘give’	δίδομι	[d-í-d5-mi]	δέδωκα	[d-é-d5-k-a]
t ^h ē-	‘place’	τίθημι	[t-í-t ^h ē-mi]	τέθηκα	[t-é-t ^h ē-k-a]
p ^h au-	‘show’	πιφάσκω	[p-i-p ^h au-sk-5]		not applicable
teuk ^h -	‘prepare’	τιτύσκομαι	[t-i-tú-sko-mai]	τέτευχα	[t-é-teuk ^h -a]
klē-	‘call’	κικλήσκω	[k-i-klē-sk-5]	κέκληκα	[k-é-klē-k-a]

³⁴ Those roots like \sqrt{ag} ($< \sqrt{*h_2e\acute{g}}$) that had laryngeals but do not surface in Ancient Greek with AR can be described as having failed to receive the lexical index, though exactly why this might have happened is unclear.

Table 8

Present reduplication to non–stop-sonorant clusters

Root	Present	Perfect	
mnē-	‘remind’	μῆμνήσκω [m̄-i-mnē-sk-ḡ]	μέμνημαι [m̄-é-mnē-mai]
stē-	‘stand’	ἵστημι [h̄-í-stē-mi] (< *sistēmi)	ἴσθηκα [h̄-é-stē-ka] (< *sestēka)
pet-	‘fall’	πίπτω [p̄-í-pt-ḡ]	πέπτωκα [p̄-é-ptḡ-ka]

present stems that display reduplication. As illustrated in table 7, these forms basically mirror the perfect, differing only in having a fixed *i* rather than *e*. What is noteworthy about the reduplicated presents relative to the perfect, however, is the behavior of roots that begin in non–stop-sonorant clusters. As shown in table 8, contrary to the productive pattern for the perfect, these roots display default C₁-copying rather than noncopying. Even more noteworthy are the perfect forms associated with these roots: these are perfects whose root allomorphs begin in non–stop-sonorant clusters, yet display default C₁-copying reduplication. That is to say, they contradict the productive pattern even though they are members of the productive category.

What results is a striking gap: there are no C₁-copying perfects to roots beginning in *mn*, *st*, *pt*, and so on, that do not also have a reduplicated present.³⁵ (One further exception, *kéktiēmai*, will be discussed below.)³⁶ This gap requires an explanation; RM(RED)_{lex} provides it. If these roots are lexically indexed, which is necessary to generate reduplication in the present, RM(RED)_{lex} predicts that copying will also occur in the perfect, despite being dispreferred by the phonotactics.

First let us consider why the presents to these roots still retain the C₁-copying pattern. Since present reduplication is nonproductive in Ancient Greek, it is possible to assume that the characteristics of the formation originate in an earlier period of the language, similar to the way we accounted for AR. The noncopying pattern rests upon the application of the antirepetition constraint *C_αVC_α/___[–son] (see section 2.1.4), but we have no direct evidence that this constraint was active in Pre-Greek. (The only antirepetition constraint whose activity is evident in Pre-Greek is the one targeting laryngeals, *H_αVH_α/___C (29), which was the impetus for Pre-

³⁵ The forms associated with the root √pet ‘fall’ appear to have contaminated forms of phonologically similar, and perhaps etymologically related, roots that have initial *p(e)t*-. Despite not having reduplicated presents of their own, the verbal systems associated with *petánnūmi* ‘spread out’, *pétomai* ‘fly’, and *ptéssō* ‘crouch’ all attest perfects in *pept* . . . , alongside more expected perfects in *ept* . . . in the first two cases (see van de Laar 2000:246–248, 253, 259–260). An anonymous reviewer points also to a form *pepterúgōmai*, from root *pterugízō* ‘flutter with wings’, in a fragment of Sappho/Alcaeus.

It appears as though the lexical idiosyncrasy that is proper to the root √pet ‘fall’, owing to the presence of reduplicated *píptō* in its verbal system, has come to be transferred to these other roots, such that they build C₁-copying perfects via RM(RED)_{lex}. This state of affairs may have a comparandum among AR forms. The root √or ‘incite’ etymologically contains a laryngeal (PIE √*h_{3er}) and builds an AR perfect stem *orōr*-. There is a phonologically nearly identical root in Greek √^(h)or(a) ‘see, watch’, which historically did not contain a laryngeal (PIE √*(s)wer; see Chantraine 1968:813–815, Beekes and Van Beek 2010:1095–1096), yet attests AR forms in *orōr*- (at least dialectally). (Van de Laar (2000:235) associates this form with an entry *oromai* ‘keep watch’.) It thus seems likely that the etymologically validated AR associated with √or ‘incite’ has contaminated a similar root, just as √pet ‘fly’ has done to other *pt* roots.

³⁶ There are perfect forms in *pep^ht^han*- to the root √p^ht^han- ‘anticipate’, but these are not attested until well after the Classical period (Beekes and Van Beek 2010:1568). In Classical and Pre-Classical Greek, this root shows the expected noncopying forms in *ep^ht^han*-.

AR.) If $*C_{\alpha}VC_{\alpha}/_[-son]$ was indeed *not* active in Pre-Greek, we predict across-the-board C_1 -copying (except to laryngeal-initial roots), as suggested in section 3.4.1. This generates Pre-Greek *pipt-* from (the zero grade of) the Pre-Greek root \sqrt{pet} .

(41) *Copying to non-stop-sonorant roots in Pre-Greek*

\sqrt{pet} - → present $\pi\acute{\iota}\pi\tau\omega$ [p-í-pt-ṽ]

/RED, i, pt, ṽ/	ONSET	DEP-IO	*CC	$*C_{\alpha}VC_{\alpha}/_[-son]$
a. $\pi\acute{\iota}$ -i-pt-ṽ			*	*
b. $\pi\tau$ -i-pt-ṽ			**!	
c. $\pi\tau$ -i-pt-ṽ		*!	*	
d. $_$ -i-pt-ṽ	*!		*	

This solution entails that the noncopying pattern is an innovation induced by the change in sensitivity to the repetition constraints. Prior to the higher ranking of $*C_{\alpha}VC_{\alpha}/_[-son]$, the noncopying perfects would have been normal C_1 -copying perfects. This is supported by the existence of the perfects in table 8. It is possibly also supported by the distribution of perfect forms built to the root \sqrt{kta} ‘acquire’. This root has two distinct stem formation patterns in the perfect: the expected noncopying pattern $e-kt\bar{e}$ -, but also the unexpected copying pattern $k-e-kt\bar{e}$ -. The expected noncopying form has the expected perfect semantics ‘have acquired’. The unexpected C_1 -copying perfect, however, displays unexpected behavior.³⁷ First, it has present semantics, consistently meaning ‘possess’. Second, it serves as the base of derivation for a future stem $ke-kt\bar{e}-s$ - ‘will possess’ and other modal forms, which is not typical of perfect stems. These facts indicate that the stem $ke-kt\bar{e}$ - became paradigmatically isolated at some point in its history. There is no reason why, after becoming isolated, it should have developed C_1 -copying reduplication if it had previously shown noncopying. The only explanation is that the isolated stem *retained* C_1 -copying (or at least the phonological string that it resulted in), and the paradigmatically regular stem changed according to the regular grammar to yield a noncopying stem. Therefore, $ke-kt\bar{e}$ - must be an archaism, attesting to a pre-stage at which kt clusters copied C_1 just like stop-sonorant clusters, even in the perfect.

The fact that the reduplicated presents never get remodeled—as opposed to the perfects, which do get remodeled (except when they are associated with a reduplicated present)—must be due to differences in productivity between the two categories. For the perfect, reduplication is a productive marker of all forms, blocked on the surface in certain cases by phonotactics but always there ‘underlyingly.’ In present-tense stem formation, reduplication is one of many derivational markers and thus is never obligatory. It is completely unproductive by the time of Ancient Greek.

³⁷ Thank you to an anonymous *LI* reviewer for pointing out these distributional regularities.

This means that present reduplication, maybe even prior to the change in ranking of the antirepetition constraints, must in some way be lexically restricted, possibly indexed to $RM(RED)_{lex}$.

Before the antirepetition constraint $*C_{\alpha}VC_{\alpha}/__[-son]$ came to be active in the grammar, the reduplicated present forms could be productively generated as such once the proper morphemes were entered into the underlying representation, as was illustrated in (41). However, after $*C_{\alpha}VC_{\alpha}/__[-son]$ became higher-ranked (above ONSET), the proper underlying form would fail to generate any copying. Armed with the mechanism of $RM(RED)_{lex}$, which they independently had to deduce to account for the AR forms, speakers could avoid losing the reduplication here by assigning these roots to the lexical class of $RM(RED)_{lex}$. If $RM(RED)_{lex}$ dominates the antirepetition constraint(s) in Ancient Greek, then we can generate copying even to non-stop-sonorant cluster-initial roots. Tableau (42) illustrates how this generates *píptō* in the synchronic grammar of Ancient Greek.

(42) *Present reduplication in Ancient Greek*

\sqrt{pet} - → present $\pi\acute{\iota}\pi\tau\omega$ [p-í-pt-ō]

/RED, i, pt _{lex} , ɔ̄/	$RM(RED)_{lex}$	DEP-IO	*CC	$*C_{\alpha}VC_{\alpha}/__[-son]$	ONSET
a. $\pi\acute{\iota}\pi\tau\omega$ p-i-pt-ō			*	*	
b. \underline{pt} -i-pt-ō			**!		
c. \underline{pet} -i-pt-ō		*!	*		
d. $__$ -i-pt-ō	*!		*		*

What is most tantalizing about this solution is that it immediately provides an account for the more surprising forms of this type, the unexpectedly copying perfects to these same roots. When these roots become indexed to $RM(RED)_{lex}$, $RM(RED)_{lex}$ applies not only in the present, but also in the perfect, as demonstrated in (43). Therefore, the aberrant and idiosyncratic copying behavior of the present carries over to the perfect despite there being no category-internal reason for its doing so.

(43) $RM(RED)_{lex}$ in present-perfect pairs in Ancient Greek

\sqrt{pt} - → perfect $\pi\acute{\epsilon}\pi\tau\omega\kappa\alpha$ [p-é-ptō-k-a]; present $\pi\acute{\iota}\pi\tau\omega$ [p-í-pt-ō]

/RED, e, pt _{lex} , k, a/	$RM(RED)_{lex}$	$*C_{\alpha}VC_{\alpha}/__[-son]$	ONSET
a. $\pi\acute{\epsilon}\pi\tau\omega\kappa\alpha$ p-e-ptō-k-a		*	
b. $__$ -e-ptō-k-a	*!		*

The crucial point here is the $RM(RED)_{lex}$ violation in the noncopying candidate (43b). This violation supersedes the $*C_{\alpha}VC_{\alpha}/__[-son]$ violation of the C_1 -copying candidate (43a). If the root were not indexed to $RM(RED)_{lex}$, that $*C_{\alpha}VC_{\alpha}/__[-son]$ violation would be fatal, as it is

in the general case for roots with non-stop-sonorant clusters. But because of $RM(RED)_{lex}$, copying is required, and the C_1 -copying candidate emerges. Thus, the grammar obeys the copying requirement at the cost of the phonotactics. This is the same sort of constraint interaction that led to the selection of the AR form in (39) and (40).³⁸

5 Conclusions

This article has provided a comprehensive account of the historical development of the Attic reduplication pattern of Ancient Greek, set within the larger reduplicative system of Greek. It was demonstrated that the synchronic reduplicative system of Ancient Greek simultaneously generates the patterns displayed by consonant-initial roots and the productive vowel-lengthening pattern for vowel-initial roots. What was not evident from the facts of basic reduplication was how and why the AR pattern coexisted with the vowel-lengthening pattern for vowel-initial roots.

On the basis of the clear etymological connection between AR and the laryngeals, it was argued that laryngeal-specific phonotactics operative in Pre-Greek spawned the precursor of AR (Pre-AR). Pre-AR was then shown to be consistent with, and maybe even to directly follow from (via principles of phonological learning), the interaction of another laryngeal-specific phonotactic repair (laryngeal vocalization) with the normal reduplicative grammar as still evidenced in attested Ancient Greek.

In an attempt to retain the pattern as faithfully as possible subsequent to the loss of the laryngeals (and thus the loss of the pattern's conditioning factors), speakers innovated a new constraint system based on lexical indexation. This same system can be used to account for a previously unrecognized regularity, namely, the unexpectedly copying cluster-initial perfects associated with reduplicated presents. This demonstrates that both patterns are not simply frozen, archaic forms that have arbitrarily persisted in the language; rather, they are synchronically generable minority patterns that are subject to the normal demands of the grammar.

This article illustrates how synchrony and diachrony can be used in tandem to help explain systematic irregularities. Constructing the synchronic grammar of Ancient Greek made it possible to formalize the exceptionality of the AR pattern. Consideration of historical reconstruction allowed a clear hypothesis to be generated about why the irregularity should exist, namely, the behavior of laryngeals. This suggested the possibility of integrating another known phonological process of a similar time depth and scope—namely, laryngeal vocalization—into a new synchronic account of the phenomenon at a distinct diachronic stage. In turn, consideration of how the output of this stage interacted with subsequent diachronic change made it possible to connect the exceptional behavior of AR roots to other, very different root types with similar exceptional behavior (the reduplicated presents and their exceptionally copying associated perfects), which was hitherto completely without principled explanation.

³⁸ There may be one more corner of the grammar that displays similar $RM(RED)_{lex}$ effects. Brent Vine (pers. comm.) points out that there is a set of apparently reduplicated nouns built to $*HeC$ roots that bear a striking resemblance to AR verbal forms—in fact, they are built to many of the same roots that display AR in the perfect: for example, $\sqrt{ag} < *h_2eǵ$ 'lead' → ἀγωγή [agǵǵé], $\sqrt{ed} < *h_1ed$ 'eat' → ἐδωδή [edǵdǵé] (see Vine 1998). As of now, I cannot reconstruct the scenario by which these forms would have arisen, but the connection seems relevant.

Appendix: Attic Reduplication Perfects

Table 9 lists the set of attested AR perfects, coupled with their root etymologies and their forms reconstructed for Pre-Greek based on the analysis developed in this article. Forms are drawn primarily from van de Laar 2000:59–320; see also Beekes 1969:116–120.

Table 9

Attic reduplication perfects

Root (Greek < *PIE)		Present stem	Perfect stem	Pre-Greek reconstruction of perfect stem ^a
#*h₁				
eger < *h ₁ ger	‘wake’	egēr-	egrēgor- ^b	*h ₁ əg-e-h ₁ gor-
ela(u) < *h ₁ elh ₂	‘drive’	ela(u)-	elēla-	*h ₁ əl-e-h ₁ l-a-
eleut ^h < *h ₁ lewd ^h	‘go, come’	—	elēl(o)ut ^h -	*h ₁ əl-e-h ₁ l(o)ud ^h -
(en-)eŋk < *h ₁ nek	‘bring’	—	enēnok ^h -	*h ₁ ən-e-h ₁ nok ^h -
eme < *wemh ₁	‘vomit’	eme-	emēme-	—
ered < *h ₁ reyd	‘cause to lean’	ereid-	erēreis-	*h ₁ ər-e-h ₁ rei ^d / _s -
ereip < *h ₁ reyp	‘throw down’	ereip-	erērip- ^c	*h ₁ ər-e-h ₁ rip-
#*h₂				
ager < *h ₂ ger	‘gather together’	agēr-	agāger-	*h ₂ əg-e-h ₂ ger-
ako(u) < *h ₂ kow(s)	‘hear’	akou-	akāko-	*h ₂ ək-e-h ₂ kow(s)-
ale < *h ₂ elh ₁	‘grind’	ale	alāle-s-	*h ₂ əl-e-h ₂ le-s-
ar < *h ₂ er	‘join’	arar-	arār-	*h ₂ ər-e-h ₂ r-
aro < *h ₂ erh ₃	‘plow’	aro-	arāro-	*h ₂ ər-e-h ₂ r-o-
#*h₃				
od < *h ₃ ed	‘smell’	ozd-	odōd-	*h ₃ əd-e-h ₃ d-
ol < *h ₃ elh ₁	‘destroy’	ol-	olōl-	*h ₃ əl-e-h ₃ l-
om < *h ₃ emh ₃	‘swear’	om-	omōmo-	*h ₃ əm-e-h ₃ m-o-
op < *h ₃ ek ^w	‘see’	—	opōp-	*h ₃ ək ^w -e-h ₃ k ^w -
or < *h ₃ er	‘incite’	or-	orōr(e)-	*h ₃ ər-e-h ₃ r(-e)-
or < *(s)wer	‘keep watch’	or-o-	orōr-	—
oreg < *h ₃ reg	‘stretch’	oreg-	orōreg-	*h ₃ ər-e-h ₃ reg-
orug < *h ₃ ru-g ^h	‘dig’	orus-	orōrug-	*h ₃ ər-e-h ₃ ru-g ^h -

^a Stem-final material may be anachronistic.

^b The [r] in the reduplicant is secondary. Brent Vine (pers. comm.) suggests that it is the result of hypercorrective *r*-insertion, along the lines of the phenomenon discussed in Vine 2011.

^c Beside this there is also *ererim*- with short [e] for long [ē].

References

- Alderete, John, Jill Beckman, Laura Benua, Amalia Gnanadesikan, John McCarthy, and Suzanne Urbanczyk. 1999. Reduplication with fixed segmentism. *Linguistic Inquiry* 30:327–364.
- Beekes, Robert S. P. 1969. *The development of the Proto-Indo-European laryngeals in Greek*. The Hague: Mouton.

- Beekes, Robert S. P., and Lucien van Beek. 2010. *Etymological dictionary of Greek*. Leiden: Brill.
- Brugmann, Karl, and Berthold Delbrück. 1897–1916. *Grundriss der vergleichenden Grammatik der indogermanischen Sprachen*. Strassburg: K. J. Trübner.
- Byrd, Andrew Miles. 2010. *Reconstructing Indo-European syllabification*. Doctoral dissertation, UCLA, Los Angeles, CA.
- Byrd, Andrew Miles. 2011. Laryngeal vocalization as schwa epenthesis: Why does compensatory lengthening not occur? Paper presented at the 30th East Coast Indo-European Conference, Harvard University, Cambridge, MA.
- Byrd, Andrew Miles. 2015. *The Indo-European syllable*. Leiden: Brill.
- Byrd, Andrew Miles. To appear. The phonology of Proto-Indo-European. In *Comparative Indo-European linguistics: An international handbook of language comparison and the reconstruction of Indo-European*, ed. by Matthias Fritz, Jared Klein, and Brian Joseph. Berlin: Mouton de Gruyter.
- Chantraine, Pierre. 1968. *Dictionnaire étymologique de la langue grecque: Histoire des mots*. Paris: Editions Klincksieck.
- Clackson, James. 1994. *The linguistic relationship between Armenian and Greek*. Oxford: Blackwell.
- Cooper, Adam. 2012. *Syllable nucleus and margin in Greek, Vedic, and Proto-Indo-European*. Doctoral dissertation, Cornell University, Ithaca, NY.
- Cooper, Adam. 2014. *Reconciling Indo-European syllabification*. Leiden: Brill.
- Cowgill, Warren. 1965. Evidence in Greek. In *Evidence for laryngeals*, ed. by Werner Winter, 142–180. The Hague: Mouton.
- Devine, Andrew M., and Laurence D. Stephens. 1994. *The prosody of Greek speech*. New York: Oxford University Press.
- Fleischhacker, Heidi Anne. 2005. *Similarity in phonology: Evidence from reduplication and loan adaptation*. Doctoral dissertation, UCLA, Los Angeles, CA.
- Fortson, Benjamin W. 2010. *Indo-European language and culture: An introduction*. 2nd ed. Malden, MA: Wiley-Blackwell.
- Frampton, John. 2009. *Distributed reduplication*. Cambridge, MA: MIT Press.
- Fukazawa, Haruka. 1999. *Theoretical implications of OCP effects on features in Optimality Theory*. Doctoral dissertation, University of Maryland, College Park. Rutgers Optimality Archive 307. Available at <http://roa.rutgers.edu>.
- Gafos, Diamandis. 1998. A-templatic reduplication. *Linguistic Inquiry* 29:515–527.
- Giannakis, Giorgios K. 1992. *Studies in the syntax and semantics of the reduplicated presents in Homeric Greek and Indo-European*. Doctoral dissertation, UCLA, Los Angeles, CA.
- Golston, Chris. 2014. Hiatus. In *Encyclopedia of Ancient Greek language and linguistics*, ed. by Giorgios K. Giannakis, Vit Bubenik, Emilio Crespo, Chris Golston, and Alexandra Lianeri, 2:160–161. Leiden: Brill.
- Graff, Peter, and T. Florian Jaeger. 2009. Locality and feature specificity in OCP effects: Evidence from Aymara, Dutch, and Javanese. In *CLS 45-1: The Main Session. Papers from the 45th Annual Meeting of the Chicago Linguistic Society*, ed. by M. Ryan Bochnak, Peter Klecha, Alice Lemieux, Nassira Nicola, Jasmin Urban, and Christina Weaver, 127–141. Chicago: University of Chicago, Chicago Linguistic Society.
- Haas, Wim de. 1988. *A formal theory of vowel coalescence: A case study of Ancient Greek*. Dordrecht: Foris.
- Halle, Morris. 2008. Reduplication. In *Foundational issues in linguistic theory: Essays in honor of Jean-Roger Vergnaud*, ed. by Robert Freidin, Carlos P. Otero, and Maria Luisa Zubizarreta, 325–357. Cambridge, MA: MIT Press.
- Hendricks, Sean Q. 1999. *Reduplication without template constraints: A study in bare-consonant reduplication*. Doctoral dissertation, University of Arizona, Tucson.

- Hermann, Eduard. 1923. *Silbenbildung im Griechischen und in den andern indogermanischen Sprachen*. Göttingen: Vandenhoeck & Ruprecht.
- Idsardi, William, and Eric Raimy. 2008. Reduplicative economy. In *Rules, constraints, and phonological phenomena*, ed. by Bert Vaux and Andrew Nevins, 149–185. Oxford: Oxford University Press.
- Inkelas, Sharon, and Cheryl Zoll. 2005. *Reduplication: Doubling in morphology*. Cambridge: Cambridge University Press.
- Itô, Junko, and Armin Mester. 1999. The phonological lexicon. In *The handbook of Japanese linguistics*, ed. by Natsuko Tsujimura, 62–100. Oxford: Blackwell.
- Itô, Junko, and Armin Mester. 2001. Covert generalizations in Optimality Theory: The role of stratal faithfulness constraints. *Studies in Phonetics, Phonology, and Morphology* 7:273–299.
- Kenstowicz, Michael. 1994. Syllabification in Chukchee: A constraints-based analysis. In *Proceedings of the Formal Linguistics Society of Mid-America*, ed. by Alice Davison, Nicole Maier, Glauca Silva, and Wan Su Yan, 4:160–181. Iowa City: University of Iowa, Department of Linguistics. Rutgers Optimality Archive 30. Available at <http://roa.rutgers.edu>.
- Keydana, Götz. 2006. Die indogermanische Perfektreduktion. *Folia Linguistica Historica* 27:61–116.
- 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*, ed. by Benedicte Nielsen Whitehead, Thomas Olander, and Birgit Anette Olsen, 99–117. Copenhagen: Museum Tusulanum Press.
- Kiparsky, Paul. 2010. Reduplication in Stratal OT. In *Reality exploration and discovery: Pattern interaction in language & life*, ed. by Linda Uyechi and Lian Hee Wee, 125–142. Stanford, CA: CSLI Publications.
- Kraska-Szlenk, Iwona. 1999. Syllable structure constraints in exceptions. In *Phonologica 1996: Syllables!?*, ed. by John Rennison and Klaus Kühnhammer, 113–131. The Hague: Thesus.
- Kümmel, Martin Joachim. 2000. *Das Perfekt im Indoiranischen*. Wiesbaden: Reichert.
- Kurusu, Kazutaka. 2001. The phonology of morpheme realization. Doctoral dissertation, University of California, Santa Cruz.
- Kuryłowicz, Jerzy. 1927. Origine indoeuropéenne du redoublement attique. *EOS: Commentarii Societatis Philologae Polonorum* 30:206–210.
- van de Laar, Henri M. F. M. 2000. *Description of the Greek individual verbal systems*. Amsterdam: Rodopi.
- Mayrhofer, Manfred. 1986. Lautlehre (Segmentale Phonologie des Indogermanischen). In *Indogermanische Grammatik*, ed. by Manfred Mayrhofer, 1:73–181. Heidelberg: Carl Winter.
- McCarthy, John J. 2003. OT constraints are categorical. *Phonology* 20:75–138.
- McCarthy, John J., Wendell Kimper, and Kevin Mullin. 2012. Reduplication in Harmonic Serialism. *Morphology* 22:173–232.
- McCarthy, John J., and Alan Prince. 1986/1996. Prosodic Morphology. Linguistics Department Faculty Publication Series 13. Available at http://scholarworks.umass.edu/linguist_faculty_pubs/13.
- McCarthy, John J., and Alan Prince. 1993. Generalized Alignment. *Yearbook of Morphology* 1993:79–153.
- McCarthy, John J., and Alan Prince. 1994. The emergence of the unmarked: Optimality in Prosodic Morphology. In *NELS 24*, ed. by Mercè González, 333–379. Amherst: University of Massachusetts, Graduate Linguistic Student Association. Available at http://works.bepress.com/john_j_mccarthy/43.
- McCarthy, John J., and Alan Prince. 1995. Faithfulness and reduplicative identity. In *Papers in Optimality Theory*, ed. by Jill Beckman, Suzanne Urbanczyk, and Laura Walsh Dickey, 249–384. University of Massachusetts Occasional Papers in Linguistics 18. Amherst: University of Massachusetts, Graduate Linguistic Student Association. Available at http://works.bepress.com/john_j_mccarthy/44.
- Nelson, Nicole. 2003. Asymmetric anchoring. Doctoral dissertation, Rutgers University, New Brunswick, NJ.
- Nevins, Andrew, and Bert Vaux. 2003. Metalinguistic, shmetalinguistic: The phonology of *shm*-reduplication. In *CLS 39: Papers from the 39th Annual Meeting of the Chicago Linguistic Society*, ed. by J.

- Cihlar, A. Franklin, D. Kaiser, and I. Kimbara, 1:702–721. Chicago: University of Chicago, Chicago Linguistic Society.
- Niepokuj, Mary. 1997. *The development of verbal reduplication in Indo-European*. Washington, DC: Institute for the Study of Man.
- Pater, Joe. 2000. Non-uniformity in English secondary stress: The role of ranked and lexically specific constraints. *Phonology* 17:237–274.
- Pater, Joe. 2009. Morpheme-specific phonology: Constraint indexation and inconsistency resolution. In *Phonological argumentation: Essays on evidence and motivation*, ed. by Stephen Parker, 123–154. London: Equinox.
- Prince, Alan, and Paul Smolensky. 1993/2004. *Optimality Theory: Constraint interaction in generative grammar*. Malden, MA: Blackwell.
- Prince, Alan, and Bruce Tesar. 2004. Learning phonotactic distributions. In *Constraints in phonological acquisition*, ed. by René Kager, Joe Pater, and Wim Zonneveld, 245–291. Cambridge: Cambridge University Press.
- Raimy, Eric. 2000. *The phonology and morphology of reduplication*. Berlin: Mouton de Gruyter.
- Raimy, Eric. 2009. Deriving reduplicative templates in a modular fashion. In *Contemporary views on architecture and representations in phonology*, ed. by Eric Raimy and Charles E. Cairns, 383–404. Cambridge, MA: MIT Press.
- Riggle, Jason. 2006. Infixing reduplication in Pima and its theoretical consequences. *Natural Language and Linguistic Theory* 24:857–891.
- Rix, Helmut. 1992. *Historische Grammatik des Griechischen: Laut- und Formenlehre*. 2nd ed. Darmstadt: Wissenschaftliche Buchgesellschaft.
- Rix, Helmut, Martin Kümmel, Thomas Zehnder, Reiner Lipp, and Brigitte Schirmer. 2001. *LIV: Lexikon der indogermanischen Verben*. 2nd ed. Wiesbaden: Reichert.
- Saussure, Ferdinand de. 1879. *Mémoire sur le système primitif des voyelles dans les langues indo-européennes*. Leipzig: Teubner.
- Saussure, Ferdinand de. 1884. Une loi rythmique de la langue grecque. In *Mélanges Graux: Recueil de travaux d'érudition classique dédié à la mémoire de Charles Graux, 737–748*. Paris: Ernest Thorin.
- Schwyzler, Eduard. 1939. *Griechische Grammatik*. Munich: C. H. Beck.
- Sihler, Andrew L. 1995. *New comparative grammar of Greek and Latin*. New York: Oxford University Press.
- Smyth, Herbert Weir. 1920 [1984]. *Greek grammar*. Cambridge, MA: Harvard University Press.
- Spaelti, Philip. 1997. Dimensions of variation in multi-pattern reduplication. Doctoral dissertation, University of California, Santa Cruz.
- Steriade, Donca. 1982. Greek prosodies and the nature of syllabification. Doctoral dissertation, MIT, Cambridge, MA.
- Steriade, Donca. 1988. Reduplication and syllable transfer in Sanskrit and elsewhere. *Phonology Yearbook* 5:73–155.
- Steriade, Donca. 2015. Changes in the weight of clusters: Evidence from Ancient Greek. Paper presented at the annual meeting of the Linguistic Society of America, Portland, OR, 8–11 January.
- Suzuki, Seiichi. 1994. Accounting for Attic reduplication: A synthesis. *Journal of Indo-European Studies* 22:399–415.
- Vine, Brent. 1998. The etymology of Greek κῶμη and related problems. In *Mír curad: Studies in honor of Calvert Watkins*, ed. by Jay Jasanoff, H. Craig Melchert, and Lisi Olivier, 685–702. Innsbruck: Institut für Sprachwissenschaft der Universität Innsbruck.
- Vine, Brent. 2011. On dissimilatory *r*-loss in Greek. In *Indogermanistik und Linguistik im Dialog*, ed. by Thomas Krisch and Thomas Lindner, 1–17. Wiesbaden: Reichert.
- Walter, Mary Ann. 2007. Repetition avoidance in human language. Doctoral dissertation, MIT, Cambridge, MA.

- Winter, Werner. 1950. On the origin of the *saṃprasaraṇa* reduplication in Sanskrit. *Language* 26:365–370.
- Wright, Richard. 2004. A review of perceptual cues and cue robustness. In *Phonetically based phonology*, ed. by Bruce Hayes, Robert Kirchner, and Donca Steriade, 34–57. Cambridge: Cambridge University Press.
- Yu, Alan C. L. 2007. *A natural history of infixation*. Oxford: Oxford University Press.
- Zukoff, Sam. 2014. On the origins of Attic reduplication. In *Proceedings of the 25th Annual UCLA Indo-European Conference*, ed. by Stephanie W. Jamison, H. Craig Melchert, and Brent Vine, 257–278. Bremen: Hemen.
- Zukoff, Sam. 2015a. Poorly-cued repetition avoidance in Indo-European reduplication. Paper presented at the annual meeting of the Linguistic Society of America, Portland, OR, 8–11 January.
- Zukoff, Sam. 2015b. Repetition avoidance and the exceptional reduplication patterns of Indo-European. Paper presented at the 27th Annual UCLA Indo-European Conference, UCLA, 23–24 October.

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