On the Origins of Attic Reduplication

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1. Introduction

The Attic Reduplication (AR) pattern of Ancient Greek can be motivated as the outcome of the regular phonology of a Pre-Greek\(^1\) system that still contained laryngeals. Contrary to many previous analyses, analogy is not required in order to account for the inception of the pattern. The solution is derived from a combination of three factors: (i) the grammar that generates the basic pattern of reduplication in the language; (ii) a contextual restriction on the distribution of laryngeals that produces the phenomenon of “vowel prothesis;” and (iii) a specific version of the Obligatory Contour Principle (OCP), for which there is robust evidence in the reduplication patterns of Ancient Greek and other early Indo-European languages. The interaction of these three factors ultimately results in cluster-copying and reduplicant-internal epenthesis exclusively for laryngeal-initial roots, which contrasts with the normal pattern of \(CV\) reduplication, as can be represented schematically in (1):

\[
(1) \quad \text{AR and non-AR pre-forms:} \\
\begin{align*}
\bullet & \text{Attic Reduplication pre-forms: } \ast \text{HVCV-HCVC- or } \ast \text{HVCV-HC-} \\
\bullet & \text{Normal reduplication pre-forms: } \ast \text{CV-C(C)VC-}
\end{align*}
\]

1.1. Attic Reduplication

In Ancient Greek, the perfect tense is productively marked by reduplication. For consonant-initial roots, reduplication normally takes the form of a \(CV\) reduplicant, for example: √\(kri\) ‘judge’ \(\rightarrow\) perfect κέκριμαι [ke-kri-mai].\(^2\) For vowel-initial roots, the perfect is generally marked by vowel lengthening, for example:

\* Special thanks to Donca Steriade, Adam Albright, Jared Klein, Anya Lunden, Andrew Byrd, Ryan Sandell, Juliet Stanton, Tony Yates, Craig Melchert, and Brent Vine, and also to the audience at WeCIEC 25, and audiences at MIT, Harvard, and UCLA. All mistakes are, of course, mine.

\(^1\) In this paper, “Pre-Greek” refers to an earlier stage of the language described through internal reconstruction, temporally located between Proto-Indo-European and Proto-Greek.

\(^2\) A particular class of roots with initial clusters shows an \(e\)-reduplication strategy, discussed in §6.1 below.
√ag ‘lead’ → perfect ἕγαμαι [ἐγ-маі]. However, for a subset of the (synchronously) vowel-initial roots, there is a different pattern, known as Attic Reduplication (AR). AR forms show a reduplicant of the shape VC with concomitant lengthening of the root-initial vowel:

Table 1. Some Attic Reduplication perfects and likely etymologies. 

<table>
<thead>
<tr>
<th>Root (Greek &lt; *PIE)</th>
<th>Present tense</th>
<th>Perfect tense</th>
</tr>
</thead>
<tbody>
<tr>
<td>(en-)enk</td>
<td>&lt; *h₁nek</td>
<td>‘bring’</td>
</tr>
<tr>
<td>eleut</td>
<td>&lt; *h₁leud</td>
<td>‘go, come’</td>
</tr>
<tr>
<td>ager</td>
<td>&lt; *h₂ger</td>
<td>‘gather’</td>
</tr>
<tr>
<td>ar</td>
<td>&lt; *h₂er</td>
<td>‘join’</td>
</tr>
<tr>
<td>od</td>
<td>&lt; *h₃ed</td>
<td>‘smell’</td>
</tr>
<tr>
<td>or</td>
<td>&lt; *h₃er</td>
<td>‘incite’</td>
</tr>
</tbody>
</table>


The literature agrees that this pattern must in some way be tied to laryngeals (Winter 1950:368–9; Beekes 1969:113–26; Suzuki 1994; Sihler 1995:489; Keydana 2006:90–1, 2012:107–8). This can be confirmed by two facts. First, virtually all AR forms are built to roots which can be securely reconstructed with an initial laryngeal. Only two of at least twenty AR roots are definitively not laryngeal-initial. One of these is √or ‘keep watch’ < *(s)uer, which has a perfect ὀρωρα | [ὀρωρ-]. This form has clearly been attracted to the perfect of the homophonous root √or ‘incite’ < *h₂er, which also has a perfect ὀρωρα. The other is √eme ‘vomit’ < *u₃emh₁, whose perfect is ἐμεμεκα [ἐμεμέκα]-. While there is no obvious source of analogy for this root, after the loss of */u̯/, the shape of this root would be equivalent to that of many other AR forms. Secondly, only non-high vowel-initial roots participate in AR, i.e., only roots beginning in [e, a, o].

3 Zukoff (2012:105–26) argues that vowel-lengthening can be productively derived from the same reduplicative process as applies to consonant-initial roots. See likewise Steriade 1982: 310–1.
4 Cowgill (1965:153) takes the opposing view.
5 The unusual o-vocalism of the root may imply that this root is not of early date, but possibly a later secondary formation built to an o-grade nominal (LIV²:539). As such, it would likely not have inherited a perfect, obtaining one instead by analogy.
6 This form is likely also not of early date (Beekes 1969:116).
Since these are exactly the outcomes associated with the vocalization of the three laryngeals, respectively, this fact strongly implies a connection between AR and laryngeal coloration and vocalization.\(^7\)

However, invoking laryngeals is not on its own sufficient to explain AR. If we project the origin of the AR pattern back to a period when laryngeals were still present, the relevant roots were consonant-initial, and thus would be expected to reduplicate according to the normal pattern, namely to have a \(CV\) reduplicant. This would yield a pre-form of the shape \(HV-H(C)VC\)-. Given the root *\(\sqrt{h_2ger}\) ‘gather together’, this would predict the following derivation:

\[
(2) \quad \text{If laryngeal roots reduplicated normally:} \quad *\sqrt{h_2ger} \rightarrow \text{perfect } *h_2e-h_2ger-mai > \text{Attic-Ionic } **[\acute{\varepsilon}germai]^{8}\]
\]

The actual form, which does display the AR pattern, is \(\acute{\alpha}g\acute{e}r\eta\mu\alpha\) [\(\acute{\alpha}germai\)]. This form is clearly incompatible with such a derivation.

Some accounts (Sihler 1995:489, Byrd 2010:123) have taken this to be the starting point for an analogical development. These accounts treat the initial \(VC\) sequence of the AR pattern as a sort of “re-application” of reduplication subsequent to the loss of the laryngeals:

\[
(3) \quad \text{Analogical re-application of reduplication:} \quad *\sqrt{h_2ger} \rightarrow \text{perfect } *h_2e-h_2ger-mai > \text{Pre-Greek } *[\acute{\alpha}germai] \rightarrow \text{(analogy)} \quad \text{Att.-Ion. } [\acute{\alpha}germai]
\]

It is possible to create a grammar that can formally derive this “analogy;” but, without careful consideration of the facts, this analogy would make incorrect predictions about the general reduplicative grammar of the (later) language. An across-the-board mechanism that induces this sort of reduplication would predict copying for two types of roots for which it does not productively occur: (i) vowel-initial roots, for which the default pattern is vowel-lengthening; and (ii) non-rising sonority cluster-initial roots. For this reason, the analogy must be lexically restricted. But the lexical restriction is based on phonological properties—namely the earlier presence of a laryngeal. This clearly implies that a phonological generalization is being missed. Furthermore, positing this analogy

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7 In Attic-Ionic, there is a sound change that changes \(/\acute{\alpha}/\) to \(/\acute{\varepsilon}/\). This results in a phonemic merger, and thus also a merger of the outcomes of *\(h_1\) roots and *\(h_2\) roots with respect to the second vowel of the AR forms. The two can still be distinguished by their initial vowel, *\(h_1\) roots having [\(\acute{\varepsilon}\)], *\(h_2\) roots having [\(\acute{\alpha}\)].

8 “>” indicates a diachronic development, “→” indicates a synchronic Input-Output mapping.
as the original source of Attic Reduplication yields no insight regarding the motivation for the pattern.

The more common approach, on the other hand, has been to assert that \( *HC \) clusters exceptionally copied both elements to create a reduplicant of shape \( *HCE- \) (Winter 1950:368–9; Beekes 1969:113–26; Rix 1992:204–5; Keydana 2006:90–1, 2012:107–8). Once the forms are fixed in such a way, they would derive correctly into Greek:

(4) **Copying root-initial \( *HC \):**

\[
*\sqrt{h2ger} \rightarrow \text{perf.} \ast h.ge-h2ger- (> [*h̥2.ge-h̥2.ger-]) > \text{Att.-Ion. [a.ge.ger.mai]}
\]

However, there is no intrinsic reason to think that laryngeal clusters should have had an exceptional copying pattern, i.e., \( C_1 C_2 V-C_1 C_2 - \) rather than \( C_1 V-C_1 C_2 - \).

While some have tried to connect this cluster copying for laryngeals to the behavior of \( s + \text{stop}-\text{initial roots} \) (Keydana 2012), it is demonstrably the case that such roots did indeed follow the normal \( C_1 \)-copying pattern. As was shown by Byrd (2010:103–4), the exact correspondence between the reduplication patterns in the archaic reduplicated present forms of the root \( *\sqrt{steh2} '\text{stand}' \) in Greek ἱστημι [hi-stē-mi] (< Proto-Greek *sistāmi) and Latin sistō (/si-st-ō/), neither of which conform to the languages’ productive patterns for perfect reduplication, requires that we reconstruct this pattern for Proto-Indo-European, and thus Pre-Greek as well. This would leave \( *HC \)-initial roots as the only type not to follow the \( CV \) reduplication pattern, with no clear motivation for doing so.\(^9\)

The account to be presented here is a phonological one. It produces a pre-form similar to that of the cluster-copying approaches, but includes a phonological motivation for the apparent exceptional behavior of laryngeal-initial roots. While the use of “analogy” will be unnecessary for explaining the inception of the Attic Reduplication pattern, it may ultimately be useful in accounting for the retention of the pattern after the loss of the original phonological conditioning environment, namely the laryngeals.

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\(^9\) Suzuki (1994) uses a hybrid approach. He asserts that \( *HC \) clusters employed single-consonant copy, but of \( C_2 \) rather than \( C_1 \) (i.e., \( H \)), due to a rule of laryngeal re-syllabification. This generates a pre-form in \( *C_2V'-HC_2VC' \), but still requires analogical reintroduction of the initial vowel.
2. Reduplication in Greek

In order to see how AR is a divergence from the basic reduplication pattern, we must first have an articulated view of the grammar that generates the basic pattern.10 This will do much of the work in explaining the development of the AR pattern.

2.1. The reduplicative morpheme

Outside of Attic Reduplication forms, there is never any variation in the quality of the reduplicative vowel in Greek: it is always [e] in the perfect and the aorist, and [i] in the present. This contrasts with a system like Sanskrit, where, at least in certain contexts/categories, there is clearly copying of a root [i, u].11 Therefore, we should view the reduplicative vowel as deriving from the underlying form of the reduplicative morpheme (i.e., an instance of “morphological fixed segmentism” as discussed in Alderete et al. 1999), not by copying. I will represent the reduplicative morpheme for the perfect tense as /RED_e/.12 This is meant to show that there is a morphologically fixed e which is preceded by a string of reduplicated segments.

2.2. Deriving basic reduplication

While there are a number of interesting exceptions—most notably, of course, Attic Reduplication, but also non-copying perfects like ἔκτονα [e-kton-a] ‘I have killed’ (cf. §6.1)—the basic reduplication pattern of Ancient Greek can be illustrated by the data in table 2:

Table 2. Basic reduplication in Ancient Greek.

<table>
<thead>
<tr>
<th>Root</th>
<th>Present tense</th>
<th>Perfect tense</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roots with initial singleton consonants</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dɔ̄-  ‘give’</td>
<td>δίδωμι [di-dɔ̄-]</td>
<td>δέδωκα [de-dɔ̄-]</td>
</tr>
<tr>
<td>lu-  ‘loosen’</td>
<td>λύω [lu-]</td>
<td>λέλῡκα [le-lu-]</td>
</tr>
<tr>
<td>pemp-  ‘send’</td>
<td>πέμπω [pemp-]</td>
<td>πέπειμαι [pe-pemp-]</td>
</tr>
</tbody>
</table>

10 For a more thorough analysis of the basic pattern of reduplication in Ancient Greek, see Steriade 1982:195–208, Zukoff 2012. See also Fleischhacker 2005 for a discussion of the Greek pattern embedded within a theory of similarity-based reduplication.


12 For the reduplicated present, it would be /REDi/.
Table 2 continued

<table>
<thead>
<tr>
<th>Root</th>
<th>Present tense</th>
<th>Perfect tense</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roots with initial obstruent + resonant clusters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>κρι(ν)- ‘decide’</td>
<td>κρίνω [κρι-ν-] κέκριμαι [κε-κρι-]</td>
<td></td>
</tr>
<tr>
<td>τλά-/τλέ- ‘suffer, dare’</td>
<td>τλάω [τλα-] τέτληκα [τε-τλέ-]</td>
<td></td>
</tr>
<tr>
<td>πνευ- ‘breathe’</td>
<td>πνέω [πνε-] πέπνῡμαι [πε-πνῡ-]</td>
<td></td>
</tr>
</tbody>
</table>

From this data, we can adduce several crucial generalizations that will help us analyze the basic pattern. These are listed in (5):

(5) Key generalizations about the basic reduplication pattern:
   a. The reduplicant is always the leftmost element in the word.13
   b. The default pattern for reduplication is CV.
   c. The initial segment of the reduplicant always corresponds to the initial segment of the root.
   d. The reduplicating syllable always has an onset consonant.

The basic pattern displays a familiar pattern of minimal partial reduplication. Four constraints are needed to derive this pattern, one for each of the generalizations in (5):

(6) ALIGN-RED-e-L
   Assign one violation mark * for each segment which intervenes between the left edge of the prosodic word and the left edge of the reduplicant.14

(7) ALIGN-ROOT-L
   Assign one violation mark * for each segment which intervenes between the left edge of the prosodic word and the left edge of the root.

The generalization in (5b)—that the reduplicant is of the shape CV—will fall out from the ranking ALIGN-RED-e-L ≫ ALIGN-ROOT-L. CV is the smallest possible (phonotactically preferred) syllable, and therefore will yield the best satisfaction of ALIGN-ROOT-L, given that it cannot be perfectly satisfied due to the higher-ranking priority of left-aligning the reduplicant.

Generalizations (5c) and (5d) can be captured by the familiar constraints ANCHOR-L-BR and ONSET, respectively:

13 The reduplicant can be preceded by preverbs, and also by the augment in the pluperfect and the reduplicated aorist.
14 The ALIGNMENT constraints employed in this paper are evaluated gradiently rather than categorically.
(8) **ANCHOR-L-BR**
The segment at the left edge of the reduplicant corresponds with the segment at the left edge of the base.

(9) **ONSET**
Assign one violation mark * for each onsetless syllable.

To properly derive the data in its totality, all we will need is to critically rank **ALIGN-ROOT-L** below the other three constraints defined in (6)–(9):

```
ANCHOR-L-BR  ONSET  ALIGN-REDe-L
ALIGN-ROOT-L
```

Fig. 1. **Critical Ranking:** **ANCHOR-L-BR, ONSET, ALIGN-REDe-L >> ALIGN-ROOT-L**.

With this ranking in place, we can demonstrate the derivation of the basic reduplication pattern for the root $\sqrt{kri}$ ‘judge’ in tableau (10):

(10) **Basic reduplication:** κέκριμαι [κε.-κρι.-mai] ‘I have (been) judged’

<table>
<thead>
<tr>
<th>/REDe, kri, mai/</th>
<th>ALIGN-REDe-L</th>
<th>ANCHOR-L-BR</th>
<th>ONSET</th>
<th>ALIGN-ROOT-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. κε.-κρι.-mai</td>
<td></td>
<td>k, e</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. κρε.-κρι.-mai</td>
<td></td>
<td>k, r, e!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. ε.-κρι.-mai</td>
<td></td>
<td>*!</td>
<td>e</td>
<td></td>
</tr>
<tr>
<td>d. γε.-κρι.-mai</td>
<td></td>
<td>*!</td>
<td>r, e</td>
<td></td>
</tr>
<tr>
<td>e. κρι.-κε.-mai</td>
<td>k!, r, i</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Candidate (e), which doesn’t have its reduplicant at the left edge of the word, is ruled out by **ALIGN-REDe-L**. Candidate (d), which has copied a consonant from non-root-initial position, is ruled out by **ANCHOR-L-BR**. Candidate (c), which has left the reduplicant’s fixed /e/ without an onset, is ruled out by **ONSET**. Lastly, the choice between (a) and (b) is made by **ALIGN-ROOT-L**. Candidate (a) has two segments preceding the root, but candidate (b) has three. By copying the [r] of the root, (b) has incurred a gratuitous violation of **ALIGN-ROOT-L**, and is thus ruled out in favor of (a).

This grammar derives CV reduplication in the general case for the perfect tense in Ancient Greek. Projecting this back to the period when laryngeals were

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15 Violations of **ALIGN** are indicated by the offending segments for expository clarity.
still present in the phonemic inventory of the language, this grammar predicts an HV reduplicant for roots beginning in a laryngeal. As discussed in §1, it is clear that this will not correctly produce a form which will regularly develop into the attested AR pattern. However, once we integrate this piece of the constraint ranking with that which will be independently motivated for “vowel prothesis,” we will see that CV reduplication will be disrupted for laryngeal-initial roots. In order to repair the problems introduced by the vowel prothesis grammar, an alternative copying strategy develops. This alternative strategy will ultimately yield a viable pre-form for the AR pattern. This will be made explicit in §4.

3. Motivating “vowel prothesis”

In Greek, Armenian, and Phrygian, reconstructed Proto-Indo-European word-initial laryngeal + consonant (HC) sequences ultimately surface as the sequence VC. In Greek, the quality of the vowel corresponds to the quality of the laryngeal; for example, Greek ἀνήρ [anɛ̄r] ‘man’ < PIE *h₂nēr (cf. Skt nar-). This process is traditionally referred to as “vowel prothesis.”

We can formulate the conditioning environment for the development of vowel prothesis as a ban on laryngeal + consonant complex onsets (i.e., HC sequences in syllable-initial position). This ban can be framed in Optimality Theoretic terms as follows:

\[
\text{Assign one violation mark * for every complex onset whose first member is a laryngeal.}
\]

Defining the constraint with reference to syllable position rather than word position appears to be consistent with, if not directly responsible for, word-medial “laryngeal vocalization” in Greek. In the sequence *-VC₁HC₂V*, we might reasonably expect the post-consonantal *HC₂* sequence to form a complex onset (particularly when C₂ is a resonant); but instead, we do see vocalization: e.g., Pre-Greek */h₂en₁-mos/ → *[h₂e.n₁h₁.mos] or *[h₂-en₁h₁.mos] > Greek ἀνεμός [anemos] ‘breath’ (Rix 1992:71); Pre-Greek */ğenh₁-tör/ → *[ğe.n₁h₁.tör] or *[ğen₁.h₁.tör] > Greek γενέτωρ [genetör] ‘begetter’ (Sihler 1995:99). If the constraint inducing vowel prothesis were framed in terms of word-initial position

\[
*_{a}[HC]
\]

16 *h₁C > eC, *h₁C > aC, *h₁C > oC.

17 For further discussion of laryngeal behavior in Greek, see, for example, Cowgill 1965, Beekes 1969, Rix 1992:68–76.
rather than syllable-initial position, we would be unable to connect these two clearly related developments.

I will be following the view in which laryngeal vocalization is not seen as direct vocalization of the consonantal segment, but rather as epenthesis of a vowel adjacent to the laryngeal. Therefore, in order to generate the “laryngeal vocalization” repair, the markedness constraint *_{HC} must dominate the faithfulness constraint DEP-IO, which militates against epenthesis:

\[
(12) \quad \text{DEP-IO} \\
\text{Segments in the output must have a corresponding segment in the input.}
\]

This constraint will also have to be dominated by MAX-IO in order to prefer an epenthesis repair over a deletion repair:

\[
(13) \quad \text{MAX-IO} \\
\text{Segments in the input must have a corresponding segment in the output.}
\]

\[
\begin{array}{c}
*_{HC} \\
\text{MAX-IO}
\end{array} \gg \begin{array}{c}
\text{DEP-IO}
\end{array}
\]

This ranking generates epenthesis in cases where an HC sequence must otherwise be syllabified as an onset. The most obvious environment for this will be in word-initial position, which is the “vowel prothesis” environment:

\[
(14) \quad \text{“Vowel prothesis”: PIE } *_{HC} \rightarrow \text{Greek áγείρω} \ [agēr-ɔ̄] \ ‘I gather’
\]

- By hypothesis: Pre-Greek *_{HC} → *[h₂geri-ɔ̄]

<table>
<thead>
<tr>
<th>/h₂ger, jô/</th>
<th>*_{HC}</th>
<th>MAX-IO</th>
<th>DEP-IO</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. h₂gerjô &gt; *gërɔ̄</td>
<td>*</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>b. gerjô &gt; *gërɔ̄</td>
<td>*</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>c. h₃erjô &gt; *ërɔ̄</td>
<td>*</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>d. h₂gerjô &gt; agërɔ̄</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

18 Cf. Mayrhofer 1986:138. See Byrd 2010, 2011 for recent accounts that make use of this view of laryngeal vocalization in an OT framework. The quality of the epenthetic vowel varies depending on which laryngeal it is adjacent to: adjacent to *h₁ it is [e], adjacent to *h₂ it is [a], and adjacent to *h₃ it is [ɔ].
The underlying \(*h_2 + g\) sequence, if it were to surface faithfully, would violate the markedness constraint against laryngeal + consonant sequences at the beginning of a syllable. Thus \(\sigma [HC]\) rules out candidate (a). The viable repairs for this problem are essentially deletion or epenthesis. Since MAX is ranked above DEP, epenthesis is preferable to deletion. This ranking will therefore choose candidate (d) over (b) and (c). Candidate (d) straightforwardly derives into Greek as άγερεω [agēr5], the attested form. This confirms the ranking in figure 2, which will come into play again in generating the AR pre-form in §4.

There is an additional candidate that has not yet been considered here: [əh2.gerjō], with initial rather than medial epenthesis. The current ranking cannot differentiate between this candidate and the winning candidate [h2.gerjō]. However, we already have a constraint in our grammar that can select the medial-epenthesis candidate over the initial-epenthesis candidate, namely ONSET. This will disfavor [əh2.gerjō] because it has created a new onsetless syllable. This does not yet give us any evidence for new critical rankings, but it will be consistent with the total ranking developed in the following section.

4. Analysis of Attic Reduplication

The roots for which the AR derivation will be most straightforward are the \(*HCeC\) roots. The exemplar \(*HCeC\) root will be ἀγὲρ ‘gather together’ < *h2ger, which, as we have already seen, has a perfect ἄγερεμαι [a.γε.γε.μαι]. Ultimately, our Pre-Greek grammar will produce is [h2.γε-h2.ger.-mai] as its optimal output. This form copies both members of the root-initial cluster, with an epenthetic vowel between the copied segments in the reduplicant, and heterosyllabifies the root-initial cluster. This emerges as a repair for two markedness constraints (*\(\sigma [HC]\) and OCP-SYLLABLE, which will be introduced below) constrained by the existing rankings for the basic reduplication pattern and for vowel prothesis.

4.1. The state of affairs in PIE and early Pre-Greek

In the grammar of Proto-Indo-European and early Pre-Greek, there was nothing to differentiate the treatment of laryngeal-initial roots from all other consonant-initial roots in reduplication. That is to say, laryngeal-initial roots would have had a CV reduplicant (i.e., \(HV\)), as reflected in, for example, Vedic [ānāśa] (RV

19 There will be a trade-off between ONSET and a different constraint (CONTIGUITY-IO) that disfavors the medial epenthesis candidate.
6.16.26c) $< \*_{h_2 e-h_1 n o k-e}$. Applying this pattern to our example root $\sqrt{\*h_2 g e}$, these grammars select a candidate $[h_2 e.h_2 g e.mai]$, which copies just $C_1$. Such a form would have developed into Attic-Ionic as $**\bar{e}g e m a i$, which is clearly not the AR pattern.

4.2. Markedness forces a repair!

At some point in time, the grammar begins to display the effects of the dispreference for laryngeal $+$ consonant complex onsets, as represented by the high-ranking $\*\sigma[HC]$. It is at this point that the “prothetic vowel” develops. High-ranking $\*\sigma[HC]$ creates a problem for laryngeal-initial roots in reduplication. The output which conforms to the default pattern, $[h_2 e.h_2 g e.mai]$—which was the optimal form in the earlier grammars—now fatally violates this constraint. This forces a repair.

What we might expect to be the simplest repair for a $\*\sigma[HC]$ violation is just to syllabify the laryngeal as a coda. This candidate would be $[h_2 e.h_2 g e.mai]$. This is not the form we get, but there are currently no constraints in our rankings that will penalize this candidate. I propose that there is a constraint that targets exactly these sorts of sequences:

$$\text{(15) OCP-syllable (OCP-\(\sigma\))}$$

Assign one violation mark $*$ for every syllable that contains two identical segments.20

This constraint will eliminate the candidate $[h_2 e.h_2 g e.mai]$, because it has two $h_2$’s in the reduplicating syllable. Thus, due to the application of $\*\sigma[HC]$ and OCP-$\sigma$ in Pre-Greek, the default Ce-reduplication process is blocked for $\*H C e C$ roots. This is demonstrated in the following tableau:

$$\text{(16) Ruling out a Ce-reduplicant with $\*\sigma[HC]$ and OCP-$\sigma$:}$$

<table>
<thead>
<tr>
<th>/RED_e, h_2 g e, mai/</th>
<th>$*\sigma[HC]$</th>
<th>OCP-$\sigma$</th>
<th>DEP-IO</th>
<th>ALIGN-ROOT-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. $h_2 e.-h_2 g e.-m a i$</td>
<td>$&gt; *g e m a i$</td>
<td>*!</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>b. $h_2 e.-h_2 g e.-m a i$</td>
<td>$&gt; *g e m a i$</td>
<td>*!</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>c. $\sqrt{*h_2 g e}-h_2 g e.-m a i$</td>
<td>$&gt; a g \bar{e}g e m a i$</td>
<td></td>
<td>*</td>
<td>****</td>
</tr>
<tr>
<td>d. $\sqrt{*h_2 g e}-h_2 g e.-m a i$</td>
<td>$&gt; a g \bar{e}g e m a i$</td>
<td>*!</td>
<td></td>
<td>****</td>
</tr>
</tbody>
</table>

20 Further motivation for this constraint will be provided in §6.
With the normal Ce-reduplicant candidates blocked, an alternative copying pattern must take over. The characteristics of this alternative pattern will be determined by the relative ranking of the remaining constraints.

4.3. The alternative pattern

It has now been shown that the default reduplication pattern could not surface for laryngeal-initial roots. However, there are still a number of reasonable ways in which the *σ[HC] and OCP-σ problems might be avoided. These possibilities largely coincide with those repairs modulated by the constraints introduced independently in §2 and §3 in order to account for the basic reduplication pattern and for vowel prothesis, respectively. The most reasonable candidates are listed in (17):

(17) Potential repairs and their associated constraints:

- Epenthesis: (a) [h2.ə-gē-h2.ger.-mai]21 DEP-IO
- Unfilled onset: (b) [e-h2.ger.-mai] ONSET
- Improper anchoring: (c) [gē-h2.ger.-mai] ANCHOR-L-BR
- Deletion of a root consonant: (d) [gē.-ger.-mai] MAX-IO
  (e) [h2e.-h2er.-mai]

As alluded to previously, the hypothesized repair is epenthesis (candidate (a) [h2.ə-gē-h2.ger.-mai]). This candidate will be selected if the “don’t epenthesize” constraint DEP-IO (and also ALIGN-ROOT-L) is crucially dominated by the three constraints militating against the other repairs; see (18) on the facing page.

It appears that this ranking may, in a certain sense, follow from the critical rankings developed in §2 and §3, which are repeated on the next page in figure 3. In the evaluation in the tableau in (18), the only constraints which receive less than maximal satisfaction in the optimal form are DEP-IO and ALIGN-ROOT-L. These are exactly the two constraints which are crucially dominated—and thus can be violated—in the two processes described by the grammar in figure 3, namely vowel prothesis and default reduplication. Therefore, by merging the two ranking fragments given in figure 3—and adding OCP-σ to the resulting top stratum of the rankings—we have a grammar that generates exactly the attested repair for laryngeal-initial roots in figure 4 on the following page.

21 This candidate displays reduplicant-internal epenthesis. This will be contrasted with root-internal epenthesis below.
On the Origins of Attic Reduplication

(18) The alternative repair: low-ranking DEP-IO and ALIGN-ROOT-L:

\[
\begin{array}{|c|c|c|c|c|}
\hline
\text{/RED}\text{e, } & \text{h}_2\text{ger, mai/} & \text{MAX-IO} & \text{ANCHOR-L-BR} & \text{ONSET} & \text{DEP-IO} & \text{ALIGN-ROOT-L} \\
\hline
\text{a. } s\Rightarrow \text{h}_2\text{.ge-h}_2\text{.ger.-mai} & > \text{ag}\text{êgermai} & & & & * & **** \\
\hline
\text{b. } e\Rightarrow \text{h}_2\text{.ger.-mai} & > \text{e}g\text{êgermai} & & & *! & * & \\
\hline
\text{c. } \text{ge-h}_2\text{.ger.-mai} & > \text{g}e\text{germai} & & & *! & * & \\
\hline
\text{d. } \text{ge-ger.-mai} & > \text{e}germai & & & *! & * & \\
\hline
\text{e. } \text{h}_2\text{.e-h}_2\text{.ger.-mai} & > \text{eg}ermai & & & *! & * & \\
\hline
\end{array}
\]

Fig. 3. Critical rankings for vowel prothesis and default reduplication (cf. figures 1–2).

4.4. Epenthesis site in the optimal alternative reduplication strategy

Our independently established constraint ranking selects epenthesis as the optimal alternative reduplication strategy to avoid *\text{d}HC and OCP-\text{d} violations. However, there is an additional epenthesis option that has not yet been considered, namely root-internal epenthesis:

(19) Epenthesis candidates:
- Reduplicant-internal: \text{[h}_2\text{.ge-h}_2\text{.ger.-mai]} > Attic-Ionic \text{ag}\text{êgermai} ✓
- Root-internal: \text{[h}_2\text{.e.h}_2\text{.ger.-mai]} > Attic-Ionic **\text{e}germai ×

Fig. 4. Total ranking for AR grammar.
Root-internal epenthesis would actually allow for retention of a normal *Ce- reduplicant, but this is clearly not the attested outcome. The choice of reduplicant-internal epenthesis over root-internal epenthesis can be modeled using CONTIGUITY constraints.

CONTIGUITY constraints demand that adjacency relationships are maintained across correspondence dimensions (McCarthy and Prince 1995:123). Since we are dealing with two correspondence dimensions, we can invoke two separate constraints:

\[(20)\] \text{CONTIGUITY-IO} \\
Segments which are adjacent in the input must be adjacent in the output.

\[(21)\] \text{CONTIGUITY-BR} \\
Segments which are adjacent in the base must be adjacent in the reduplicant.

Since the reduplicant is not directly subject to Input-Output faithfulness (McCarthy and Prince 1995:4),\(^{22}\) it will be exempt from CONTIG-IO violations. Therefore, if we rank CONTIG-IO over CONTIG-BR, our grammar will prefer reduplicant-internal epenthesis to root-internal epenthesis:

\[(22)\] The epenthesis candidates:

<table>
<thead>
<tr>
<th>/RED(e), h(2)ger, mai/</th>
<th>CONTIG-IO</th>
<th>CONTIG-BR</th>
<th>ALIGN-ROOT-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. (\Rightarrow) h(2)-ger-h(2)-ger.-mai</td>
<td>(\Rightarrow) ag(\ddot{e})germai</td>
<td>*</td>
<td>****</td>
</tr>
<tr>
<td>b. h(2)-e.-h(2)-ger.-mai</td>
<td>(\Rightarrow) *germai</td>
<td>*!</td>
<td>**</td>
</tr>
<tr>
<td>c. h(2)-ger.-h(2)-ger.-mai</td>
<td>(\Rightarrow) ag(\ddot{e})germai</td>
<td>*!</td>
<td>****</td>
</tr>
</tbody>
</table>

CONTIG-IO must crucially dominate both CONTIG-BR and ALIGN-ROOT-L, as the winning candidate (a) does worse on both of these constraints in order to satisfy CONTIG-IO:

\[\text{Critical Ranking: CONTIG-IO} \gg \text{CONTIGUITY-BR, ALIGN-ROOT-L.}\]

---

\(^{22}\) If we are operating in a framework where we believe that reduplicant segments are indeed subject to IO-faithfulness, we can replace the IO constraint with a root-specific constraint, and the BR constraint with the general IO constraint.
4.5. **Interim conclusions**

In this section, we have seen that the high ranking of the constraints \( *_{\sigma}[HC] \) and OCP-\( \sigma \) in Pre-Greek made it impossible for laryngeal-initial roots to reduplicate according to the default reduplication pattern of the language. The constraint ranking, which is in large part independently necessary for the basic reduplication pattern and vowel prothesis, ultimately selects cluster copying and reduplicant-internal epenthesis as the optimal alternative reduplication pattern.

5. **The complication for \(^*\text{HeC}\) roots**

While the solution proposed above derives the Attic Reduplication pattern for \(^*\text{HCEC}\) roots without problem, there is a complication that arises for \(^*\text{HeC}\) roots. The expected ablaut grade for the perfect active singular is the o-grade. Therefore, for a \(^*\text{HeC}\) root like \(^*\sqrt{h1ed}`eat`, the root allomorph which should be entered into the derivation (for the perfect active singular) is /h1od/. Since the normal pattern for reduplication is \(C_1\) copying, the default candidate for this allomorph would be [h1e.-h1od-]. In this output, the laryngeal is intervocalic, and thus not in violation of \( *_{\sigma}[HC] \). Therefore, there would be nothing to rule out this candidate, and it would be chosen as the winner. It would become **ɔ̄d-**, which is not an attested outcome for this particular root. Instead, we do want an AR form: edēd-.

For this root, the best/oldest attested perfect form is the participle ἐδηδῶς [edēd-5s]. Since the participle is a proper zero-grade formation, the input would be /RED,e, h1d, yōs/. Plugging in the default candidate, we encounter our \( *_{\sigma}[HC] \) violation: [h1e.-h1d-yōs]. If we try to repair it by re-syllabification, we get our OCP-\( \sigma \) violation: [h1e-h1d-yōs]. This leads us down the same road as with the \(^*\text{HCEC}\) roots, ultimately choosing a candidate [h2o.de-h1.d-γōs], which directly yields the attested AR form ἐδηδῶς [edēd-5s]. Therefore, while AR should not authentically arise on e-grade or o-grade formations for \(^*\text{HeC}\) 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, \(^*\text{HeC}\) roots would have had normal reduplication in e/o-grade categories but AR-type reduplication in zero-grade categories. As ablaut distinctions collapsed, and as the transparency of the relationship between the two reduplicative allomorphs was eroded by the loss of the laryngeals,
6. The Obligatory Contour Principle and OCP-Syllable

In §4, I introduced the constraint OCP-σ, repeated below, in order to rule out candidates like \[\text{hzeh}_2\text{-ger.mai}\], schematically \(HV-H.CVC\):

\[
(23) \text{OCP-Syllable (OCP-σ)} = (15)
\]

Assign one violation mark * for every syllable that contains identical segments.

This is a (context-sensitive) version of the Obligatory Contour Principle (OCP; Goldsmith 1976:36, 130–7, 160–5; McCarthy 1986). The OCP dictates that elements within a given domain be different, and is typically used to ban identical adjacent segments. Byrd 2010:15–23 shows conclusively that this standard version of the OCP is at work in PIE in banning hetero-morphemic geminates, most notably in the “Double Dental Law” and the “metron rule.” OCP-σ would be a more specific version of this constraint whose domain of application is within the syllable. Similar constraints date back at least to Vennemann’s (1988:11) “Shell Law.”

6.1. OCP-Syllable and non-copying perfects in Ancient Greek

The effects of OCP-σ may not have been limited to the period of Greek that produced Attic Reduplication. As we have seen, the basic reduplication pattern for consonant-initial roots in Ancient Greek is to have a \([Ce-]\) reduplicant. But for

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23 Brent Vine has pointed out to me that these forms quite strikingly resemble a set of apparently reduplicated nouns built to *HeC roots—in fact, many of the same roots which display Attic Reduplication in the perfect: e.g., \(\alpha\gamma\omega\gamma\alpha\) [\(\alpha\gamma\sigma\gamma\alpha\)] ‘leading’, \(\varepsilon\delta\omega\delta\alpha\) [\(\varepsilon\\delta\delta\alpha\)] ‘food’. These forms could be accommodated within the Pre-Greek reduplicative system developed here if we were to posit a reduplicative morpheme /REDo/ employed in nominal derivation. Just as in the perfect, the application of this morpheme to a zero-grade form would result in *HaCo-HC- forms.

However, this would not be consistent with the proposal in Vine 1998:695–9, whereby the reduplication in these forms is a post-Mycenaean (and thus post-laryngeal loss) development. If that chronology is to be maintained, this reduplicative system would have nothing to say about the origin of these forms, as it crucially relies on the presence of laryngeals. Nonetheless, given that there must be some mechanism for the retention of the Attic Reduplicated verbal forms post-laryngeal loss, it seems quite likely that such a mechanism could be responsible, at least in part, for generating this nominal formation as well, particularly in light of the significant overlap in the set of roots to which these two processes apply.
roots with initial clusters which do not have rising sonority, the perfect displays a reduplicant in [e-]:

(24) Non-copying consonant-initial perfects in Ancient Greek:24

- \(\sqrt{kten}\)–‘kill’
  - perfect \(\epsilon\kappa\tau\omicron\alpha\) [e-kton-a] not **[ke-kton-a]
- \(\sqrt{\text{re(w)}}\)–‘flow’
  - perfect \(\epsilon\rho\rho\omicron\omega\kappa\alpha\) [e-rru-\(\epsilon\kappa\)] not **[re-rru-\(\epsilon\kappa\)]

If we assume that non-rising-sonority clusters had to be hetero-syllabified (due to high-ranking SONORITY SEQUENCE), but rising-sonority clusters could form themselves as complex onsets, then OCP-\(\sigma\) would cause differential treatment of the two cluster types: 25

(25) Syllabification-sensitive copying due to OCP-\(\sigma\):

- \([\text{ke.kri.mai}]\) ✓
- \([\text{kek.to.na}]\) ✗ → \([\text{ek.to.na}]\) ✓
- \([\text{rer.ru.}\(\epsilon\\kappa)\]) ✗ → \([\text{er.ru.}\(\epsilon\\kappa)\]) ✓

By not copying the root-initial consonant, they escape the OCP-\(\sigma\) violation. Thus, despite very different outcomes, OCP-\(\sigma\) can connect an exceptional reduplication pattern of Pre-Greek (Attic Reduplication) with an exceptional reduplication pattern of Ancient Greek (non-copying perfects).

6.2. OCP-SYLLABLE and the Indo-European long-vowel preterites and perfects

If we expand the scope of our inquiry beyond Greek, we may also be able to see the effects of OCP-\(\sigma\) on reduplicated formations in other ancient Indo-European languages. The origin and nature of the so-called “long-vowel preterites” has long been a matter of debate. As summarized in Jasanoff 2012:128–9, opinions on the subject generally fall into either the “Narten Theory” or the “Reduplication Theory.” The Narten Theory, argued for in Jasanoff 2012, holds that these forms

\[\text{See Steriade 1982:195–208, 304–12, Zukoff 2012:40–104 for more extensive examination of these patterns.}\]

\[\text{An OCP-\(\sigma\)-based account of the phenomena discussed in §6.1 and §6.2 presupposes this difference in syllabification: rising sonority clusters were tauto-syllabic (forming a complex onset), whereas non-rising sonority clusters were hetero-syllabic (forming a coda + simplex onset). If all clusters were hetero-syllabified, OCP-\(\sigma\) would be violated in the reduplicated forms of all cluster-initial roots, thus requiring repair in all circumstances, not just those described here. Cooper 2012, following Hermann 1923, argues in favor of across-the-board hetero-syllabification in PIE, Greek, and Vedic, largely on the basis of metrical evidence. If this view were to be followed, we would need to find an alternative property, one which largely but not perfectly mirrors syllabification, over which we could define the OCP constraint.}\]
derive from one or more morphological categories in Proto-Indo-European characterized by lengthened-grade ablaut. The Reduplication Theory, on the other hand, recently advocated by Schumacher 2005, takes the long vowel of such forms to be the result of compensatory lengthening after consonant deletion in an originally reduplicated formation.

While the matter is far from settled, the introduction of a constraint like OCP-σ immediately brings to bear a motivation for deletion + compensatory lengthening in the Reduplication Theory. The forms under discussion are virtually all built to roots of the shape CVC, in categories which have zero-grade ablaut (i.e., a root allomorph in -CC-). In these cases, if reduplication were to be carried out in the otherwise expected manner (i.e., C₁ copying), there would be identical consonants within the reduplicating syllable: [C₁V-C₁C₂]. If OCP-σ were present in this grammar, and highly-ranked enough to induce repair, such a sequence would not be allowed to surface. This repair can be illustrated, for example, by the data from the Gothic Class IV and V strong preterites and the Sanskrit CeC-perfects.26

(26) Gothic Class IV and V preterite plurals (forms from Lambdin 2006:51):
- √gib ‘give’ : preterite plural gebum [gēβ-] (< *ge-g.b-um)
- √qilp ‘say’ : preterite plural qelum [kʷēθ-] (< *qe-q.p-um)
- √bair ‘bear’ : preterite plural berum [bēr-] (< *be-b.r-um)

(27) Sanskrit perfect weak stems in [C₁C₂] (forms from Sandell 2013):
- √tap ‘be warm’: perfect weak stem tep- (< *ta-t.p-)
- √nam ‘bow’: perfect weak stem nem- (< *na-n.m-)
- √dabh ‘deceive’: perfect weak stem debh- (< *da-d.bh-)
- √pac ‘cook’: perfect weak stem pec- (< *pa-p.c-)
- √bhaj ‘divide’: perfect weak stem bhej- (< *ba-bh.j-)

I leave as a question for further research whether or not this grammar can be ascribed to PIE, or just to (some stage of) the individual daughter languages. The details of the repair in the various languages might shed some light on the issue. The compensatory lengthening that yields Gothic e (< PGMc *ǣ) matches the outcome in, e.g., Old Irish: √gan ‘be born’ → pret-erite gēnair [gēn-]. Sanskrit e [ē] most often arises from contraction of /-aj/-1/ Therefore, alternately, it is possible that the e vowel could be due to lenition of C₁ of the root to i with subsequent contraction, rather than deletion of C₁ of the root with subsequent compensatory lengthening. This question is not directly relevant to the argument for the existence of OCP-σ, since, under either scenario, a repair is being enacted in service of OCP-σ. It is, though, relevant for the chronology, as a different repair might more directly indicate that we are dealing with a post-PIE development.

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26
6.3. OCP(-SYLLABLE?) in the lexicon

Lastly, we can notice that very few if any roots in the PIE lexicon have two identical segments. Cooper (2009) identifies only four, the status of each of which is in some way questionable:

*ses- is said to be onomatopoetic, and *telēk- and *h₁reh₁s- are likely products of reduplication; as for *skek-, its contiguous distribution only in Germanic, Slavic and Celtic may make its PIE status questionable. (p.58 n.14)

There is, though, √h₁reh₁ ‘ask’ and √h₁reh₁ ‘row’ (LIV 2:251–2), both with unquestioned attestation. Whether or not these exceptions are to be included as bona fide PIE roots, such a root type would be very significantly underrepresented in the lexicon. While the domain for this effect need not be identified as the syllable, it definitely points to some version of the OCP being active at the lexical level.28

7. Conclusions

This paper has shown that the pattern of Attic Reduplication can be viewed as the outcome of the regular phonology of a Pre-Greek system that still contained laryngeals (as opposed to being the result of analogy). This pattern is induced by a new dispreference for laryngeal-initial complex onsets (as instantiated by the *σ[HC] constraint), which can be seen independently in the process of “vowel prothesis.” The interaction of this constraint with another markedness constraint —OCP-σ, for which there appears to be external evidence in the reduplicative formations of other ancient Indo-European languages—makes it impossible for laryngeal-initial roots to reduplicate according to the basic reduplication pattern of the language. Attic Reduplication thus comes about as an avoidance strategy so that reduplication can occur without violation of the *σ[HC] and OCP-σ constraints. This creates a unique *HVCV reduplicant for laryngeal-initial roots, distinct from the normal CV reduplicant of other consonant-initial roots.

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27 It may be worth noting, however, that *h₁reh₁ has a distinct consonant intervening between the identical ones. If the OCP effect is mitigated by intervening consonants, then this root does not serve as a relevant counterexample.

28 Lexical OCP effects are extremely common cross-linguistically, if not universal (cf. Pozdniakov and Segerer 2007). However, this case seems unusual in that it refers specifically to complete identity rather than general similarity (usually related to place of articulation). See Cooper 2009 for further discussion of these effects in PIE.


