Metathesis with /r/ in Classical Armenian: an Optimality Theory Approach

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One of the numerous phonological features that sets Classical Armenian apart from its Indo-European sister languages is the numerous instances of metathesis. Many of these instances center around the presence of the Proto-Indo-European segment /*r/. Thus, the key may well lie in the phonetic nature of the sound itself. The two most likely phonetic values of this segment are the dental/alveolar flap [ɾ] or trill [r]. Articulatorily speaking, these sounds, particularly [ɾ], seem poorly suited for onset position, and, more specifically, non-post-vocalic position. With this in mind, the process of metathesis in Classical Armenian involving /*r/ can be viewed as a development by which /*r/ has moved from non-post-vocalic position to post-vocalic position. Previous attempts to codify this circumstance have relied on rule-based frameworks. However, the conceptual simplicity of the problem coupled with its phonetic grounding lends itself to being analyzed through Optimality Theory (OT; Prince & Smolensky, 1993). When this positional restriction is cast as a context-sensitive markedness constraint, metathesis becomes an easily-obtained, logical output of a singular and unified process.

The process of metathesis with /*r/ in Classical Armenian has often been connected with a similarly prominent process of prothesis, both seemingly driven by the segment /*r/. Many traditional grammars, such as Meillet (1936: 46-7) and Godel (1975), address the problem of the wide ranging reflexes of sequences with Proto-Indo-European /*r/ in Classical Armenian, but do not attempt to provide a comprehensive account of the problems, either historically or synchronically. Ravnæs (1991) discusses both metathesis and prothesis in great detail, but does not thoroughly attempt to connect the two processes or place them within a larger theoretical framework. Winter (1962) gives the most concise and organized account of these changes. He

places the metathesis and prothesis involving /*r/ within a larger context of sonority-driven changes.

Vennemann (1986) is the first to examine these processes in a modern theoretical framework. His approach is one of Syllable Preference Laws, which is in some ways a precursor to OT, particularly in its use of syllable well-formedness constraints. Picard (1989) is a direct response to Vennemann. Picard comes to only slightly different conclusions, but lays out a much more systematic progression in his argumentation. This paper will take Picard's argumentation as its starting point, although largely arguing against it. His examples will be sufficient to begin elucidating the problems at hand,[1] so they will be used throughout the paper and reproduced below.

Picard identifies four specific environments where metathesis and/or prothesis involving the segment /*r/ has occurred. The first three types all involve "the emergence of a prothetic vowel, usually *e* but sometimes *a* or *o*" (Picard 1989: 61). The first type he puts forward, Type I, is comprised of forms which he reconstructs as having an initial /r/, either inherited directly as such from Proto-Indo-European or from a loss of an initial consonant within the prehistory of Armenian. Type II are the avatars of the PIE **dw*- roots, the classic *erku* question. Picard's analysis takes these roots through an intermediate form in Pre-Armenian with the initial sequence **#rC*, from which point they are then subject to prothesis. Picard's Type III contains those roots which in PIE had an initial **#Cr* cluster, and are resolved by metathesis of the cluster and the epenthesis of a prothetic vowel. Type IV are those instances which display non-initial (i.e. medial/final) metathesis. Picard's examples are as follows:

[1] Although several of his derivations, particularly in Type I, will need revision.

(1) Examples from Picard (1989)[2]

Type I – prothesis to pre-vocalic initial-*r*

a) ***er****ek* ‘evening’ < ****reg*^{w}*os*

b) ***ar****ew* ‘sun’ < ****r****ewis*

c) ***or****cam*[3] ‘I vomit’ < ****r****ug-*

d) ***er****ek*^{h} ‘three’ < ****tr****eyes*

Type II – prothesis to initial **rC* sequences[4]

e) ***er****ku* ‘two’ < ****d****wō*

f) ***er****kiwł* ‘fear’ < ****d****wi-*

g) ***er****kar* ‘long’ < ****d****wāros*

Type III – prothesis and metathesis of *#*Cr*

h) *arˆu* (< ****ars****uy*) ‘canal’ < ****sr****utis*

i) ***art****awsr*[5] ‘tear’ < ****dr****aḱu*[6]

j) ***erk****an* ‘millstone’ < ****g***^{w}***r****āwon*

k) ***ałb****ewr*[7] ‘spring-well’ < ****b***^{h}***r****ēwr̥*

l) ***ełb****ayr* ‘brother’ < ****b***^{h}***r****āter*

Type IV – non-initial metathesis

m) *su****rb*** ‘holy’ < **ḱub*^{h}***r****os*

n) *k*^{h}*i****rt****n* ‘sweat’ < **swi****dr****o-*

o) *me****rj*** [8] ‘near, at’ < ****meg***^{h}***r****i*

Picard first treats Types I-III. His starting point is the “standard account” of vowel prothesis:

Ø → e / #_r.

He feels that this concept should be extended to Types II & III as well. In Type II, he posits via regular sound laws a change of the PIE sequence *#*dwV* to (Pre-)Armenian *#*rkV*, where it would be naturally subject to the prothesis rule.[9]

His major departure from the standard account is in extending this rule to Type III. While he acknowledges that it is a common process cross-linguistically for initial *s + obstruent* clusters to acquire a prothetic vowel (Picard: 63-4) – as in Spanish (e.g. Latin *stare* > Spanish *estar* ‘to be’), and in fact in Classical Armenian itself (although often unwritten) – he rightly

[2] The order of examples is maintained, but the numbering is not.
[3] < c > = IPA [ts]
[4] These examples are all derived from PIE **dw*- roots.
[5] The final [r] in this form is a case ending, and the sequence <sr#> in this instance would have been pronounced [sər]. This can easily be explained by appealing to a high ranking ALIGNMENT constraint that dictates inflectional ending must align to the right edge of the word.
[6] This appears to be a by-form of **daḱru*, which is shown in Greek δακρύ.
[7] [ł] is a (conditioned?) reflex of /r/, generally thought to arise from dissimilation. The details of this are not relevant to this discussion.
[8] < j > = IPA [dz]
[9] This paper will make no claims about the precise historical developments that seem to take PIE *#*dw*- to Armenian #*erk*-; but rather only take the position that this cluster’s eventual outcome is consistent with the other data involving /r/, and therefore, at whatever point the cluster comes to be analyzed as having /r/, it becomes subject to the constraints to be proposed in this paper.

claims that the more common repair strategy for illicit consonant clusters, in all positions, is the epenthesis of a vowel between the consonants. Taking this as his guiding principle, he posits an intermediate (pre-metathesis) development for Type III of **CrV* → **CerV*. He has extended the prothesis rule to be a more wide-spread epenthesis rule, in which an [e] is pre-posed to any /r/ which does not follow a vowel:

Ø → e / {#,C}_r

He thus claims that the initial-position metathesis data is explained as a fronting of the entire [*er] sequence.

While this solution can explain Types I-III, Picard states that it does not have any relationship with Type IV, which thus requires a separate analysis. His analysis of Type IV is a straightforward metathesis of a final *Cr#* cluster brought about by the ubiquitous loss of final syllables in Armenian, and, more specifically and more crucially, the loss of the vowel that originally followed the /r/. This metathesis is thus then well-motivated by the standard sonority requirements of the syllable.[10]

He admits the possibility that the metathesis occurred before the loss of final syllables, in which case the cluster would have been intervocalic. If this is the case, then his analysis is significantly less well-motived. His response to this alternative is to extend the vowel insertion rule to this environment as well, which requires again a metathesis of the [*er] sequence and then subsequent absorption of the epenthetic vowel by the etymological root vowel. This seems an unattractive complication, but unavoidable in such an account.

Assuming his preference that the metathesis in Type IV postdated the loss of final syllables, Picard's analysis thus postulates that Armenian has undergone two wholly separate metatheses which must be represented differently in his rule-based formalism. Considering the

[10] In Optimality Theory terms, this is the constraint SONORITY SEQUENCE.

fact that these two regular processes center around the properties of a single segment /*r/, it would be desirable to join them under a unitary solution.[11] It would be even more desirable to account for these metatheses and the apparent "prothetic vowel" in a single step, rather than treating them as unconnected developments in separate diachronic layers. Writing as he did in 1989, Picard had recourse only to a strict rule-based framework.

In critiquing Vennemann's prothesis rule (Ø → e / #_ {r, Cr, tk[12]} V), Picard states, "Given the well-known propensity for both the focus and determinant of regular sound changes to involve only natural classes of segments, this must be viewed as a most improbable scenario" (1989: 63). In a framework where the conditioning environment must be stated in positive terms, i.e. what it *is*, the disparate nature of the three environments cannot be collapsed into a reasonable rule. However, if the environment can be defined negatively, i.e. what it *is not*, then a singular answer presents itself. This is the power that Optimality Theory can provide.

Consider the conditioning environments stated for the four Types in standard rule-based structure (at the point in the derivation where the *r* becomes relevant):

Type I: **#r-* Type II: **#rk-* Type III: **#Cr-* Type IV: **-Cr(-/#)*

Having abstracted away to this point, we can make the observation that these four types of environments can be categorized as positions where the underlying /*r/ follows a word boundary (#) or a consonant (C). It would be ideal to push this one step further to state the generalization that /r/ must follow a vowel. However, this is a positive statement, which has no place in OT. One could attempt to reframe this in a negative light by saying that /r/ cannot follow anything

[11] The SONORITY SEQUENCE account is probably necessary, as the same loss of final syllables induces metathesis of other would-be final resonants; e.g. PIE **alyos* 'other' > Pre-Armenian **aly* > Classical Armenian *ayl*. However, what this seems to represent is a conspiracy, rather than an undermining of the notion that the phonetics of /r/ are exceptional. A more complete account of metatheses involving the other segments would be needed before this statement can be properly evaluated.

[12] Picard would have *rk* in place of *tk*, which would to some extent better unify the environments, although not enough to motivate such a rule in such a framework.

other than a vocalic segment. This would lead us to a constraint something like the following: ***[-vocalic]r**. This is very attractive, but has a very significant flaw. In order for such a constraint to be valid, it requires the word boundary (#) to be treated as a segment. In a standard rule-based formalism, this would be somewhat less problematic, as it is not atypical to have conditioning environments for a single rule defined as *either* some segmental sequence *or* word-boundary. However, it is a rather difficult conceptual leap within the terms of OT to consider a word boundary to be an entity in and of itself. Therefore, if we are not to allow word boundary to be a segment, we cannot advance upon the extended generalization of "/r/ must follow a vowel."

With this being something of a strike against an OT analysis, we must stop to consider whether a rule-based framework can take better advantage of this generalization. The answer, happily, is no. If we were to try to directly transfer this generalization into the form of a rule, it might look like the following:

/r/ → [Vr] / {#,C}_ or Ø → [V] / {#,C}_r

Notice that this exactly recapitulates Picard's analysis which requires an intermediate step of epenthesis before metathesis. It cannot directly take us from the generalization to the final outcome. Therefore, while the OT analysis cannot be perfectly unified, neither can the rule-based framework.

The place where OT shows itself to be superior in this instance is in how it deals with the original generalization that the metathetic and prothetic environments are those where /*r/ follows a word boundary (#) or a consonant (C). While we cannot create a single constraint that captures both environments, we can propose related constraints to account for them separately:

***#r** [r] cannot appear word-initially	***Cr** [r] cannot appear after a [+consonantal] segment

Together, these constraints properly capture our generalization.[13]

The ***#r** constraint must have been highly ranked (and likely undominated) in Proto-Indo-European, just as in Classical Armenian. According to Lehmann (1951: 17), "PIE must be reconstructed without initial /r/." With the integration of the laryngeals into Indo-European phonology, it has become apparent that many if not all of those roots which had previously been reconstructed with an initial /*r/, such as those presented by Picard in examples (1a)-(1c), should instead be reconstructed with an initial laryngeal. The standard analysis prior to the advent of laryngeal theory was that Greek and Armenian had developed a "prothetic vowel," and that all other Indo-European daughter languages preserved the conditions of PIE. But it has since become widely accepted that the reverse is true. Greek and Armenian (and Anatolian) are the only languages that retain evidence of the initial laryngeal,[14] which surfaces as an initial vowel (i.e. the reflex of a vocalized laryngeal). Therefore, "this feature of distribution [i.e. prohibition on initial /r/] was preserved in Greek, Armenian, and the Anatolian languages. Presumably, in roots with an original initial laryngeal, the laryngeal influenced the prothetic vowel" (Lehmann 1951: 17).

The other markedness constraint on [r], ***Cr**, however, could not have been highly ranked in PIE. We need only look at the PIE reconstructions already presented to see that this is the case. Consider Picard's first example, (1a) ClArm *erek* 'evening.' His derivation is from PIE **reg^{w}os*. But knowing now that that this cannot be, we can (uncontroversially) reconstruct this word as PIE **H_1reg^{w}os*, as is clearly seen from its outcome in Greek, ἔρεβος 'darkness; underworld'. **H_1* is here consonantal, giving the sequence *Cr*, which would incur violation of ***Cr**. Likewise, (1k) ClArm *aṙbewr* < PIE ****b^{h}rēw̥r*** 'spring-well', (1n) ClArm *k^{h}irtn* < PIE

[13] These constraints almost certainly needs to be refined to refer to a more specific phonetic instantiation of /r/, matching whatever was the exact phonetic nature of the Armenian segment.
[14] Aside from simple vowel coloration.

*swi***dr***o-* 'sweat', and all other examples from Types I, III, and IV have *Cr* sequences. Considering that ***Cr** is so often violated, it must be very low ranked in Proto-Indo-European.

Looking at the evidence from PIE, it appears that we have in that language the ranking ***#r » *Cr, *Vr** (with ***Vr** representing a constraint against [-consonantal], i.e. [+vocalic], segments followed by [r].) This ranking can be determined from the fact that the latter two positions (post-consonantal and post-vocalic) are licit for [r] in PIE, whereas word-initial position is not. Following this into Classical Armenian, a different set of facts presents itself. As discussed earlier, Classical Armenian prohibits the word-initial and post-consonantal positions for [r], allowing only post-vocalic position.[15] This can directly lead us to the following ranking for Classical Armenian: ***#r, *Cr » *Vr**.

The patterning together of the ***#r** and ***Cr** constraints in Classical Armenian seems to have good phonetic motivation. Simply put, it is difficult to articulate most rhotic sounds starting from silence. The exact phonetic nature of the phoneme /*r/ is difficult to determine (just as with many, many phonemes in historical terms), both in PIE and in Classical Armenian. Ravnæs (1991: 88-90) suggests that the most likely candidates are a trilled [r] or a flap [ɾ]. If the sound is a trill, an airstream is needed to initiate the vibration of the tongue against the teeth or alveolar ridge. If it is a flap, there must be a very rapid movement of the tongue and an extremely short duration of constriction. It is a simple matter of physics that it takes more energy to move something that is at rest than something that is already in motion.[16] With the need for such precise, speedy articulation, this extra energy would be "costly", articulatorily speaking. By no means is it impossible to make these sounds from silence (as is seen from the numerous languages that do just that), but it is clear that it requires additional articulatory effort,

[15] This includes the position after a glide, since these segments are also [-consonantal].
[16] This can most assuredly be said of any type of sound. But one could well imagine that the specific articulatory requirements of many rhotic sounds would make this notion uniquely relevantly in this case.

which is the very definition of markedness. Furthermore, particularly in the case of [ɾ], if articulation were held for even the slightest amount of time too long, perceptual distinctiveness from a [d] would be almost non-existent; and this could well be the result of an attempted articulation from a difficult position, i.e. one with no airstream. Therefore, a prohibition against this segment in articulatorily poor positions could serve to prevent a partial merger.

Notationally, it may not be immediately apparent that there are any phonetic similarities that would crucially link word boundary (#) and consonant (C), the respective conditioning environments for the first two constraints in the hierarchy. But if we examine what those notational elements truly represent on the levels where the processes of natural language are operative, the puzzle comes together. As stated above, it is difficult to articulate an /r/ after silence. Obviously a word boundary is silence. But not so obviously, a stop closure is also silence. Silence might in fact be better conceptualized as a lack of airstream and a lack of articulatory movement. Therefore, by having recourse to the phonetic facts, rather than being held hostage by notational constraints, Optimality Theory can bridge the gap between linguistic realities and theoretical elegance.

The motivation for positing a markedness constraint surrounding the segment /*r/ is further supported by external evidence. Ravnæs suggests that "the repugnance to initial r- is probably due to substratum influence in Greek and Armenian…: r- is unknown in most languages in Asia Minor and neighboring areas" (1991:19). Conceiving of Armenian as a language highly affected by substratum influence might lend even more credence to the idea that these changes were brought about because of an inability to properly articulate the /r/.

A relevant question to ask here is whether or not the rankings of the contextual-markedness constraints on [r] from the two different language states can come together to shed

light on any bigger picture concerns. We can notice that, while there is no direct evidence from either period, a fully fixed ranking ***#r » *Cr » *Vr** can simultaneously account for both the PIE and the Classical Armenian facts.[17] If we allow for this fixed ranking, we can see the changes from PIE into Armenian as being due to the difference in the ranking of ***Cr** relative to other constraints, namely CORRESPONDENCE constraints. In Armenian, as will be demonstrated below, a specific ranking of the CORRESPONDENCE constraints beneath ***Cr** dictates various repair strategies to eliminate *Cr* sequences. However, in PIE, as evidenced by the fact that such a sequence was perfectly allowable, these CORRESPONDENCE constraints must have dominated ***Cr**; but the disallowance of initial /*r/ shows that ***#r** still dominated them, as it also does in Armenian. That is to say, in PIE, a change in the output would have been acceptable in order to prevent an initial [r], because violation of *#r would have been too costly; yet nothing would cause a change to prevent the sequence *C + r*, because this would incur a violation of one or more CORRESPONDENCE constraints, which would be more costly than a violation of *Cr. Therefore, the metathesis and prothesis which are displayed in Classical Armenian must be the result of a change in the relative rankings of the (relevant) CORRESPONDENCE constraints and the second element of the aforementioned constraint hierarchy, ***Cr**. We can indicate this schematically as follows:

PIE: ***#r** » (relevant) CORRESPONDENCE constraints » ***Cr** » ***Vr**

Classical Armenian: ***#r** » ***Cr** » (relevant) CORRESPONDENCE constraints » ***Vr**[18]

Having identified potential constraints that could be instigating the metathesis and prothesis in Classical Armenian, we must now find a ranking of these constraints that properly accounts for the data. Since we hypothesize that it is the individual constraints of the constraint

[17] One might wonder if this ranking is in any sense universal, whether for all rhotic sounds or just [ɾ]. This question will require a cross-linguistic examination that is beyond the scope of this paper.
[18] A language in which *Vr also dominates the CORRESPONDENCE constraints will be one that bans [r] altogether.

hierarchy on [r] that are motivating the change, we should start by assuming them to be undominated, i.e. extremely highly ranked in the grammar of the language at the time when they were active. But the high ranking of these constraints only implies that *some change* must occur in all of the four types of environments. However, there is nothing about them that inherently says the problem must be resolved through metathesis and/or prothesis. In other words, the use of these constraints does not in and of itself immediately rule out Picard's explanation or something of its ilk. The actual account of the data, and a rebuttal to previous explanations, is achieved through the proper application of CORRESPONDENCE constraints (Kager, 2007: 248-52). In their basic forms, these are:

> Maximality (**MAX-IO**) – "every element of S_1 has a correspondent in S_2." [19]
> Dependence (**DEP-IO**) – "every element in S_2 has a correspondent in S_1."
> Identity[F] (**IDENT-IO[F]**)[20] – "Correspondent segments have identical values for feature [F]."
> Contiguity (**CONTIG-IO**) – "The portion of S_1 standing in correspondence forms a contiguous string, as does the correspondent portion of S_2."
> Linearity (**LINEARITY-IO**) – "S_1 is consistent with the precedence structure of S_2, and vice versa."
> Anchoring (**ANCHOR-IO**) – "Any element at the designated periphery of S_1 has a correspondent at the designated periphery of S_2."

Whichever constraints are violated must necessarily be dominated by ***#r** and ***Cr**.[21] If this were not the case, no change would occur (because their violation would be less costly than a violation of the CORRESPONDENCE constraints). Certain elements of the ranking can, therefore, be immediately generated by seeing which constraints are violated in the attested Armenian forms.

[19] S_1 is defined as the input segment/string, S_2 is defined as the correspondent output segment/string. IO refers to the relationship between Input and Output.
[20] IDENTITY will not play a direct role in anything to be discussed here.
[21] From here on, *#r and *Cr will often be treated together as *{#,C}r, except in cases where it is informative to treat them separately.

Type III has the most complex repair strategy, so an example from this group will be most illuminating. Let us consider example (1i) ClArm *artawsr* < PIE *draḱu 'tear'. The anti-epenthesis constraint, DEP-IO, is violated, since the initial /a/ was not present in the original form. The constraint militating against insertion or deletion at word edges, ANCHOR-IO, is violated because this epenthesis is in initial position. And LINEARITY-IO, the anti-metathesis constraint, is obviously violated by the metathesis of the /r/ and the /t/. These constraints are all violated in order to avoid violations of the positional markedness constraints on [r], and are therefore dominated by ***{#,C}r**. To restate this schematically, we have the following ranking:

***{#,C}r » DEP-IO, ANCHOR-IO, LINEAR-IO**

The next question to be answered is why the epenthetic vowel is initial (i.e. prothetic) rather than interposed between the first and second consonants in Type III (and potentially Type II). As Picard rightly points out, the latter option is far more common cross-linguistically. The choice between these two options crucially comes down to the relative ranking of two of the aforementioned CORRESPONDENCE constraints: ANCHOR-IO and CONTIG-IO.

If ANCHOR-IO were relatively highly ranked, the word edges would need to remain consistent from the input to the output. Since this is not the case, there must be some constraint which incurs a more costly violation. So we must find something that internal epenthesis would violate. It cannot simply be DEP-IO, since this is violated whether epenthesis is initial or medial. What it must be is CONTIG-IO, or at least some version of it.

CONTIGUITY is a very strong concept. In its most basic form, it requires all segments in the input to surface in the output with the exact same precedence relationships. Therefore, any insertion or deletion automatically incurs a violation, since different elements are contiguous in the output than were in the input. It is furthermore difficult to determine exactly how to apply

violations of CONTIG-IO. Are we to assign a violation mark based on each segment which stands in a different contiguity relationship, or each sequence of segments that stands in a different contiguity relationship? It is a difficult question. Whether or not it is expressly necessary, positing a more explicit definition of the CONTIGUITY constraint for this situation will at least to some extent clarify the problem.

The key aspect of CONTIGUITY that is seen in the optimal forms is that those contiguous consonants of the input which actually do surface, surface still in a contiguous relationship with one another. This is not relevant for the forms of Type I, which are simply prothetic. But for the other three types, where /r/ is underlyingly adjacent to (i.e. contiguous with) another consonant, the optimal form is always one where the [r] is still adjacent to that same consonant. In the metathetic forms (Type III and IV), however, the precedence relations between the underlying consonants and their underlyingly adjacent vowels is thoroughly altered. If we were to rely on the basic definition of CONTIG-IO, this would incur serious violations, regardless of how such instances were evaluated. Therefore, it is reasonable to posit that the relevant aspect of CONTIGUITY in this situation only relates to CONTIGUITY of consonants.[22] Refining the constraint to capture this generalization, we have:

> **CONTIG(CC)-I→O**
> Any two consonants that are contiguous in the input (and that both surface in the output), must be contiguous in the output.

With our revised CONTIGUITY constraint, we have a motivating factor for initial epenthesis over medial epenthesis if we rank CONTIG(CC)-I→O » ANCHOR-IO, which can be seen in (2):

[22] This would seem to imply that consonants and vowels might exist on different tiers, even in Optimality Theory, just as in earlier autosegmental approaches.

(2) Tableau for example (1i) PIE **draḱu* > ClArm *artawsr* 'tear'

/tra-/[23]	***#r**	***Cr**	**CONTIG(CC)-I→O**	**ANCHOR-IO**
a. tra-		*!		
b. ta.ra-			*!	
☞ c. ar.ta-				*
d. at.ra-		*!		*

Candidate (2a), *tra-,* is the faithful candidate, agreeing fully with the input string. This candidate will obviously not incur violations of any CORRESPONDENCE constraint, since no Input-Output relationships have been altered. However, it does violate the high ranked markedness constraint ***Cr** (which is the motivation for the changes), and is thus eliminated. Likewise, candidate (2d), *atra-,* is eliminated for a violation of ***Cr**. The remaining candidates, (2b) *tara-* and (2c) *arta-*, pass the markedness constraints. The choice between them will crucially come down to the relative ranking of the CORRESPONDENCE constraints as discussed above. Candidate (2b) has altered the contiguity relationship between the /t/ and the /r/ (i.e. the two segments are not adjacent in the output), and thus incurs a violation of CONTIG. Candidate (2c), on the other hand, has not altered the contiguity relationship, but rather the anchoring relationship, incurring a violation of ANCHOR, since the presence of the prothetic vowel has changed which segment sits in initial position. Therefore, by ranking CONTIG over ANCHOR, candidate (2b) is eliminated before ANCHOR can enter into the evaluation, and the optimal output (2c) is correctly predicted.

It is in examining the position of the epenthetic vowel and its relationship to metathesis that we can understand the true differences between Vennemann's account and Picard's account, and why both of them ultimately fail to produce an adequate solution. Vennemann posited prothesis (that is, initial epenthesis) before initial *Cr* sequences, and a subsequent metathesis of

[23] The tableaux will present as their input the value of the segments after the developments of the "Armenian sound shift," a sound change very reminiscent of Grimm's Law in Germanic, that has altered the values of the three different Indo-European stop series.

just *C* & *r*. Picard, as described earlier, posited internal epenthesis between *C* & *r*, with a subsequent metathesis of the *Vr* sequence into pre-consonantal position. Vennemann's problem is that the *epenthesis* is unmotivated, whereas Picard's problem is that the *metathesis* is unmotivated.[24] The proper solution only comes when the two developments, metathesis and epenthesis, occur simultaneously, which is exactly the case in the input to output framework of Optimality Theory. Both processes are working in concert to avoid illicit positions for [r], with minimally costly violations of CORRESPONDENCE constraints.

However, the choice of prothesis rather than internal epenthesis does come at an additional cost. Whereas internal epenthesis on its own would have been enough to satisfy the ***Cr** constraint, initial epenthesis on its own does not, as seen in the suboptimal form, (2d) *atra-*. The optimal candidate, (2c) *arta-,* has also undergone metathesis of the underlying consonants. Clearly this must incur some violation, and it does. This violates the anti-metathesis constraint LINEARITY-IO. With this in mind, in order for metathesis to be the optimal output, LINEARITY must be dominated by CONTIG (since a high ranking of LINEARITY-IO would block metathesis).

(3) Tableau for *artawsr* with LINEARITY

/tra-/	***#r**	***Cr**	**CONTIG(CC)-I→O**	**LINEARITY-IO**	**ANCHOR-IO**
a. tra-		*!			
b. ta.ra-			*!		
☞ c. ar.ta-				*	*
d. at.ra-		*!			*

It is impossible to yet determine the relative ranking of LINEARITY-IO and ANCHOR-IO, since both are violated in the optimal form, yet LINEARITY is not violated elsewhere. It is sufficient to say that they are both very low in the constraint ranking.

[24] Motivation, particularly for Vennemann's account, might be found with reference to syllable structure (namely a ban on complex onsets), but not directly from other markedness considerations.

One other potential output, (4e) *ta-*, would also prevent a violation of ***{#,C}r**, since it simply deletes the problematic /r/. However, this would create a new violation for MAX-IO, which requires every input segment to have a correspondent in the output. If MAX-IO were dominated by either ANCHOR-IO or LINEARITY-IO, the optimal candidate (2c) would be eliminated, since it would incur violations of those two constraints before the deletion candidate could be eliminated by MAX-IO. Therefore, the opposite must be true, and MAX-IO must dominate both ANCHOR-IO and LINEARITY-IO (which still cannot be critically ranked), properly ruling out the deletion candidate (4e)**ta-*.

A similar deletion candidate, (4f) *ra-*, would be harmonically bounded by (4e) *ta-*, since it would likewise incur a violation of MAX-IO, while additionally violating both ANCHOR and ***#r** (which may be an even more serious violation than for the ***Cr** problem it would be trying to repair, if we subscribe to the critical ranking of ***#r** » ***Cr**).

(4) Tableau for *artawsr* with MAX

/tra-/	***#r**	***Cr**	**CONTIG(CC)-I→O**	**MAX-IO**	**LINEARITY-IO**	**ANCHOR-IO**
a. tra-		*!				
b. ta.ra-			*!			
☞ c. ar.ta-					*	*
d. at.ra-		*!				*
e. ta-				*!		
f. ra-	*!			*		*

Based simply on this data, the ranking of MAX-IO relative to CONTIG and ***{#,C}r** cannot be fixed, since its domination of those constraints would not change the evaluation either, as all the suboptimal candidates each incur one violation of a constraint that dominates ANCHOR-IO and LINEARITY-IO.[25]

[25] For consistency of presentation, I will continue to show ***{#,C}r** to dominate MAX and CONTIG, since it is the motivating factor behind the change, but their relative ranking cannot actually be determined.

What has been thus far implicit in the tableaux is the constant violation of DEP-IO. It has already been established that DEP-IO must be dominated by ***{#,C}r**, since otherwise epenthesis would not occur in any position (at least as a repair mechanism on the position of /r/). Yet it remains to be seen how it ranks relative to the other CORRESPONDENCE constraints. It turns out that, based on our current candidates, the only CORRESPONDENCE constraint it can be definitively ranked with is MAX. If DEP were to dominate MAX, regardless of the ranking of CONTIG, both epenthesis candidates would lose to the suboptimal deletion candidate. Therefore, MAX **»** DEP. But beyond this, DEP cannot be crucially ranked with respect to any other CORRESPONDENCE constraint. This can be most clearly demonstrated by examining Tableau (5), which shows DEP with its highest possible ranking:

(5) Tableau for *artwasr* with DEP

/tra-/	***#r**	***Cr**	**MAX-IO**	**DEP-IO**	**CONTIG**	**LINEARITY-IO**	**ANCHOR-IO**
a. tra-		*!					
b. ta.ra-				*	*!		
☞ c. ar.ta-				*		*	*
d. at.ra-		*!					*
e. ta-			*!				
f. ra-	*!		*				

It having been established that MAX **»** DEP, the only candidates that are still in play by the time DEP could enter into the evaluation are (5b) and (5c). Since both of these candidates incur a violation of DEP, DEP will never be able to choose between them, regardless of its ranking – it will always pass the evaluation on to the next constraint. Therefore, DEP cannot yet be crucially ranked with any other constraint.

However, one additional candidate could help fix the ranking. So far, all of the candidates have attempted to alleviate the markedness constraints by altering the structure at the beginning of the word, i.e. with metathesis, epenthesis, and/or deletion. It is possible, however,

to come up with a candidate that does the opposite – altering the structure towards the right rather than the left. What exactly the form would look like is somewhat difficult to say. Using the PIE form[26] as the starting point for ease of explanation, the derivation might look like this:

**draḱu* > †*darḱu* > †*tarsu+r* > †*tarsur* or †*tawrsr*[27]

Plugging these two new candidates into our constraint ranking, we see that the ranking of CONTIG is already sufficient to rule them out.

(6) Tableau for *artawsr* with rightward metathesis candidates[28]

/dr**a**ḱu, -r/	*#r	*Cr	MAX-IO	CONTIG	LINEARITY-IO	DEP-IO	ANCHOR-IO
☞ c. a**r**.taw.s(ə)r					*	*	*
g. ta**r**.sur				*!	*		
h. taw**r**.s(ə)r				*!(*)[29]	**		

Both of the new candidates, (6g) and (6h), display rightward metathesis of the /r/ (which is bolded in the candidate set). In all three candidates, metathesis has successfully avoided violation of the markedness constraints. (Notice that the glide [w] is a [-consonantal] segment, so it does not violate ***Cr** as it is defined above.) The choice between leftward metathesis and rightward metathesis, therefore, comes down to CONTIGUITY, the same issue as was previously crucial in choosing the position of epenthesis. If rightward, the originally contiguous /*d/ & /*r/ would no longer be contiguous. Yet leftward metathesis keeps the /*r/ adjacent to the consonant, and passes CONTIG.

CONTIGUITY thus accounts for the direction of metathesis in forms of Type III. However, it will not be sufficient on its own to account for certain other forms, namely those of Type I.

[26] Or rather the transponat by-form with with the [r] in the first rather than the second syllable (see note 6 above).
[27] †*tawrsr* would involve an intermediate step: †*tars**u**r* > †*tars**w**ər* > †*ta**w**rsər*. It seems unlikely that the *u would consonantalize only to subsequently metathesize, and metathesize more than one segmental distance. The point is moot regardless.
[28] Because of the complexities of the potential derivation, I use the PIE form here as the input.
[29] How to evaluate the contiguity of the **u* > †*w* is completely unclear, and (luckily) extraneous. But it should serve to illustrate the potential complexities of an unfettered CONTIG-IO.

For forms like Classical Armenian *erek^h* 'three,' LINEARITY-IO must come into play in determining the optimal form. By fixing the order of this constraint with respect to our other CORRESPONDENCE constraints, the proper output will be selected.

(7) Tableau for example (1d) PIE **treyes* (> PreArm **rek^h*) > ClArm *erek^h* 'three'

/rek^h/[30]	*#r	*Cr	MAX-IO	CONTIG	LINEARITY-IO	DEP-IO	ANCHOR-IO
a. rek^h	*!						
☞ b. erek^h						*	*
c. ek^h			*!				*
d. erk^h					*!		*

There are only a few possible candidates for this form. Two are quickly eliminated in exactly the same fashion as seen many times previously: the faithful candidate, (7a) *rek^h*, is eliminated for its violation of *#r, and the deletion candidate, (7c) *ek^h*, for its violation of MAX-IO. The remaining candidates are (7b) *erek^h* (which is the optimal form), and (7d) *erk^h*. (7d) represents rightward metathesis, just as did (6g) and (6h). The crucial difference is, however, that there is no consonant originally adjacent to the /r/. Under the highly specified CONTIGUITY constraint proposed earlier, where CONTIGUITY violations are only evaluated based on adjacency of consonants in the input, this rightward metathesis would incur no violations of CONTIGUITY. There are thus two potential solutions: alter the definition of our CONTIGUITY constraint, or find something in our ranking that can properly select the optimal form.

The former might be simpler. If the CONTIGUITY constraint were a basic bidirectional Input-Output constraint, then an adjacency of two consonants in the output that were not adjacent in the input would incur a violation. This is the case with *erk^h*, because the [r] and the [k^h] were not adjacent in the input. However, I fear this would have unintended consequences, as the shapes of Classical Armenian words have so often undergone very significant alterations from

[30] Note that in candidates (7a), (7c), and (7d), the [e] corresponds to the /e/ of the input. In candidate (7b), the first [e] is epenthetic, and the second [e] corresponds to that of the input.

their Proto-Indo-European form. It is often the case that there are consonantal reflexes of Indo-European sounds that are adjacent in Armenian that were not so in PIE. But, of course, one could easily make recourse to different diachronic layers and turn the problem into one of diachronic "rule-ordering."

The other solution – tweaking our existing constraint ranking – may be preferable, and this is what is shown above in Tableau (7). If the CONTIG constraint is left unmodified, both (7b) and (7d) will pass all the way through it with no violations. For the first time, the low ranked faithfulness constraints come into play. Both will violate ANCHOR, since the /r/ is no longer in initial position. But the two candidates will respectively violate one of the two remaining other CORRESPONDENCE constraints. (7b) *erek^h* shows epenthesis, thus violating DEP, whereas (7d) *erk^h* has undergone metathesis, violating LINEARITY. With there now apparently being a relevant distinction between these two constraints, we have evidence to motivate a crucial ranking. In order to use these two constraints to select (7b) over (7d), all that is needed is to have LINEARITY dominate DEP. This crucial ranking is demonstrated again here:

/rek^h/	***#r**	***Cr**	**MAX-IO**	**CONTIG**	**LINEARITY-IO**	**DEP-IO**	**ANCHOR-IO**
☞ b. erek^h						*	*
d. erk^h					*!		*

Therefore, if we choose to place the burden of these examples on our already proposed constraints, rather than redefining CONTIG, we not only avoid significant potential complications, but also gain greater detail in our constraint ranking.

Now that all of the CORRESPONDENCE constraints have been examined, and taking the preceding argument to be correct, we can represent the ranking schematically as:

***#r, *Cr » MAX-IO, CONTIG(CC)-I→O » LINEARITY-IO » DEP-IO, ANCHOR-IO**

This ranking admits of three major groupings of constraints, each playing a different role in the derivation. First is the highly ranked markedness constraints on [r], ***#r** and ***Cr**. These constraints induce a change in the form by indicating that a highly marked structure is present. The second group is the highly ranked faithfulness constraints, MAX-IO and CONTIG. These dictate the types of CORRESPONDENCE relationships which cannot be violated, even in order to repair a highly marked structure. In essence, these are more similar in power to the markedness constraints than to the lower ranked faithfulness constraints, since both are inviolable in any normal circumstance. Last is the set of lowly ranked faithfulness constraints, DEP-IO and ANCHOR-IO, and, somewhat less so, LINEARITY-IO. These are the constraints that represent CORRESPONDENCE relationships that can be consistently violated in order to avoid marked structures. It appears that LINEARITY-IO is somewhere in between the two major groupings of faithfulness constraints; but the fact that it is so often violated in the more complex repairs indicates that it is probably more in line with the lower group than the middle one.

Thus far, the ranking has been motivated primarily through an example of Type III (initial metathesis), with some additional support from Type I (simple prothesis). It remains to be seen if this ranking can account for the remaining types.

(8) Tableau for example (1d) PIE **dwo* (> Pre-Arm **rku*) > ClArm *erku* 'two' *(Type II)*

/rku/	***#r**	***Cr**	**MAX-IO**	**CONTIG**	**LINEARITY-IO**	**DEP-IO**	**ANCHOR-IO**
a. rku	*!						
b. reku	*!			*		*	
☞ c. erku						*	*
d. ekru		*!			*	*	*
e. kru		*!			*		*
f. kur				*!	*		**
g. ku			*!				*
h. eru			*!			*	*

Forms of Type II have a large array of potential candidates, which can be classified into several groups according to which constraints they violate. Candidates (8a) and (8b) are eliminated for violating ***#r**; candidates (8d) and (8e) are eliminated for violating ***Cr**; candidate (8f) is eliminated for violating CONTIG; and candidates (8g) and (8h) are eliminated for violating MAX. This leaves us with candidate (8c), *erku*, which passes all of these constraints, all the while violating each remaining low ranked CORRESPONDENCE constraint. Just as in the forms of Type III, the evaluation is complete before any of the low ranked CORRESPONDENCE constraints could ever come into play.

This same pattern is evident in Tableau (9), which illustrates the derivation for forms of Type IV based on example (1m) ClArm *surb* 'holy'.

(9) Tableau for example (1m) PIE *ḱub^{h}ros > ClArm *surb* 'holy' *(Type IV)*

/ subr(-) /	***#r**	***Cr**	**MAX-IO**	**CONTIG**	**LINEARITY-IO**	**DEP-IO**	**ANCHOR-IO**[31]
a. subr		*!					
b. suber				*!		*	
☞ c. surb					*		
d. srub		*!		*	*		
e. sub			*!				
f. sur			*!				

Again, the highly ranked markedness constraints (***{#,C}r**) and highly ranked faithfulness constraints, MAX and CONTIG, eliminate all suboptimal candidates before LINEARITY and the other low ranked faithfulness constraints have a chance to enter into the evaluation. This example, and the others of Type IV, in many ways mirror those of Type III. Suboptimal candidate (9b), *suber,* and optimal candidate (9c), *surb,* in this tableau stand in essentially the same relationship as the (b) and (c) candidates in the *artawsr* tableaux (e.g. tableau 5).

[31] Since this analysis is agnostic as to the chronology of these metatheses relative to the loss of final syllables, no evaluation will be made of ANCHOR at the right edge of the word in this case. Furthermore, it is clear based on this tableau that a violation of this constraint would have no effect on the evaluation.

Candidate (9b), *suber,* displays the internal epenthesis seen in the suboptimal candidate (5b), *tara-*. And the optimal candidate (9c), *surb*, wins by moving the /r/ into post-vocalic position, just as in optimal candidate (5c), *arta-*. The difference is that, in type IV, DEP does not need to be violated at all, since a nearby vowel already exists that can support the /r/. The only constraint which needs to be violated in order to satisfy ***Cr** is LINEARITY (that is, a violation due to simple metathesis).

As an additional reference, tableau (10) shows that the proposed constraint ranking is equally satisfactory for other examples of Type III, as well.

(10) Tableau of example (1j) PIE *g^wrawon > ClArm *erkan* 'millstone' *(Type III)*

/kra-/	***#r**	***Cr**	**MAX-IO**	**CONTIG-IO**	**LINEARITY-IO**	**DEP-IO**	**ANCHOR-IO**
a. kra-		*!					
b. kera-				*!		*	
☞ c. erka-					*	*	*
d. ekra-		*!				*	*
e. ka-			*!				
f. ra-	*!		*				*
g. kar-				*!	*		

Thus far, no mention has been made of syllable well-formedness constraints (i.e. *COMPLEX, NOCODA, ONSET, etc.). We immediately see based simply on the outcome of examples like *ar.taw.s(ə)r* < **dra.ḱu* that NOCODA and ONSET must not be highly ranked constraints, as the output displays a new syllable that violates both constraints. Furthermore, based on Type IV – medial/final metathesis – it appears that *COMPLEX (or at least *$\text{COMPLEX}_{\text{CODA}}$) must not be highly ranked either, as seen in the following example:

(1m) PIE *$ḱub^h.ros$ > Cl.Arm *surb* 'holy'

If *$\text{COMPLEX}_{\text{CODA}}$ were ranked above CONTIG and DEP, then the cluster would be resolved with epenthesis rather than metathesis.

It is clear also that such a metathesis as this, provided it occurred after the loss of the final syllable, could be perfectly well-motivated without any special reference to [r]. A syllable-final sequence *obstruent* + *sonorant* would immediately violate SONORITY SEQUENCE, which requires falling sonority in codas. This must be at the heart of certain instances of metathesis involving *obstruent* + *glide* sequences. However, in either instance, the ranking of the CORRESPONDENCE constraints must be one that favors metathesis over epenthesis or deletion, which is precisely what has been put forth as the repair mechanism for /*r/.

The one syllable well-formedness constraint that may be relevant to this discussion is *$\text{COMPLEX}_{\text{ONSET}}$. The historical developments into Armenian very much point to a dispreference of complex onsets. Winter (1962) emphatically states "Only single consonants are tolerated in word- and syllable-initial position" (255). In instances of initial PIE **voiceless stop* + *C* (namely a resonant consonant), the Armenian form is marked by deletion of the *voiceless stop*. In some cases, this has resulted in the environment for Type I:

(1d) PIE *$\underline{tr}eyes$ (> Pre-Arm *$\underline{r}ek^h$) > ClArm $\underline{er}ek^h$ 'three'

As we have seen, PIE initial sequences of *voiced/voiced aspirated stop* + *liquid* tend to be resolved by metathesis. The developments of most *stop* + *glide* sequences are not wholly transparent (Ravnæs, 1991: 160-8), but the pattern seems to indicate a trend towards eventual simplification, particularly in onset position. Taking this into account, the constraint *$\text{COMPLEX}_{\text{ONS}}$ would appear to be a possible motivation for some of the types of developments discussed in this paper, namely Types II & III. However, if ***{#,C}r** were to be totally removed from the equation and replaced by *$\text{Complex}_{\text{ONS}}$, the proper outcomes are not achieved, since there is nothing to motivate metathesis over simple prothesis (i.e. optimal candidate (11c) over suboptimal candidate (11d) below):

(11) Tableau for *artawsr* with *COMPLEX$_{ONSET}$

/tra-/	*COMPLEX$_{ONS}$	MAX-IO	CONTIG	LINEARITY-IO	DEP-IO	ANCHOR-IO
a. tra-	*!					
b. ta.ra-			*!		*	
☹ c. ar.ta-				*!	*	*
💣 d. at.ra-					*	*
e. ta-		*!				
f. ra-		*!				*
g. a.tra-	*!				*	*

*Complex$_{ONSET}$ is enough to eliminate the faithful candidate (11a) *tra-*, as well as a new candidate (11g) *a.tra-* (which is simply a different syllabification of (11d)). However, by taking away ***{#,C}r**, there is no high ranked constraint to eliminate candidate (11d) *at.ra-*. Therefore, (11d) remains undifferentiated from the actual optimal candidate (11c) until LINEARITY-IO is evaluated, by which (11d) is selected. This means that, without ***{#,C}r**, there is no longer motivation for metathesis; that is to say, there is nothing overriding LINEARITY-IO, the anti-metathesis constraint.[32] This shows that, while *COMPLEX$_{ONSET}$ may be active in the language, particularly at the point when **treyes* > *erek^{h}*, it is not enough to account for these metatheses.

In conclusion, I believe this analysis has a number of benefits over previous accounts. It can account for the data in a more unified way, through the use of a single hierarchy of markedness constraints, namely ***#r** and ***Cr**, coupled with a basic ranking of standard faithfulness constraints. It connects these developments back to the state of affairs in Indo-European, where it appears the ***#r** constraint was active as well. And most importantly, since the markedness constraints are grounded in phonetics, from the perspective of both articulation and perception, this account is also able to provide motivation for these developments, which was largely lacking from previous explanations.

[32] It is possible that such a motivation could be found in the constraint SYLLABLECONTACT, which penalizes a rise in sonority across a syllable boundary (i.e. a coda that has lower sonority than an immediately following onset). This question demands further examination.

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