Tier-based locality in Armenian conjugation classes: Relativized adjacency in long-distance allomorphy

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Abstract

A cross-linguistic tendency is that linguistic processes respect locality constraints. In this paper, we analyze the distribution of conjugation classes in Armenian. We analyze different types of allomorphy which apply across these classes. On the surface, we show that such allomorphy is long-distant. However, we argue that allomorphy respects 'relativized adjacency' (Toosarvandani 2016) or tier-based locality (Aksënova et al. 2016). Specifically, allomorphy is sensitive to the interaction between multiple morphemes which are not linearly or structurally adjacent. However, the interaction is local on a tier which is projected from the morphology. This computational formalizes generalizes across many separate theories of allomorphy, including phases and structural adjacency.

keywords: phase, theme vowel, tier, allomorphy, suppletion, locality, morphologically-conditioned allomorphy, phase-based locality, tier-based locality, locality domains.

1   Introduction

It is a cross-linguistic tendency that morphologically-conditioned allomorphy is conditioned by local or adjacent triggers (Siegel 1974; Allen 1979). Because of this tendency, most theories of allomorphy assume that local conditioning is the default or norm, and that any apparent cases of non-locally triggered allomorphy requires special mechanisms. However, non-local allomorphy is typologically attested (Bobaljik 2000; Bruening 2018; Deal 2018; Lee and Amato 2018; Wu 2018). In order to incorporate these cases, there is a wealth of disparate and elaborated theoretical

machinery.[1] Finding the right theoretical treatment for non-local allomorphy is an active area of research and dispute (Gribanova and Shih 2017; Newell et al. 2017).

In this paper, we contribute to this debate from two angles: empirical and computational. On the empirical side, we provide data on long-distance allomorphy in Armenian. Armenian is an understudied Indo-European language isolate with two standard dialects: Western and Eastern Armenian. We focus on Western Armenian. There are some partial treatments of Armenian (Baronian 2002, 2004, 2006; Khanjian 2013). Our paper is the first extensive theoretical analysis of Armenian conjugation classes and allomorphy.[2] We focus on the surface morphotactics of Armenian conjugation classes and of their component morphs.

We do not model Armenian with any existing proposed model in morphological theory. Instead, we incorporate strategies from computational morphology. We argue that Armenian displays tier-based locality among its multiple long-distance allomorphy processes. By using tiers, we formalize different intuitions of 'relativized adjacency' (Toosarvandani 2016) and 'closest triggers' in allomorphy (Choi and Harley 2019). Our result is agnostic to different controversies in theoretical morphology. For example, we analyze our data in a realizational piece-based framework like Distributed Morphology (Halle and Marantz 1993), but our tier-based analysis can be equivalently expressed in process-based approaches (Aronoff 1976; Anderson 1992; Stump 2001) or non-realizational piece-based models (Lieber 1980; Selkirk 1982). We assume that the verb is cyclically spelled-out starting from the root, and that phonology applies after morphology. However, our tier-based analysis is again agnostic to these assumptions. The only necessary assumption is that morphological features like class cannot be deleted in spell-out.

We go over three morphological processes which differ in locality and directionality: class-assignment, aorist agreement, and *i*-neutralization. All three concern affix suppletion, not root suppletion. The first two processes are inwardly-sensitive, while the third is outwardly-sensitive. The first process is local, while the latter two are long-distant processes that respect tier-based locality. The third process is likewise sensitive to a host of phonological factors which require a morpheme-specific phonological rule. The rule must apply after the output of phonology.

In §2, we first go over the different conjugation classes in Armenian. These are the E-Class, I-Class, and A-Class. These classes are distinguished based on the type of theme vowel: -*e*-, -*i*-, and -*a*-. The conjugation class of the verb is locally computed based on the morphological class features of roots and valency-changing morphology. In complex verbs with multiple class-bearing

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[1]An incomplete list of strategies include feature percolation (Lieber 1989), c-command (Chung 2007, 2009), phase-based locality (Marvin 2002; Marantz 2007, 2013; Embick 2010), domain suspension (Bobaljik and Wurmbrand 2013), accessibility domains (Moskal 2015a,b), linear spans (Merchant 2015; Guekguezian 2020), morphological fusion and re-bracketing (Christopoulos and Petrosino 2017), rules with multiple conditioning triggers (Moskal and Smith 2016), bounded windows or stacks (Božič 2019), parameterizing the phase-status of morphemes (Kilborne-Ceron et al. 2016), structural adjacency with articulated tree structures (Bobaljik 2012; Gribanova 2015), or assumptions on the elsewhere-status of morphs (Ganenkov 2020).

[2]Data was elicited by native Western-speaking informants. Data was double-checked with paradigms from multiple descriptive grammars and teaching grammars (Gulian 1902; Boyacioglu 2010; Hagopian 2005; Andonian 1999; Bardakjian and Thomson 1977; Bardakjian and Vaux 1999, 2001; Fairbanks 1948; Johnson 1954; Kogian 1949; Kozintseva 1995; Dum-Tragut 2009; Sakayan 2000, 2007).

morphemes, these morphemes locally compete to determine the conjugation class of the verb.

Although the selection of conjugation class is a local process, these classes trigger long-distance allomorphy in aorist agreement (§3). The agreement marker in the past perfective has two sets of allomorphs. The trigger and target of this allomorphy are not adjacent. Instead, the choice of allomorph depends on the class-features of the closest class-bearing morpheme. We formalize the notation of 'closest' with the use of morphological tiers. The tiers essentially formalize phase-based or cyclic locality (Embick 2010). Thus, we still have locality but not in linear terms.

The second type of allomorphy is more complicated: *i*-neutralization (§4). In certain constructions, the *-i-* theme vowel is neutralized into the *-e-* theme vowel despite being in the I-Class. Some triggers are phonological, while some are morphological. Phonologically, unstressed *-i-* is replaced with *-e-*. This rule is a morpheme-specific phonological rule that only applies to the *-i-* theme vowel, and to no other high vowel in the language. In contrast, the morphological trigger is the imperfective morpheme which idiosyncratically triggers neutralization. The imperfective morpheme can either linearly follow the theme vowel or non-immediately precede it. In the second case, the imperfective is on an adjacent auxiliary in a periphrastic construction. Structurally, the commonality is that the imperfective has scope over the theme vowel. We use tiers to formalize this dependence on scope. The tier that is projected from the morphological tree.

We discuss computational aspects of our analysis in §5. In §5.1, we discuss how tier-based computation formalizes different strands of work in morphology theory, especially phase-based locality. In §5.2, we connect our data to the breadth of work on the use of tiers in computational phonology and morphology. In §5.3, we discuss problems and solutions in merging multiple allomorphy rules into a single process; this issue is connected to the computational problem of prefix-suffix dependencies. Conclusions are in §6.

2 Locality of class assignment

For both simple and complex verbs, class assignment is a strictly local process between the class-bearing morpheme and the theme vowel. We first go over simple verbs (§2.1). We then discuss complex verbs which consist of valency-changing morphology (§2.2), such as the passive (§2.2.1), causative (§2.2.2), or inchoative (§2.2.3). Finally, we show how multiple class-bearing morphemes compete together in a local fashion (§2.3).

2.1 Local assignment in simple verbs

Simple verbs in Armenian consist of three overt morphs: a root, a theme vowel, and an infinitival suffix *-l* (1). Verbs are divided into three conjugation classes based on the theme vowel: *-e-*, *-i-*, or *-a-*. In most descriptive grammars, these classes are called the First, Second, and Third

Conjugations (Kogian 1949). We use more mnemonic names: E-Class, I-Class, and A-Class.[3]

(1)   a. E-Class   b. I-Class   c. A-Class
   *ker-e-l*   'to scratch'   *xos-i-l*   'to speak'   *gart-a-l*   'to read'

The choice of theme vowel is unpredictable. We assume that the theme vowel is selected based on the features of the root. We label these morphological features as E-CLASS, I-CLASS, and A-CLASS. For simplicity, we treat them as privative, not binary[4]

(2)   *Selecting theme vowels after a class marker*
         TH   →   *-e-*   / [E-CLASS] ⌢ _
                    -i-   / [I-CLASS] ⌢ _
                    -a-   / [A-CLASS] ⌢ _

One issue is determining the morphological identity of theme vowels. The options are that the theme vowel is an exponent of a meaningless morpheme TH (3a), a verbalizer *v* (3b), or a voice morpheme VOICE (3c, or V for short), or a fusion of all three nodes (3d). We show these options for an E-Class verb *ker-e-l*. We use the subscript ₑ to mark the root as an E-Class verb.

(3)   *Representational options for theme vowels*
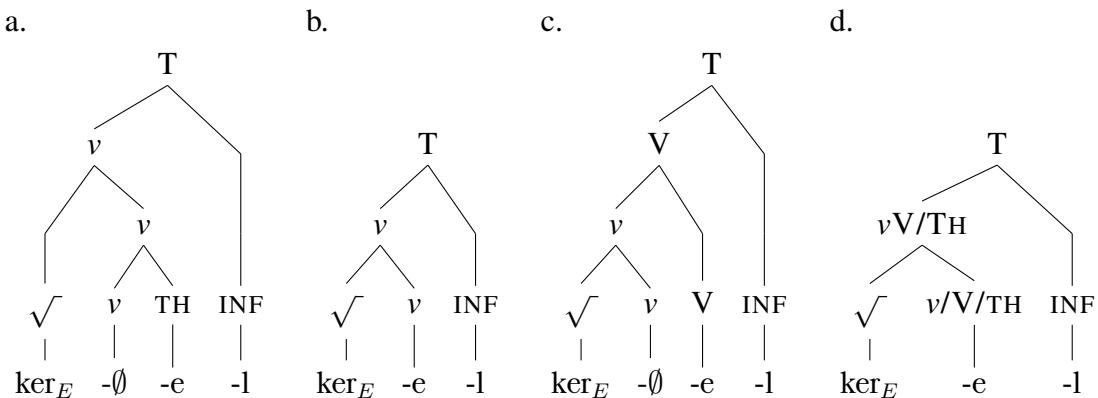
The first option treats the theme vowel as a meaningless TH node, i.e., an empty morph (Aronoff 1994), ornamental morpheme (Embick and Noyer 2007), or dissociated morpheme (Embick 1998, 2015). It is adjoined onto *v* (Oltra-Massuet 1999a,b; Oltra-Massuet and Arregi 2005). The second

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[3]The E-Class is the default or basic class. There is a fourth obsolete class where the theme vowel is *u*. This class is mentioned in some early grammars (cf. references in Boyacioglu 2010:66), but it does not exist in contemporary Armenian. In Eastern Armenian, there is no longer a theme vowel *-i-*. All I-Class verbs are instead E-Class *xos-e-l* or A-Class: Western *ʒəbd-i-l* vs. Eastern *ʒəpt-a-l* 'to smile'.

[4]Alternatively, we can place the class features on a covert verbalizer *v* (Acquaviva 2009); but it's unclear if there's evidence for this in Armenian. For simplicity, we do not assume a markedness-based hierarchy for class features (Oltra-Massuet 1999b; Trommer 2008).

option treats the theme vowel as a category-assigning affix without any additional semantics (Julien 2015; Spyropoulos et al. 2015). The third option assumes that the choice of theme affects valency i.e., if the verb is transitive or not (Harley 2009, 2013). Finally, the fourth option treats the theme vowel as a fused exponent of all these nodes (Harley 2017).

We assume the fourth option. The theme vowel is simultaneously ornamental, a verbalizer, and a voice-assigner. Its ornamental status is shown in valency morphology in §2.2. As a verbalizer, all simple verbs surface with a theme vowel between the root and tense. For example, many roots surface as a free-standing noun or adjective. They are verbalized by just adding a theme vowel.

(4)   a. *jerk*   'song'   b. *an͡tsrev*   'rain'   c. *xaɣ*   'game'
         jerk-e-l 'to sing'   *an͡tsrev-i-l* 'to rain'   *xaɣ-a-l* 'to play'

And as a voice-marker, the choice of theme vowel generally correlates with transitivity, but not perfectly. The E-Class includes transitive and intransitive verbs. The I-Class and A-Class are mostly intransitives with some exceptions (Daniel and Khurshudian 2015:486).[5]

(5)   *Conjugation classes by transitivity*

	E-Class		I-Class		A-Class	
Transitive	*azad-e-l*	'to free'	*naj-i-l*	'to look at'	*aɣ-a-l*	'to grind'
	ned-e-l	'to throw'	*sorv-i-l*	'to learn'	*havad-a-l*	'to believe'
Intransitive	*hamper-e-l*	'to be patient'	*barg-i-l*	'to lie down'	*bor-a-l*	'to shout'
	pampas-e-l	'to gossip'	*məs-i-l*	'to feel cold'	*mən-a-l*	'to remain'

The correlation between transitivity and the theme vowel is partial but it has pockets of regularity. The evidence comes from equipollent verbs which alternate in the choice of theme vowel based on transitivity: *-e-* for transitive, *-i-* for intransitive (medio-passive). Donabédian (1997:328) estimates that there around 160 equipollent verbs.[6]

(6)   *jep-e-l* 'to cook X'   *ajr-e-l* 'to burn X'   *mar-e-l* 'to extinguish X'
        jep-i-l 'to be cooked'   *ajr-i-l* 'to be burned'   *mar-i-l* 'to be extinguished'

For these alternating verbs, we assume the roots don't have an underlying class feature. The following feature-insertion rules insert the E-CLASS feature for a transitive root, and I-CLASS for an intransitive root. We assume that voice is specified in a neighboring V. For simplicity, we assume that the class feature is inserted in the root and not in V.

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[5]There are subregularities in these exceptions. For example, transitive I-Class verbs tend to be mental or sensory states such the verbs in 5. These verbs are non-dynamic and thus semantically non-canonical transitives.

[6]These verbs are variably called equipollen verbs (Haspelmath 1993), labile verbs (Daniel and Khurshudian 2015), ambitransitive verbs (Dum-Tragut 2009), or diathesis verbs (Donabédian 1997) in the literature. Because Eastern Armenian lacks the *-i-* theme vowel, many of the intransitive forms in (6) are passive verbs in Eastern Armenian, e.g., 'to be burned' is *ajr-i-l* in Western but *ajr-v-e-l* in Eastern. See §2.2.1 on the structure of passive verbs.

(7) *Inserting class features for equipollent verbs*

$$\emptyset \quad \to \quad \text{E-CLASS} \quad / \sqrt{\underline{}} \frown v \frown \text{TH} \frown \text{V[+TRNS]}$$
$$\text{I-CLASS} \quad / \sqrt{\underline{}} \frown v \frown \text{TH} \frown \text{V[-TRNS]}$$

For simple verbs, we treat the theme vowel as a fused exponent of TH, *v*, and V. Fusion applies when all three morphemes follow a simple root. We later show that fusion of the theme vowel is blocked in complex verbs with valency affixes.[7] We do not separate *v* and V in linear glosses.

(8) *Fusion of theme vowels in simplex verbs*

$$\sqrt{} \frown v \frown \text{V} \frown \text{TH} \quad \to \quad \sqrt{} \frown v/\text{V/TH}$$

2.2 Local assignment in complex verbs

Evidence for the finer decomposition of verbs comes from productive valency-changing morphology (Daniel and Khurshudian 2015:489). The causative, passive, and inchoative are marked by their own exponent and by their own theme vowel. These three valency affixes are respectively E-Class, I-Class, and A-Class.[8] Some of these affixes have a vowel before them.

(9) *Conjugation classes in simple and complex verbs*

	E-Class	I-Class	A-Class
Simple verb	*ker-e-l*	*xos-i-l*	*gart-a-l*
	'to scratch'	'to speak'	'to read'
Complex verb	Causative	Passive	Inchoative
	ker-e-t͡sən-e-l	*xos-v-i-l*	*urax-a-n-a-l*
	'to make s.o. scratch'	'to be spoken'	'to be happy'

For complex verbs, we show that theme vowel selection is locally computed between the theme vowel and the immediately preceding morpheme. We start with passives.

2.2.1 Passive is I-Class

Passive verbs are formed by adding the passive suffix *-v-* after the root. Only transitive verbs can be passivized. Passive verbs act like I-Class verbs and select the *-i-* theme vowel.[9]

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[7] *v* and V are always fused and never have distinct exponents. This is cross-linguistically common (Harley 2013).

[8] The theme vowels for valency affixes indicate a cline of transitivity: E-CLASS > A-CLASS > I-CLASS. The causative (E-CLASS) adds an argument, while the passive (I-CLASS) deletes an argument. There is a similar transitivity cline in simple verbs, though this is a tendency rather than being categorical (5).

[9] The passive suffix also derives reflexives and reciprocals (Dum-Tragut 2009:177), but these aren't morphologically any different from passives (Boyacioglu 2010:18). Because Eastern Armenian lacks the I-Class, the passive is an E-Class verb: *ker-v-e-l*. Furthermore, we don't discuss passivized A-Class verbs. Their derivation is complicated by morphomic or empty morphs, specifically the use of a morphomic aorist stem. We set this issue aside because it doesn't affect our data or generalizations.

(10) *Partial paradigm of passive verbs*

	Simple verb INF		Passive INF	
E-Class	*ker-e-l*	'to scratch'	*ker-v-i-l*	'to be scratched'
I-Class	*xos-i-l*	'to speak'	*xos-v-i-l*	'to be spoken'
	$\sqrt{}$-TH-INF		$\sqrt{}$-PASS-TH-INF	

We treat the passive morph -*v*- as an exponent of a fused *v* and V (shown as PASS). It has the I-Class diacritic, and it precedes the theme vowel -*i*-. The theme vowel acts as an adjunct on the passive. Unlike in simple verbs, the theme vowel does not fuse with the voice marker V in passives. The rule in (8) captures this fact: fusion of all 3 elements is only found after roots.

In terms of tree representations, we can argue that either a) the passive is the only little *v* and V in the verb, b) the root has its own covert *v* and theme vowel but not V, or c) the root has its own covert *v*, V, and theme vowel. We assume the third structure because the meaning of the passive verb is based on that of the active verb (Haig 1982:163; cf. Bruening 2013).[10]

(11) *Options for representing passive verbs*

There is also phonological evidence that passives are derived from active verbs. Armenian has final stress and is a CVCC language; complex codas have falling sonority. Armenian has a process of schwa-epenthesis between CC sequences and the passive: *jerk-é-l~jerk[ə]-v-í-l* (12a). This is a morpheme-specific rule that's restricted to the passive suffix (Vaux 1998:29). There is also a language-general process of destressed high vowel reduction (Khanjian 2009; Dolatian 2020b). Destressed high vowels are preferably deleted: *badíʒ~bad.ʒ-é-l* (12b-i). But they turn into a schwa if deletion would create an unsyllabifiable consonant cluster: *aɣmúg~aɣməg-é-l* (12b-ii).

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[10]The second structure would likewise work. There, the passive is in V and blocks an external argument from merging (Harley 2013; Kastner 2016). In this case, the passive is still built on the active verb, since the passive in V is above the verbalizer *v*. As we later explain, there is phonological evidence for a deleted theme vowel before the passive suffix. For this structure, the theme vowel must be fused only with root's *v*

(12)   a.   i.   jerk-é-l   'to sing'   ii.   matn-é-l   'to betray'

              jerkə-v-í-l   'to be sung'   matnə-v-í-l   'to be betrayed'

       b.   i.   badíʒ   'punishment'   ii.   aɣmúg   'noise'

              badʒ-é-l   'to punish'   aɣməg-é-l   'to make noise'

       c.   i.   badʒə-é-l   'to be punished'   ii.   aɣməg-v-í-l   'to be made noisy'

              *badəʒ-v-í-l

When reduction and epenthesis interact in passives, the destressed high vowel in the passive has the same output correspondent as in the active, i.e., either deletion in both *badʒ[ə]-v-í-l* (12c-i) or reduction in both *aɣməg-v-í-l* (12c-ii). The correct results are obtained if passives are formed from active verbs. Structurally, this means that the passive suffix follows a deleted theme vowel. Deletion can be done by using a readjustment rule (as in DM).[11] If passives were derived directly from the root, not via active verbs, then we would expect schwa-reduction in **badəʒ-v-í-l*. We illustrate these two analyses below. We don't formalize the phonological rules here; but see Dolatian (2020b) and Vaux (1998) for exact rules for reduction and epenthesis respectively.

(13)   *Deriving passives from either active verbs or roots*

Deriving passives from... Input			*... active verbs* √-*n*-TH-PASS-TH-INF	*... roots* √-*n*-PASS-TH-INF
Cycle 1	MORPHO:	Spell-out root & *n*	badiʒ - ∅	badiʒ - ∅
	PHONO:	Stress	badíʒ	badíʒ
Cycle 2	MORPHO:	Spell-out TH	badíʒ-e	
	PHONO:	Stress	badiʒ-é	
		Reduction	badʒ-é	
Cycle 3	MORPHO:	Spell-out PASS-TH-INF	badʒ-e-v-i-l	badíʒ-v-i-l
		Truncate pre-passive theme	badʒ-v-i-l	
	PHONO:	Stress	badʒ-v-í-l	badiʒ-v-í-l
		Reduction s		badəʒ-v-í-l
		Epenthesis across CC-PASS	badʒə-v-í-l	
Output			badʒə-v-í-l	*badəʒ-v-í-l

The verb above is derived from the noun *badíʒ*. In Cycle 1, the root is spelled out with a covert nominalizer and stressed. For the verb-based analysis, the active verb's theme vowel is added in Cycle 2 and triggers stress shift and reduction: *badʒ-é*. In Cycle 3, passive morphology is added and deletes the pre-passive theme vowel: *badʒ-v-i-l*. Stress shift applies with vacuous reduction, and a pre-passive schwa is epenthesized: *badʒə-v-í-l*. In contrast for the root-based analysis, there is no pre-passive theme vowel (= no Cycle 2). In Cycle 3, passive morphology is directly added

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[11]Other feasible approaches are using a truncation rule (Aronoff 1976), stem-inheritance in Network Morphology (Hippisley 1998), or Optimal Paradigms with bound stems (McCarthy 2005b,a). Output-Output correspondence (Benua 1997) is by itself inadequate because the correspondence must be established across the (bound) root in the active and passive, not between the free-standing root and the passive (cf. Orgun 1996; Orgun and Dolbey 2007).

after the root: *badíʒ-v-i-l.* After stress shift, reduction will incorrectly replace the destressed high vowel with a schwa in order to avoid the unsyllabifiable consonant cluster: **badəʒ-v-i-l.*

In sum, the passive is I-Class. It is cyclically derived from active verbs via a process of morpheme deletion (cf. similar phenomena in Darden 1988; Szpyra 1989).

2.2.2   Causative is E-Class

In contrast to passives, causatives are formed by adding the suffix *-t͡sən-* after the root's theme vowel. The causative suffix is accompanied by its own theme vowel *-e-*. When I-Class verbs are causitivized, the *-i-* theme vowel is neutralized to *-e-*. We discuss this process of *i*-neutralization in §4. For now, we focus on the morphological structure of causative verbs.[12]

(14)   *Paradigm of causative verbs*

	Simple verb INF		Causativized INF	
E-Class	*ker-e-l*	'to scratch'	*ker-e-t͡sən-e-l*	'to make s.o. scratch'
I-Class	*xos-i-l*	'to speak'	*xos-**e**-t͡sən-e-l*	'to make s.o. speak'
A-Class	*gart-a-l*	'to read'	*gart-a-t͡sən-e-l*	'to make s.o. read'
	√-TH-INF		√-TH-CAUS-TH-INF	

The causative is an exponent of *v* and voice V (shown as CAUS). But unlike passives, the causative does not delete the root's theme vowel. Furthermore, the causative suffix has the E-CLASS diacritic.[13] The causative takes its own adjoined *-e-* theme vowel regardless of the root.

(15)   *Structure of causative*

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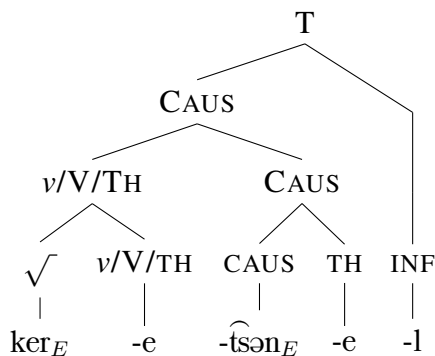
[12]The base of causativization is often, but not always, an intransitive verb (Daniel and Khurshudian 2015:487). There are some causative verbs which are not derived from an existing word (Daniel and Khurshudian 2015:491-2). Certain semantic classes of verbs are more likely to undergo causativization than others (Megerdoomian 2005:16).

[13]There is a diachronic reason as to why the causative is E-Class (Bardakjian and Thomson 1977:244; Margaryan 1997:124; Kortlandt 1999). The modern causative construction √-TH-t͡sən-e-l is derived from a compound construction in Classical Armenian: *X-a-t͡sʰut͡sʰ-a-n-e-l.* The second member of the compound is a verb with the *-e-* theme vowel in Classical Armenian: *t͡sʰut͡sʰ-a-n-e-l* 'to show'. The diachronic origin explains not only the causative's theme vowel, but also its allomorphs: present form *-t͡sən*, past form *-t͡su-* (§3.2), and passive form *-t͡s-* (§2.3).

In general, when the causative suffix is added onto a verb, the verb preserves its original theme vowel.[14] There are three exceptions. The first exception is *i*-neutralization for I-Class roots, discussed further in §4. The second exception is denominal or deadjectival causatives. When the causative suffix is added onto a non-verbal base, the pre-CAUS vowel is usually *-a-*, sometimes *-e-*.

(16) *Causatives derived from adjectives and nouns*

	Base		Causative	
Adjective	*hivant*	'sick'	*hivant-a-t͡sən-e-l*	'to make sick'
	aroxt͡ʃ	'healthy'	*aroxt͡ʃ-a-t͡sən-e-l*	'to heal'
Noun	*badger*	'picture'	*badger-a-t͡sən-e-l*	'to portray'
	vert͡ʃ	'end'	*vert͡ʃ-a-t͡sən-e-l*	'to finish'

In this case, we argue that the pre-CAUS vowel is actually the linking vowel *-a-*. This vowel is a meaningless morph used to form compounds: *tas-a-kirk* 'lesson-book' (Donabédian 2004; Dolatian 2020c). Diachronically, the causative is descended from a compound construction (footnote 13). We present a tree structure for complex verbs with linking vowels later in §3.3.

The third exception comes from syncope. Some causatives lack a pre-CAUS vowel because of a diachronic process of syncope which idiosyncratically deleted some instances of medial unstressed vowels. The syncopated versions are more common in Western Armenian, while the non-syncopated versions are more common in Eastern Armenian (Dolatian 2020a:38).[15]

(17) *Syncope of pre-causative theme vowel*

Base		Causative		
xaɣ	'game'	*xaɣ-a-t͡sən-e-l*	*xaɣ-t͡sən-e-l*	'to make to play'
vax	'fear'	*vax-e-t͡sən-e-l*	*vax-t͡sən-e-l*	'to scare someone'

Regardless of the pre-CAUS vowel, the causative is E-Class and takes the *-e-* theme vowel.

2.2.3 Inchoative is A-Class

Besides passives and causatives, Armenian also has productive inchoativization. which can turn a noun or adjective into an intransitive verb. The inchoative suffix is the segment *-n-*. The inchoative is A-Class and is followed by its own theme vowel *-a-*. It is preceded by another vowel *-a-*.

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[14]Hypothetically, the presence of two overt theme vowels in causatives could be connected to the existence of two events, while passive verbs only have one event and only one overt theme vowel. But this is problematic because Megerdoomian (2005) provides evidence that causatives are semantically a single event (monoclausal).

[15]Impressionistically, most syncopated causatives are derived from non-verbs. This tendency might be due to the fact that the pre-causative vowel for these verbs is the linking vowel *-a-,-e-* and not a theme vowel. In Armenian compounds, the meaningless linking vowel is a common target of diachronic syncope (Ēloyan 1972). Instead, theme vowels carry the function load of exponing the verbalizer in simple verbs

(18)   *Paradigm of inchoative verbs*

	Base		Inchoative	
Noun	*kar*	'rock'	*kar-a-n-a-l*	'to be petrified'
	ənger	'friend'	*ənger-a-n-a-l*	'to become friends'
Adjective	*urax*	'happy'	*urax-a-n-a-l*	'to become happy'
	t͡ʃerm	'warm'	*t͡ʃerm-a-n-a-l*	'to grow warm'

As with causativized nouns and adjectives (§2.2.2), we argue that the pre-INCH vowel is actually the linking vowel *-a-* that is used in compounds. The vowel is an empty morph that is adjoined to the base. In (19), we show the structure of a denominal and deadjectival inchoative. We treat the inchoative as a type of *v*/V marker INCH. It has the A-CLASS feature.
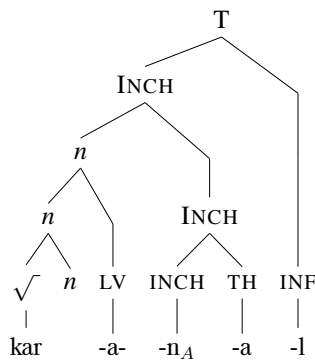
(19)   a. 'to be petrified'   b. 'to be happy'
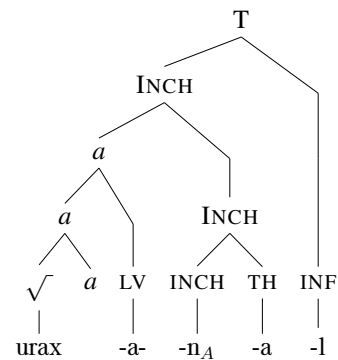
There are some inchoatives where the pre-nasal vowel is idiosyncratically absent or *-e-*. As with causatives, the deletion is because of diachronic syncope. As for *-e-*, this is a rare allomorph of the linking vowel *-a-*. It is used in some compounds: *d͡zaɣg-e-punt͡ʃ* 'flower-bunch (= bouquet)'.

(20)   *Inchoatives without a pre-nasal theme vowel -a-*

Vowel	Base		Inchoative		
-e-	*mod*	'near'	*mod-e-n-a-l*		'to come near'
	mert͡s	'close'	*mert͡s-e-n-a-l*		'to come near'
∅	*ker*	'fat'	*ker-a-n-al*	*ker-n-al*	'to become fat'
	sev	'black'	*sev-a-n-a-l*	*sev-n-a-l*	'to become black'

There are some verbs which idiosyncratically have inchoative morphology, but are transitive. Here, the inchoative meaning of the affix is bleached. Many of these verbs have a syncopated form which is more common in Western Armenian. Most of these verbs lack a free-standing base.

(21)   *Transitive verbs with inchoative morphology*

Without syncope	With syncope		Base
koɣ-a-n-al	*koɣ-n-a-l*	'to rob'	from *koɣ* 'robber'
mor-a-n-a-l	*mor-n-a-l*	'to forget'	
əst-a-n-a-l		'to receive'	

In terms of conjugation, it doesn't matter whether the verb is transitive or intransitive, or whether the pre-INCH vowel is lost or *-e-*. All of these verbs are conjugated the same as typical inchoative verbs of the form $\sqrt{}$*-a-n-a-l*. They all have the A-CLASS diacritic and take the *-a-* theme vowel.[16]

2.3   Local competition in class assignment

So far, we have seen the conjugation classes for simple verbs and complex verbs. Roots can be E-Class, I-Class, or A-Class; the passive is I-Class, the causative is E-Class, and the inchoative is A-Class. We now show how multiple valency-changing affixes affect each other. Cross-linguistically, it is expected that each suffix will cyclically alter the verb's conjugation class (cf. Svenonius 2008). As expected, only the last valency-changing suffix determines the conjugation class of the verb. We show that class-assignment is a computationally local process that obeys strict adjacency.

Among multiply derived verbs, passivized causatives are the most common. These have the morpheme order CAUS-PASS. Their meaning follows the Mirror Principle (Baker 1985).

(22)   *Formation of passivized causatives*

Base	Causative	Passivized Causative
	$\sqrt{}$-TH-CAUS-TH-INF	$\sqrt{}$-TH-CAUS-PASS-TH-INF
jer-a-l	*jer-a-t͡sən-e-l*	*jer-a-t͡s-v-i-l*
'to boil (intr.)'	'to boil (tr.)'	'to be boiled by someone'
sar-i-l	*sar-e-t͡sən-e-l*	*sar-e-t͡s-v-i-l*
'to freeze (intr.)''	'to freeze (tr.)'	'to be frozen by someone'

The causative suffix *-t͡sən-* is replaced by a special reduced allomorph *-t͡s-*. Like the simple passives, passivized causatives belong to the I-Class and have the *-i-* theme vowel. The passive affix deletes the causative's theme vowel, just like it does in simple verbs (§2.2.1).

In contrast, a causativized passive would have the morpheme order PASS-CAUS, whereby the causative scopes over the passive. Such orders are rare, and some argue that they don't exist (Daniel and Khurshudian 2015:491). We've found only one causativized passive from the Eastern

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[16]There are a handful of verbs which have the nasal affix but not the *-a-* theme vowel: *od͡z-a-n-e-l* 'to anoint' and *us-a-n-i-l* 'to learn' . These verbs are conjugated as E-Class and I-Class respectively, with the nasal intact (Boyacioglu 2010:82). The diachronic origin of these *X-a-n-e-l* and *X-a-n-i-l* constructions is disputed (Greppin 1973; Hamp 1975; Kocharov 2019). Synchronically, the nasal affix in these words is meaningless, and arguably part of the stem.

Armenian National Corpus. This verb is causativized as an E-Class just like any other causative. Note that the passive displays high vowel reduction (§2.2.1, cf. Dolatian 2020b).

(23) *Formation of causativized passives*

Base	Passive	Causative of Passive	Causative of E-Class
	$\sqrt{}$-PASS-TH-INF	$\sqrt{}$-PASS-TH-CAUS-TH-INF	$\sqrt{}$-TH-CAUS-TH-INF
kiʒ	*kəʒ-v-i-l*	*kəʒ-v-e-t͡sən-e-l*	*ker-e-t͡sən-n-i-l*
'insane'	'to go mad'	'to make s.o. go mad'	'to make s.o. scratch'

As for inchoatives, it is difficult to find unambiguous cases of interaction with other valence affixes. Most inchoatives are intransitive and thus can't be passivized. As for causativization, an alternative strategy is to apply causativization directly onto the original base of the inchoative.[17]

(24) *Ambiguous causatives derived from roots vs. from inchoatives*

Base	Inchoative	Causative
urax	*urax-a-n-a-l*	*urax-a-t͡sən-e-l*
'happy'	'to become happy'	'to make someone happy'
	$\sqrt{}$-TH-INCH-TH-INF	$\sqrt{}$-TH-CAUS-TH-INF

Synthesizing all this information, it is clear that class assignment is a local process. The theme vowel is selected based on the class features of the adjacent morpheme, whether a root or valency suffix. These valency suffixes can designate a wide range of eventive semantics.

3 Non-local allomorphy in aorist agreement

Here, we discuss the non-local allomorphy of agreement suffixes in the past perfective. We examine the allomorphy in simple verbs (§3.1), and show that it is long-distant over overt morphemes. We then turn to complex verbs, and we show that allomorphy displays relativized adjacency (Toosarvandani 2016) or tier-based locality (Aksënova et al. 2016) (§3.2). We treat the trigger as a privative feature [SECONDARY] based on the split-behavior of inchoatives (§3.3).

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[17]Megerdoomian (2005) assumes that causitivized adjectives are directly derived from inchoatives instead of directly from adjectives. There is no overt morphological evidence for this though. The most unambiguous cases of modified inchoatives are transitive verbs which have inchoative morphology: *əst-a-n-aɰl*. Their formation is complicated by the use of a morphomic aorist; see footnote (9). When passivized, the 'inchoative' nasal is replaced by a morphomic aorist: *əst-a-t͡s-v-i-l*, while the causative deletes the nasal affix entirely: *əst-a-t͡sən-e-l*. They respectively have the same I-Class and E-Class conjugation as any other passive or causative.

3.1 Non-locality over morphemes

The past perfective is often called the preterite, simple past, or aorist form. To form an aorist verb, the aorist suffix -$\widehat{ts}$- is inserted between the theme vowel and T/AGR: *ker-e-$\widehat{ts}$-i*.[18] The different conjugation classes use different T/AGR suffixes. In simple verbs, the E-Class and A-Class use one set of T/AGR suffixes which start with the vowel *-i*: *ker-e-$\widehat{ts}$-i* 'I scratched'. In contrast, I-Class verbs use a different set of T/AGR suffixes which start with the vowel *-a*: *xos-e-$\widehat{ts}$-a*.

(25) *Past perfective or aorist form of simple verbs*

	E-Class	I-Class	A-Class	Template
INF	*ker-e-l*	*xos-i-l*	*gart-a-l*	$\sqrt{}$-TH-INF
	'to scratch'	'to speak'	'to read'	
1SG	*ker-e-$\widehat{ts}$-i*	*xos-e-$\widehat{ts}$-a*	*gart-a-$\widehat{ts}$-i*	$\sqrt{}$-TH-AOR-T/AGR
	'I scratched'	'I spoke'	'I read'	
2SG	*ker-e-$\widehat{ts}$-ir*	*xos-e-$\widehat{ts}$-ar*	*gart-a-$\widehat{ts}$-ir*	
3SG	*ker-e-$\widehat{ts}$-*	*xos-e-$\widehat{ts}$-av*	*gart-a-$\widehat{ts}$*	
1PL	*ker-e-$\widehat{ts}$-ink*	*xos-e-$\widehat{ts}$-ank*	*gart-a-$\widehat{ts}$-ink*	
2PL	*ker-e-$\widehat{ts}$-ik*	*xos-e-$\widehat{ts}$-ak*	*gart-a-$\widehat{ts}$-ik*	
3PL	*ker-e-$\widehat{ts}$-in*	*xos-e-$\widehat{ts}$-an*	*gart-a-$\widehat{ts}$-in*	

We show the tree structure for aorist verbs in (26). The trigger (root) and target (agreement) of this allomorphy are not adjacent. They are separated by the theme vowel and aorist suffix. Because the aorist is the only finite perfective form in Armenian, we treat the aorist as an aspect marker (cf. Donabédian 2016). We gloss it as aorist AOR, but semantically it is a perfective PERF marker.[19]

(26) a. Aorist 1SG of E-Class   b. Aorist 1SG of I-Class   c. Aorist 1SG of A-Class
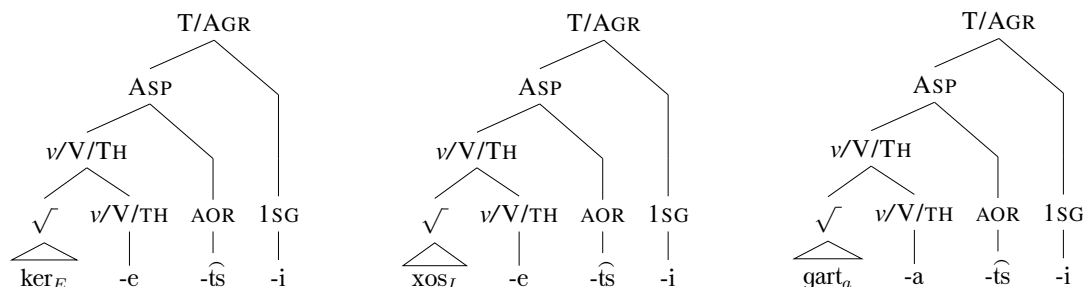
We consider the *i*-initial allomorphs as default aorist agreement or *primary aorist agreement*. The *a*-initial suffixes are marked aorist agreement or *secondary aorist agreement*. To formalize the

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[18]The aorist suffix causes the *-i-* vowel to neutralize to *-e-*. We postpone discussing *i*-neutralization till §4. In Eastern Armenian, I-Class verbs are either E-Class or A-Class verbs: *xos-e-l*. Thus, they do not trigger secondary aorist agreement: *xos-e-$\widehat{ts}$-i*. Secondary agreement is restricted to inchoatives and irregular verbs.

[19]In contrast, there is a past imperfective form *ker-e-i* 'I was speaking' with covert aspect marking (§4.3).

allomorphy, we use a privative morphological feature [SECONDARY]. Simple E-Class and A-Class verbs are unmarked without [SECONDARY], while I-Class verbs are marked with [SECONDARY]. The distribution of this feature is controlled by insertion rules (27). Representationally, this feature is a property of the I-Class feature in a form of feature geometry (cf. Trommer 2008). We assume that only morphemes with class features can undergo this rule.[20] For aorist agreement, it doesn't matter if this feature is privative or binary.

(27) *Insertion rules for the* SECONDARY *feature* (To be revised)
      $\emptyset \rightarrow$ [SECONDARY] / [I-CLASS, _]   (Simple I-Class verbs)

Secondary agreement is triggered by the presence of [SECONDARY] on the closest class-bearing morpheme, while primary agreement is used elsewhere (28). For illustration, we do not decompose aorist agreement affixes any further, But a more economic segmentation is possible (footnote 28).

(28) *Realization rules for past perfective or aorist agreement*
      T[PAST,1SG] $\rightarrow$ *-a* / [αCLASS, SECONDARY] ... ASP[AOR] $\frown$ _
                         -i / [αCLASS] ... ASP[AOR] $\frown$ _ (elsewhere)

      ...
      T[PAST,3PL] $\rightarrow$ *-an* / [αCLASS, SECONDARY] ... ASP[AOR] $\frown$ _
                         -in / [αCLASS] ... ASP[AOR] $\frown$ _ (elsewhere)

The rule in (27) references ASP locally and the class-features non-locally. The aorist suffix licenses the presence of aorist agreement, while the closest class-bearing morpheme determines the actual choice of exponents. In terms of directionality, aorist agreement is inwardly-sensitive and depends on the morphological class-features of a previously spelled out morpheme. Thus, cyclic spell-out cannot erase morphological features (cf. Bobaljik 2000).

Equipollent verbs show further evidence that the allomorphy depends on the class of the root. Recall from section §2.1 that equipollent roots are underspecified for a class feature. Their class is determined based on transitivity. In the aorist form, the transitive E-Class verbs and intransitive I-Class verbs use different T/AGR suffixes based on their class.

(29) *Aorist agreement for equipollent verbs*

	E-Class		I-Class	
INF	*ajr-e-l*	'to burn X'	*ajr-i-l*	'to be burnt'
Aorist 3PL	*ajr-e-t͡s-in*	'they are burning X'	*ajr-**e**-t͡s-an*	'they are being burnt'

Thus, it is clear that aorist agreement does not respect strict adjacency. The trigger and target are separated by at most two morphemes: the theme vowel and aorist suffix. But computationally,

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[20]The rule is incomplete. Some irregular verbs take secondary agreement despite not to being in the I-Class (Plungian 2018), or they display heteroclitic agreement, i.e., primary agreement in some slots but secondary agremenet in others (Stump 2006). We set aside irregular verbs.

strict locality is not the same as strict adjacency. A process is strictly local as long as there is a bound on the distance between the trigger and target. This bound is 2 segments/morphs for aorist agreement. Thus aorist agreement can be computed with a strictly local analysis that uses a window of size 4: the trigger (class-bearer), interveners, and target. Theoretically, this large bounded window would act as a span (Merchant 2015).

However, there are three conceptual problems with using spans. One problem is that most attested cases of strictly local phenomenon use much smaller windows (Chandlee and Heinz 2018). Second, the span conflates two facts about the allomorphy: only the non-adjacent class-bearing morpheme determines the choice of the two allomorphs. The theme vowel does nothing, while the (perfective) aorist suffix simply licenses the use of (perfective) agreement. In a sense, they are thus invisible to the computation. This acts as conceptual evidence for the use of tiers (Jardine 2016a:250; Paster 2019:26), which we argue for in the next section.[21]

3.2 Tier-based locality over morphemes

Simple verbs showed that aorist agreement is a long-distant process which does not show strict adjacency. In this section, we find that allomorphy also violates strict adjacency in complex verbs. However, the allomorphy is triggered by the closest morpheme that has a class marker. We formalize this notion of 'closest' with the use of tiers (Aksënova et al. 2016). Tier-based locality provides a declarative translation for the use of cyclic spell-out or phases in handling long-distance allomorphy (Embick 2010; Choi and Harley 2019). We discuss this issue further in §5.1.

Recall that causatives are formed with the *-tsə̂n* suffix. They are E-Class verbs and take the *-e-* vowel. Just like simple E-Class verbs, causatives trigger primary aorist agreement. The root's class features don't matter. The causative form *always* takes the E-Class suffixes even if the root is I-Class: *xos-e-t͡su-t͡s-i*. In the aorist form, the causative suffix has the allomorph *-t͡su-* instead of *-t͡sə̂n-*. It does not have a theme vowel.[22]

(30) *Aorist form of causative verbs*

	E-Class	I-Class	A-Class	*Template*
Simple INF	*ker-e-l*	*xos-i-l*	*gart-a-l*	√-TH-INF
1SG	*ker-e-t͡s-i*	*xos-e-t͡s-a*	*gart-a-t͡s-i*	√-TH-AOR-INF
Causative INF	*ker-e-t͡sə̂n-e-l*	*xos-e-t͡sə̂n-e-l*	*gart-a-t͡sə̂n-e-l*	√-TH-CAUS-TH-INF
1SG	*ker-e-t͡su-t͡s-i*	*xos-e-t͡su-t͡s-i*	*gart-a-t͡su-t͡s-i*	√-TH-AOR-T/AGR

In contrast for passives, the passive is a suffix *-v-*. It is an I-Class marker and and it takes the

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[21]Alternatively, if the class-bearing morpheme is little *v* instead of the root (Acquaviva 2009), then the locality window has now decreased to 3 overt symbols: *v*/TH, AOR, and T/AGR. The trigger (*v*/TH) and target T/AGR are still non-adjacent, since the intervening AOR is inert with respect to deciding between the two sets of allomorphs

[22]In Eastern Armenian, the causative's past allomorph is *-t͡sr-*. The theme vowel and aorist suffix are optional : *ker-e-t͡sr-e-t͡s-i* vs. *ker-e-t͡sr-i* 'I caused to scratch' (Hagopian 2005:358; Dum-Tragut 2009:208).

-*i*- theme vowel. Just like simple I-Class verbs, passives trigger secondary aorist agreement. The class features of the root do not matter.

(31)   *Comparing passive verbs with active verbs*

	Active E-Class	Passive of E-Class	Active I-Class
INF	*ker-e-l*	*ker-v-i-l*	*xos-i-l*
	$\sqrt{}$-TH-INF	$\sqrt{}$-PASS-TH-INF	$\sqrt{}$-TH-INF
Aorist 1SG	*ker-e-t͡s-i*	*ker-v-**e**-t͡s-a*	*xos-**e**-t͡s-a*
	'to scratch'	'to be scratched; to itch'	'to speak'

Thus in passives and causatives, the allomorphy is determined by the valency affix, not the root. Although aorist agreement is a non-local process, complex verbs show that the allomorphy obeys *tier-based* locality. The agreement morpheme is sensitive to the closest class-bearing morpheme. If that morpheme has the the [SECONDARY] feature, then we have secondary agreement.

We visualize tier-based locality with the use of tier projection. For any verb, a subset of its morpheme are projected onto a tier which we call the AGREEMENT tier. This tier contains the target of allomorphy (aorist agreement) and its triggers. The triggers are all class-bearing morphemes, with or without the [SECONDARY] feature, i.e., roots and valency affixes. By using tiers, we ensure that the form of the agreement allomorph is determined by the 'closest' trigger, though not necessarily an adjacent one. Following work in mathematical morphology and phonology (Heinz et al. 2011), the elements of the tier are stipulated. We first illustrate tier-based locality with the aorist form of simple verbs. We mark the dependencies between triggers and targets via arrows.

(32)   a.   Aorist of E-Class   b.   Aorist of I-Class   c.   Aorist of A-Class

$\text{ker}_E \longrightarrow$ i	$\text{xos}_I \longrightarrow$ a	$\text{gart}_A \longrightarrow$ i
agreement	agreement	agreement
ker_E e t͡s i	xos_I e t͡s a	gart_A a t͡s i
$\sqrt{}$ TH AOR 1SG	$\sqrt{}$ TH AOR 1SG	$\sqrt{}$ TH AOR 1SG
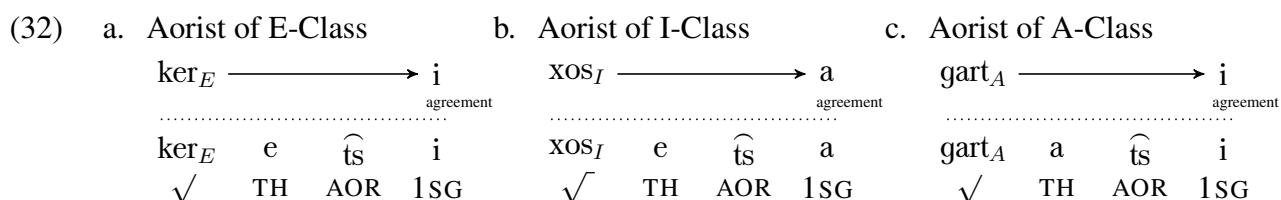
For a simple verb, the trigger and target of allomorphy are not adjacent on the string of morphemes. However, they are adjacent on the AGREEMENT tier. This makes the choice of aorist agreement become tier-based local. Tier-based locality is more visible for complex verbs. For causatives and passives, their exponents have class features so they project to the AGREEMENT tier. They determine the aorist agreement suffix because they are closer than the root. Dashed arrows represent failed dependencies, such as between the root and the agreement.

(33) a. Aorist of Causative (E-Class)   b. Aorist of Passive (I-Class)
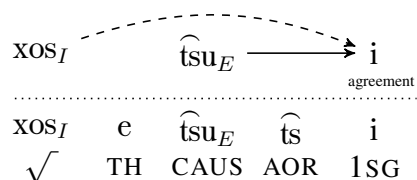
xos$_I$		$\widehat{tsu}_E$	$\longrightarrow$ i			ker$_E$	v$_I$	$\longrightarrow$ a
			agreement					agreement

xos$_I$	e	$\widehat{tsu}_E$	$\widehat{ts}$	i		ker$_E$	v$_I$	e	$\widehat{ts}$	a
$\sqrt{}$	TH	CAUS	AOR	1SG		$\sqrt{}$	PASS	TH	AOR	1SG
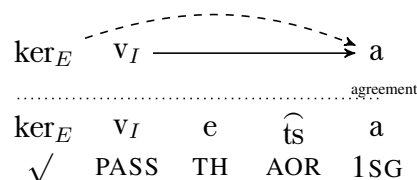
As shown above, the [SECONDARY] feature triggers correct secondary agreement for I-Class verbs. In the case of an E-Class verb that's derived from an I-Class root, secondary agreement is blocked because the closest class-bearing morpheme does not have the [SECONDARY] feature.

Recall that verbs can contain multiple valency suffixes (§2.3). These verbs likewise respect tier-locality. Passivized causatives and causativized passives are inflected like passives and causatives, i.e., agreement depends on the closest class-bearing morpheme.[23]

(34) *Aorist of causativized passive and passivized causative*

a.	Passive	*kəʒ-v-i-l*	$\sqrt{}$-PASS-TH-INF
		'to go mad'	
	Causativized	*kəʒ-v-e-$\widehat{tsə}$n-e-l*	$\sqrt{}$-PASS-TH-CAUS-TH-INF
		'to make s.o. go mad'	
	Aorist 3PL	*kəʒ-v-e-$\widehat{tsu}$-$\widehat{ts}$-in*	$\sqrt{}$PASS-TH-CAUS-AOR-3PL
		'they made s.o. go mad'	
b.	Causative	*jer-a-$\widehat{tsə}$n-e-l*	$\sqrt{}$-TH-CAUS-TH-INF
		'to boil'	
	Passivized	*jer-a-$\widehat{ts}$-v-i-l*	$\sqrt{}$-TH-CAUS-PASS-TH-INF
		'to be boiled by s.o.'	
	Aorist 3PL	*jer-a-$\widehat{ts}$-v-e-$\widehat{ts}$-an*	$\sqrt{}$-TH-CAUS-PASS-TH-AOR-3PL
		'they were boiled by s.o.'	

Below, we visualize the tier-based locality of agreement in these complex verbs. Multiple morphemes compete to select the aorist agreement marker. But only the rightmost morpheme wins.

(35) a. Aorist of passivized causative

jer$_A$		$\widehat{ts}_E$	v$_I$	$\longrightarrow$ an
				agreement

jer$_A$	a	$\widehat{ts}_E$	v$_I$	e	$\widehat{ts}$	an
$\sqrt{}$	TH	CAUS	PASS	TH	AOR	3PL

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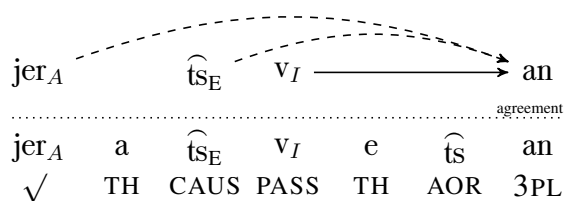
[23]The verbs in (34a) are derived from a noun *kíʒ*. We omit the covert nominalizer between the root and *v*.

b. Aorist of causativized passive

$$kəʒ \quad v_I \quad \overset{\frown}{tsu}_E \quad \longrightarrow \quad in$$

$$\begin{array}{cccccc} kəʒ & v_I & e & \overset{\frown}{tsu}_E & \overset{\frown}{ts} & in \\ \sqrt{} & \text{PASS} & \text{TH} & \text{CAUS} & \text{AOR} & 3\text{PL} \end{array}$$
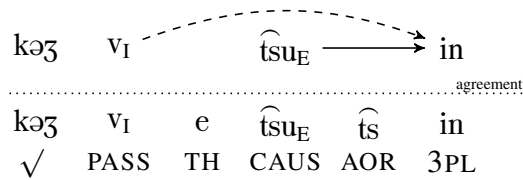
Thus, we have argued that aorist agreement is long-distant over morphemes, but it is local over a tier of relevant morphemes. The relevant morphemes are all verbalized roots or valency-suffixes. In DM terms, these include the phase head *v* (Marantz 2007). Tier-based locality is thus analogous to phase-based locality. However, matters are more complicated with inchoatives.

3.3 Inchoatives: feature decomposition and zero affixes

Inchoative verbs select the *-a-* theme vowel and thus have the A-Class marker. However, inchoative verbs do not select the same primary aorist agreement suffixes that A-Class verbs do: *gart-a-t͡s-i*. Instead, they use secondary agreement suffixes: *urax-a-t͡s-a*. The inchoative suffix *-n* and its theme vowel are deleted. Thus, the aorist form of inchoatives is thus nearly identical to both I-Class verbs (share agreement suffix) and A-Class verbs (share vowels).

(36)   *Aorist formation in inchoative verbs vs. simple A-Class and I-Class verbs*

	I-Class	Inchoative	A-Class
INF	$\sqrt{}$-TH-INF *xos-i-l*	$\sqrt{}$-TH-INCH-TH-INF *urax-a-n-a-l*	$\sqrt{}$-TH-INF *gart-a-l*
Aorist 1SG	$\sqrt{}$-TH-AOR-T/AGR *xos-e-t͡s-a*	$\sqrt{}$-TH-AOR-T/AGR *urax-a-t͡s-a*	$\sqrt{}$-TH-AOR-T/AGR *gart-a-t͡s-i*

We show the tree structure for inchoative infinitvals (37a) and the aorist 1SG (37b). The root is an adjective. The root and inchoative are connected via a linking vowel *-a-*. In the infinitival, the inchoative affix *-n-* and its theme vowel *-a-* surface. But they are covert in the aorist.

(37) a.

b.

```
              T                                        T/AGR
             /\                                        /\
         INCH   \                                  ASP   \
         /\      \                                 /\     \
        a   \     \                            INCH   \    \
       /\    \     \                           /\      \    \
      a  INCH \     \                         a   \     \    \
     /\  /\    \     \                       /\    \     \    \
    √  a LV INCH TH  INF                    a  INCH \     \    \
    |     |   |   |   |                    /\  /\    \     \    \
   urax  -a- -n_A -a  -l                  √  a LV INCH TH  AOR  1SG
                                          |     |   |   |   |    |
                                         urax  -a-         -t͡s  -a
```
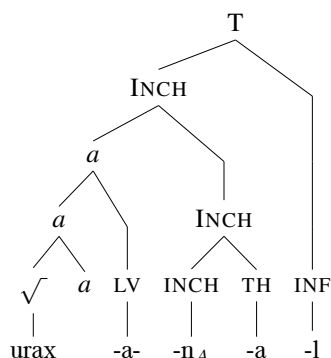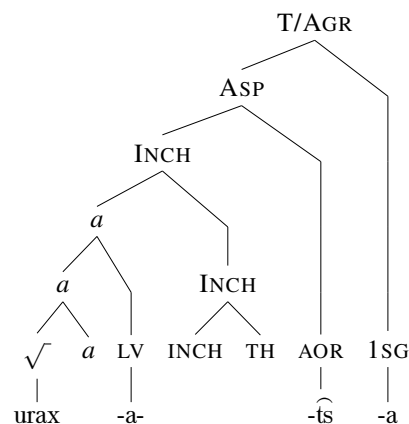
The split behavior of inchoative verbs is evidence for the minute division of morphological features. On the one hand, we have features which select theme vowels: E-CLASS, I-CLASS, and A-CLASS. On the other hand, we have a separate feature for aorist agreement: [SECONDARY]. Causatives and passives are respectively E-Class and I-Class verbs; of these two, only the passive takes [SECONDARY] from the insertion rules in (38), revised from (27). In contrast, inchoatives are A-Class but they exceptionally take [SECONDARY]. Thus our use of [SECONDARY] is a shorthand for the disjunction-based distribution in (38).

(38)   *Insertion rules for the* SECONDARY *feature* (Final)
       ∅ → [SECONDARY]   / [I-CLASS, _]   (I-Class verbs, including passives)
          → [SECONDARY]   / [INCH, _]   (Inchoatives)
          → no insertion / elsewhere   (Simple E-Class and A-Class, causatives)

In terms of aorist agreement, inchoatives verbs likewise show tier-based locality. In their infinitival form, inchoatives take the *-a-* theme vowel (39a). In the aorist, the inchoative is covert but it still triggers the secondary aorist agreement via its [SECONDARY] feature (39b). For our tier-based analysis, this means that covert affixes are able to project onto the tier. This is analogous to how covert affixes in exocentric compounds can block the inheritance of irregular morphology (Kiparsky 1982; Ackema and Neeleman 2004; Steddy 2019; Dolatian 2020c).

(39) a. Inchoative Infinitival   b. Inchoative aorist

```
                                               ∅_A ————————————→ a
                                          ...................................................agreement
   urax   a    n_A → a    l             urax   a    ∅_A    ∅    t͡s    a
    √     LV   INCH   TH  INF             √     LV  INCH   TH   AOR  1SG
```
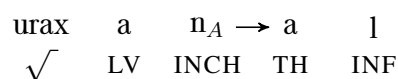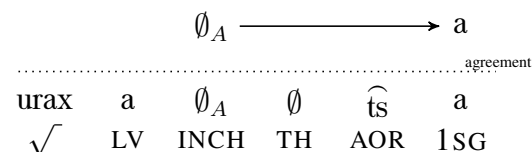
In sum, aorist agreement displays non-local allomorphy which obeys tier-based locality. Tier-locality is displayed across simple, derived, and multiply-derived verbs. The next section discusses the role of *i*-neutralization as an outwardly-sensitive process that also references tiers.

4 Non-locality in theme neutralization

Section §2 showed that choice of theme vowel depended on the immediately preceding class marker. We then showed in §3 that conjugation classes displayed tier-based local allomorphy in aorist agreement. Throughout those sections, we briefly mentioned how the *-i-* theme vowel neutralized to *-e-* in certain contexts. In this section, we discuss *i*-neutralization in depth.

We show that neutralization is not about deleting class-features but it only affects theme vowels (§4.1). As a process, neutralization has two classes of triggers: phonological and morphological. The phonological trigger is if the theme vowel is unstressed (§4.2). The morphological trigger is the presence of the imperfective affix, either inside the word (§4.3) or on an adjacent auxiliary (§4.4). Both phonologically-based and morphologically-based neutralization are specific to the *-i-* theme vowel. They do not affect any other segment or morpheme. Both act as outwardly-sensitive processes. For morphologically-based neutralization, the trigger is long-distant (§4.4). We argue that the trigger and target is tier-based local. But unlike aorist agreement, *i*-neutralization uses a tier defined over the morphological tree based on scope.

4.1 Neutralization is not feature deletion

In many morphological contexts, the three theme vowels stay constant. For example in present tense verbs, the infinitival morph *-l* is replaced a tense/agreement suffix: *ker-e-m* 'I scratch'. This suffix is the same across the three conjugation classes. The present 3SG suffix is a zero morph.[24]

(40) *Present tense for simple verbs*

	E-Class	I-Class	A-Class	*Template*
INF	*ker-e-l*	*xos-i-l*	*gart-a-l*	$\sqrt{}$-TH-T/AGR
	'to scratch'	'to speak'	'to read'	
1SG	*ker-e-m*	*xos-i-m*	*gart-a-m*	
	'I scratch'	'I speak'	'I read'	
2SG	*ker-e-s*	*xos-i-s*	*gart-a-s*	
3SG	*ker-e-*	*xos-i-*	*gart-a-*	
1PL	*ker-e-nk*	*xos-i-nk*	*gart-a-nk*	
2PL	*ker-e-k*	*xos-i-k*	*gart-a-k*	
3PL	*ker-e-n*	*xos-i-n*	*gart-a-n*	

But in certain contexts, the *-i-* theme vowel is neutralized to *-e-*. Two such constructions are causative formation and aorist formation. The replaced theme vowel is in **bold**. This neutralization applies for all I-Class verbs, including simple verbs and passive verbs. For contrast, we show A-Class and E-Class verbs which never change their theme vowel.

---

[24]These verbs are interpreted as present subjunctive. To make them indicative, the prefix *g(ə)-* is added. See Bezrukov and Dolatian (2020) on the morphotactics of the indicative prefix across Western dialects.

(41)   *i-neutralization in aorists and causatives*

	E-Class	I-Class verb	A-Class
Base verb	*ker-e-l*	*xos-i-l*	*gart-a-l*
	'to scratch'	'to speak'	'to read'
Aorist 1SG	*ker-e-t͡s-i*	*xos-**e**-t͡s-a*	*gart-a-t͡s-i*
	'I scratched'	'I spoke'	'I read'
Causative	*ker-e-t͡sən-e-l*	*xos-**e**-t͡sən-e-l*	*gart-a-t͡sən-e-l*
	'to make s.o. scratch'	'to make s.o. speak'	'to make s.o. read'

It is not the case that the causative suffix or aorist suffix change the class features of the root. This is clearer for the aorist of I-Class roots: *xos-**e**-t͡s-a*. As an I-Class root, the root has the [SECONDARY] feature which triggers secondary aorist agreement. In contrast, aorist E-Class roots trigger primary aorist agreement: *ker-e-t͡s-i*. If *i*-neutralization deleted the I-CLASS feature, we would incorrectly predict that I-Class verbs take primary aorist agreement: **xos-**e**-t͡s-i*.[25]

Thus, regardless of the trigger of *i*-neutralization, the result is simply changing the exponent of the theme vowel. There are no changes in the class-features of morphemes.

4.2   Phonologically-based neutralization

In the previous section, we showed that *i*-neutralization applies in causative and aorist verbs. In this section, we argue that for a range of contexts, the trigger of neutralization is not any specific morpheme. Instead, the trigger is phonological. There is a morpheme-specific rule which changes the unstressed theme vowel -*i*- to -*e*-. The evidence is the disparate contexts for neutralization.

Armenian has final-stress. Stress is placed last vowel if it is a full vowel; otherwise if the last vowel is a schwa, then stress is placed on the penultimate full vowel.

(42) a. i. badasxán   'answer'   b. i. ker-é-l   'to scratch'
          ii. badasxan-óv   'answer-INST'   ii. xos-i-l   'to speak'
          iii. badasxán-ə   'answer-DEF'   iii. gart-á-l   'to read'

In simple verbs, the theme vowel is often the rightmost full vowel in the word. It is stressed in infinitvals and present tense verbs. However, in causatives and aorists, the theme vowel is not the rightmost vowel and it is unstressed. In these contexts, we have *i*-neutralization.

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[25]If *i*-neutralization deleted the class-features of the root, it would not be able to trigger the the correct secondary aorist agreement. In bottom-up spell-out (Bobaljik 2000), the theme vowel must be inserted before the aorist. Once the AOR morpheme is inserted, it would form the context for *i*-neutralization and delete class features. These deleted features would be missing by the time the T/AGR is spelled out, preventing the choice of secondary aorist agreement.

(43)   *i-neutralization and stress*

	E-Class	I-Class verb	A-Class
INF	*ker-é-l*	*xos-í-l*	*gart-á-l*
	'to scratch'	'to speak'	'to read'
Present 1SG	*ker-é-m*	*xos-í-m*	*gart-á-m*
Aorist 1SG	*ker-e-t͡s-í*	*xos-e-t͡s-á*	*gart-a-t͡s-í*
Causative	*ker-e-t͡sən-é-l*	*xos-e-t͡sən-é-l*	*gart-a-t͡sən-é-l*
	'to make s.o. scratch'	'to make s.o. speak'	'to make s.o. read'

We formalize this change with the morpheme-specific rule in (44) which changes the unstressed theme vowel *-i-* to *-e-*. We argue that theme vowel selection operates in three informal stages (45). First, the theme vowel is spelled-out by the morphology. Later, the phonology places stress on the rightmost full vowel. After this, the *i*-neutralization rule applies.[26]

(44)   *i-neutralization rule from stress shift*

$\text{-}i\text{-}_{\text{TH}} \quad \rightarrow \quad \text{-}e\text{-}_{\text{TH}} \quad / \quad [\_, \text{-STRESS}]$

(45)   *Stages for application of phonologically-based i-neutralization*

	'to speak'	'I spoke'
Input	XOS-TH-INF	XOS-TH-AOR-1SG
Morphology	xos-i-l	xos-i-t͡s-a
Phonology (Stress)	xos-í-l	xos-i-t͡s-á
Morpheme-specific phonology		xos-**e**-t͡s-á

The use of a late morpheme-specific rule is relatively unconventional (cf. Aronoff 1976), but it is necessary. The rule in (44) must be morpheme specific because it does not apply to any other unstressed *i* segments in Armenian (46a). Furthermore, Armenian has a process of destressed high vowel reduction whereby destresesd high vowels are either deleted or reduced to a schwa (46b) (Dolatian 2020b). This reduction process has no synchronic connection to *i*-neutralization. The unstressed theme vowel is never replaced by a schwa or deleted under stress shift (46c).

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[26]The final two stages can be conflated into a single phonology stage that uses parallelist constraints with morpheme-specific indexed-constraints (Pater 2007). As an alternative to morpheme-specific processes, we can postpone theme-vowel selection to after the phonology has applied, i.e., morphology and phonology apply in parallel (McCarthy and Prince 1993). But this has conceptual and empirical problems (Paster 2006; Yu 2007; Embick 2010; Kalin 2020). Another alternative is to treat the underlying form of the *-i-* theme vowel as the set of allomorphs {*-i-*,*-e-*} (cf. Bermúdez-Otero 2013). The *-e-* vowel is picked because of a low-ranking constraint against unstressed high vowels. A separate PRIORITY constraint is needed to ensure that *-i-* is prioritized over *-e-* so that *-i-* surfaces when it is stressed (cf. Mascaró 2007). This makes Armenian a case of phonologically-conditioned outwardly-sensitive allomorphy, with the condition between output prosody

(46) a. *mǝxitár*   'comforter'   *nihár*   'thin'
          **mǝxitár*   **nhar*
      b. *amusín*   'husband'   *tív*   'number'
          amusn-utjún   'marriage'   *tǝv-agán*   'date'
      c. *xos-i-l*   'to speak'
          *xos-**e**-t͡s-a*   'I spoke'   **xos-t͡s-a-, *xos-ǝ-t͡s-a-*

Further evidence for the role of stress comes from other morphological constructions which trigger *i*-neutralization. Like any other free-standing word, infinitivals can take derivational suffixes or form compounds. Compounds are formed by concatenating stems with the linking vowel *-a-*. Both derivation and compounding trigger stress shift. The theme vowels *-e-, -a-* stay intact, while the *-i-* vowel is neutralized to *-e-*: *nǝst-**e**-l-ík*.

(47) *i-neutralization in words derived from infinitivals*

	Derivatives		Compounds	
E-Class verbs	*kǝm-é-l*	'to drink'	*kord͡z-é-l + gérb*	'to work + manner'
	kǝm-e-l-ík	'beverage'	*kord͡z-e-l-a-gérb*	'tactic'
I-Class verbs	*nǝst-í-l*	'to sit'	*abr-í-l + t͡sév*	'to live + manner'
	nǝst-e-l-ík	'sittable'	*abr-e-l-a-t͡sév*	'lifestyle'
A-Class verbs	*xǝnt-á-l*	'to laugh'	*ǝsk-á-l + bés*	'to feel + manner'
	xǝnt-a-l-ík	'funny'	*ǝsk-a-l-a-bés*	'sensibly'

Besides stress, an alternative analysis is to argue that neutralization applies when the theme vowel is not the rightmost vowel. This is false. There are contexts where there are vowels after theme vowel, but the theme vowel keeps stress and is not neutralized. For example, infinitivals can be nominalized by adding nominal inflection. These suffixes are determiner suffixes and case markers. The determiner suffixes include the definite and possessive suffixes (48a). These contain a schwa after C-final bases. They don't trigger stress shift or *i*-neutralization: *xos-í-l-ǝ*. In contrast, the case markers have full vowels, trigger stress shift, and trigger *i*-neutralization: *xos-**e**-l-óv* (48b).

(48) *i-neutralization in nominalized infinitivals*

		E-Class	I-Class	A-Class
	Infinitival	*ker-é-l*	*xos-í-l*	*gart-á-l*
a.	Definite	*ker-é-l-ǝ*	*xos-í-l-ǝ*	*gart-á-l-ǝ*
		'the act of scratching'	'the act of speaking'	'the act of reading'
	1SG Possessive	*ker-é-l-ǝs*	*xos-í-l-ǝs*	*gart-á-l-ǝs*
	2SG Possessive	*ker-é-l-ǝt*	*xos-í-l-ǝt*	*gart-á-l-ǝt*
b.	Instrumental	*ker-e-l-óv*	*xos-**e**-l-óv*	*gart-a-l-óv*
	Ablative	*ker-e-l-é*	*xos-**e**-l-é*	*gart-a-l-é*
	Dative/Genitive	*ker-e-l-ú*	*xos-**e**-l-ú*	*gart-a-l-ú*

Furthermore, it is not the case that the mere presence of these morphological constructions causes neutralization. In contrast, these constructions have to trigger stress shift in order to then

apply neutralization. For example, in (47), we showed that when an infinitival undergoes compounding, it will lose stress and undergo neutralization. However, it is not the mere presence of compounding which triggers neutralization. When a compound is a noun or adjective, it can get verbalized by adding a theme vowel: *her-a-t͡sajn-é-l.* In general, compound verbs follow the E-Class. When these verbs are passivized, they become I-Class verbs and take the *-i-* theme vowel: *her-a-t͡sajnə-v-í-l.* The theme vowel is not neutralized to *-e-* despite the presence of compounding.[27] Neutralization is blocked because the theme vowel is stressed.

(49)   *Blocking i-neutralization in verbalized compounds*

N + N	*heru + t͡sajn*	'far + voice'	*tas + gark*	'class + order'
N-a-N	*her-a-t͡sajn*	'telephone'	*tas-a-gark*	'class, category'
N-a-N-TH-INF	*her-a-t͡sajn-e-l*	'to telephone'	*tas-a-gark-e-l*	'to classify'
N-a-N-PASS-TH-INF	*her-a-t͡sajnə-v-i-l*	'to be telephoned'	*tas-a-garkə-v-i-l*	'to be classified'
	**her-a-t͡sajnə-v-e-l*		**tas-a-garkə-v-e-l*	

Thus, we have 5 constructions which trigger neutralization: causatives, aorists, derivation, compounding, and case-marking. The common factor across all these constructions is that they trigger stress shift away from the theme vowel. Thus, the morpheme-specific process of neutralization must apply after the phonology places final stress.

If we were to analyze these factors in terms of the morphology, then there wouldn't be a clear and simple trigger for neutralization. We would have to argue that all derivational suffixes and compounding constructions would have some arbitrary morphological feature that triggered neutralization (cf. similar problems in Harley and Tubino Blanco 2013). Furthermore, in most of these constructions, the theme vowel is preceded by the infinitival suffix which is then preceded by additional material. Because the infinitival suffix forms free-standing words, we assume that it acts as a cyclic boundary or phase boundary. Thus, a morphological analysis for these neutralization contexts would require that neutralization ignore cyclic boundaries. This is problematic for theories of allomorphy which argue that cyclic boundaries block allomorphy (Bobaljik 2012), with some possibility of laxer restrictions (Embick 2010; Moskal 2015a)

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[27]The behavior of compounds is complicated by exocentricity and feature percolation. Consider the I-Class root *xos* (a). There are many exocentric compounds where the second stem is the root of a verb (c). When these exocentric compounds are verbalized, they take the *-e-* theme vowel (d). The second stem does not percolate its class features, and is unable to select the *-i-* theme vowel (e). This is unsurprising because exocentric compounds tend to block the prevention of morphological features (Stump 1995, 2001). See Dolatian (2020c) for data on how exocentric compounds behave differently in irregular inflection and other bracketing paradoxes.

(1)   a.   *xos-i-l*   'to speak'
      b.   *heru + xos-*   'far + $\sqrt{\text{speak}}$'
      c.   *her-a-xos*   'telephone'
      d.   *her-a-xos-e-l* 'to telephone'
      e.   **her-a-xos-i-l*

4.3 Morphologically-based neutralization in imperfectives

In the previous section, we went through a large set of contexts which trigger *i*-neutralization. We argued that the trigger for neutralization was a morpheme-specific phonological rule that targeted the unstressed *-i-* theme vowel. In this section and the following, we go through two contexts where *i*-neutralization applies without any stress shift: imperfectives and negated imperfectives. We argue that the trigger for neutralization in these contexts is not phonological or morpheme-specific phonology. Instead, the trigger is morphological. The trigger is the imperfective morpheme which can be either after the theme vowel or on an adjacent auxiliary.

The first construction we go over is the past imperfective, also just called the imperfective. The imperfective is formed by replacing the final T/AGR slot with one of the following suffixes: *-i, -ir, -r, -ink, -ik, in.* These suffixes are the same across conjugation classes: *ker-e-i* '(If) I were to scratch'. Except for the 3SG, these suffixes are vowel initial; vowel hiatus is repaired by glide *j*-epenthesis (not shown).[28] The imperfective affix is underlined whenever it triggers neutralization.[29]

(50) *Imperfective of simple verbs*

	E-Class	I-Class	A-Class
INF	*ker-é-l*	*xos-í-l*	*gart-á-l*
1SG	*ker-é-i*	*xos-**é**-<u>i</u>*	*gart-á-i*
2SG	*ker-é-ir*	*xos-**é**-<u>ir</u>*	*gart-á-ir*
3SG	*ker-é-r*	*xos-**é**-<u>r</u>*	*gart-á-r*
1PL	*ker-é-ink*	*xos-**é**-<u>ink</u>*	*gart-á-ink*
2PL	*ker-é-ik*	*xos-**é**-<u>ik</u>*	*gart-á-ik*
3PL	*ker-é-in*	*xos-**é**-<u>in</u>*	*gart-á-in*

These suffixes idiosyncratically trigger *i*-neutralization. Crucially, they idiosyncratically do *not* trigger stress shift.[30] Thus in the I-Class, stress stays on the theme vowel even though the theme vowel is neutralized to *-e-*. Furthermore, we can't argue that neutralization is caused by the dissimilation of the theme vowel *-i-* before *i*-initial T/Agr suffixes (*xos-í-i). This is because the imperfective 3SG suffix is *-r* but it still triggers neutralization: *xos-é-r*. It is possible that, diachronically, dissimilation was the trigger and that neutralization spread via analogy (cf. with Optimal Paradigms, McCarthy 2005b). But synchronically, imperfectives *idiosyncratically* trigger neutralization without any phonological motivation. In this context, we formalize neutralization with the following rule.

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[28]The imperfective and aorist use the same agreement markers except for the 3SG. Fairbanks (1948:72) decomposes the past imperfective marking into a past marker *-i-* and a number marker. The two affixes fuse into a portmanteau *-r* in the 3SG. This analysis is plausible because the 1PL, 2PL, and 3PL suffixes use the same final substring of segments *-nk, -k, -n* across all tenses. This decomposition would fit well with an analysis that uses separate T and AGR morphemes. We leave out a finer decomposition to future work.

[29]As with present tense verbs (24), past imperfectives are subjunctive; they become indicative with the prefix *g(ə)-*.

[30]In the Lebanese sub-dialect of Standard Western Armenian, the imperfective suffixes don't trigger stress shift. But in the Istanbul sub-dialect of Standard Western Armenian, they do trigger stress shift (Tabita Toparlak, p.c.). These suffixes likewise trigger stress shift in Standard Eastern Armenian (Margaryan 1997:77).

(51)   *i-neutralization for imperfectives* (To be revised)
       $-i_{\text{TH}}$ $\rightarrow$ $-e_{\text{TH}}$ /   _ IMPF

The rule says that the theme vowel *-i-* is replaced by *-e-* before the imperfective affix. This rule can apply in the Morphology component either a) after theme-vowels are selected, or b) in parallel with theme-vowel selection. We are ultimately agnostic about the choice of timing; for illustration, we assume neutralization applies after theme-selection. We discuss the computaitonal consequences of this choice in §5.3. The above rule requires that the theme vowel and imperfective are adjacent, but we later revise this rule to incorporate long-distance triggers in the next section.

4.4   Tier-based locality in morphological neutralization

The previous showed that imperfectives trigger neutralization, such that target theme vowel and the trigger imperfective suffix are adjacent. In this section, we discuss long-distant neutralization in the negated imperfective. The directionality of neutralization is over morphological scope, not linear order. We translate these conditions into a tier-based analysis.

Present and imperfective verbs are negated in a complicated manner.[31] The verb uses a participle form, the *negative participle*, that does not bear any T/Agr markers. The T/AGR slot is replaced by a suffix *-r*. Negation, tense, and agreement are marked periphrastically by adding a negated copula before the verb: *t͡ʃ-e-m ker-e-r* 'I do not scratch'. The copula carries all T/Agr marking.[32]

(52)   *Negated present tense of simple verbs*

	E-Class		I-Class		A-Class	
INF		*ker-e-l*		*xos-i-l*		*gart-a-l*
1SG	*t͡ʃ-e-m*	*ker-e-r*	*t͡ʃ-e-m*	*xos-i-r*	*t͡ʃ-e-m*	*gart-a-r*
2SG	*t͡ʃ-e-s*	*ker-e-r*	*t͡ʃ-e-s*	*xos-i-r*	*t͡ʃ-e-s*	*gart-a-r*
3SG	*t͡ʃ-i*	*ker-e-r*	*t͡ʃ-i*	*xos-i-r*	*t͡ʃ-i*	*gart-a-r*
1PL	*t͡ʃ-e-nk*	*ker-e-r*	*t͡ʃ-e-nk*	*xos-i-r*	*t͡ʃ-e-nk*	*gart-a-r*
2PL	*t͡ʃ-e-k*	*ker-e-r*	*t͡ʃ-e-k*	*xos-i-r*	*t͡ʃ-e-k*	*gart-a-r*
3PL	*t͡ʃ-e-n*	*ker-e-r*	*t͡ʃ-e-n*	*xos-i-r*	*t͡ʃ-e-n*	*gart-a-r*
Template:	NEG-COP-T/AGR	$\sqrt{}$-TH-PTCP				

For the negated present tense, the verb takes the suffix *-r* without any *i*-neutralization. But for the negated imperfective, the I-Class undergoes *i*-neutralization: *t͡ʃ-e-i xos-**e**-r* 'I wasn't speaking'. The trigger for neutralization is thus the T/AGR morpheme, not phonology. The segmental environment of the *i* theme vowel is the same between the negated present (52) and negated imperfective (53). The underlined imperfective is linearly before the root and theme vowel.

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[31]Negated aorists simply involve adding the prefix *t͡ʃ(ə)-* before the verb: *t͡ʃə-ker-e-t͡s-i* 'I didn't scratch'.

[32]For 3SG, the negated copula uses a portmanteau: *t͡ʃ-i*. In Eastern Armenian, the negative participle suffix is zero for the A-Class, but *-i* for E-Class without a theme vowel: *t͡ʃ-e-m gart-a*, *t͡ʃ-e-m ker-i* (Dum-Tragut 2009:200).

(53) *Long-distance neutralization in the negated imperfective of simple verbs*

	E-Class		I-Class		A-Class	
INF		*ker-e-l*		*xos-i-l*		*gart-a-l*
NEG PRES 1SG	*t͡ʃ-e-i*	*ker-e-r*	*t͡ʃ-e-i̱*	*xos-**e**-r*	*t͡ʃ-e-i*	*gart-a-r*
NEG PRES 2SG	*t͡ʃ-e-ir*	*ker-e-r*	*t͡ʃ-e-i̱r*	*xos-**e**-r*	*t͡ʃ-e-ir*	*gart-a-r*
NEG PRES 3SG	*t͡ʃ-e-r*	*ker-e-r*	*t͡ʃ-e-ṟ*	*xos-**e**-r*	*t͡ʃ-e-r*	*gart-a-r*
NEG PRES 1PL	*t͡ʃ-e-ink*	*ker-e-r*	*t͡ʃ-e-i̱nk*	*xos-**e**-r*	*t͡ʃ-e-ink*	*gart-a-r*
NEG PRES 2PL	*t͡ʃ-e-ik*	*ker-e-r*	*t͡ʃ-e-i̱k*	*xos-**e**-r*	*t͡ʃ-e-ik*	*gart-a-r*
NEG PRES 3PL	*t͡ʃ-e-in*	*ker-e-r*	*t͡ʃ-e-i̱n*	*xos-**e**-r*	*t͡ʃ-e-in*	*gart-a-r*
Template:	NEG-COP-T/AGR $\sqrt{}$-TH-PTCP					

In the above paradigm, the theme vowel and underlined neutralizer are linearly separated by only one morpheme, the root. However, passives and causativized passives show that there is no limit on how many morphemes or segments can separate the neutralizer and theme vowel. Passive verbs undergo *i*-neutralization in the same contexts as simple I-Class verbs.

(54) *Long-distance neutralization in the negated imperfective of passives*

	Active E-Class		Active Causative		Active I-Class	
Active INF		*ker-e-l*		*jer-a-t͡sən-e-l*		*xos-i-l*
Passive INF		*ker-v-i-l*		*jer-a-t͡s-v-i-l*		*xos-v-i-l*
NEG IMPF 3PL	*t͡ʃ-e-i̱n*	*ker-v-**e**-r*	*t͡ʃ-e-i̱n*	*jer-a-t͡s-v-**e**-r*	*t͡ʃ-e-i̱n*	*xos-v-**e**-r*

Thus, the trigger for neutralization is the imperfective affix, whether inside the verb or an adjacent auxiliary. Linearly, the imperfective morpheme can either follow the theme vowel (in imperfectives) or precede it (in negated imperfectives). Structurally, these two environments are unified in terms of morphological scope. In both imperfectives and negated imperfectives, the imperfective suffix has scope over the theme vowel.
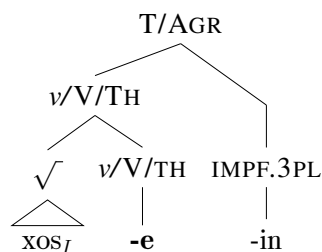
(55) a. *Imperfective*   b. *Negated imperfective*
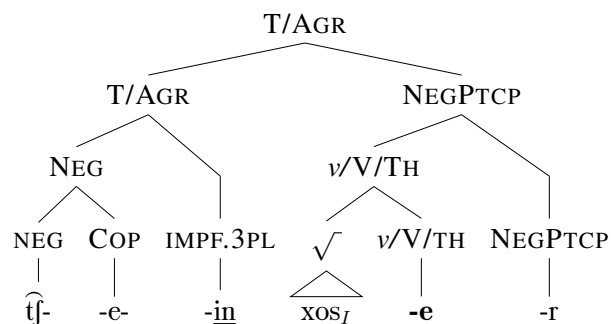
We argue that the imperfective affix triggers neutralization because it scopes over the theme vowel. Linear order does not matter.

(56) *i-neutralization for imperfectives* (Final)
       $-i\text{-}_{\text{TH}}$ $\rightarrow$ $-e\text{-}_{\text{TH}}$ / $[\ldots \_ \ldots]$ IMPF *or* IMPF $[\ldots \_ \ldots]$

We capture this long-distance dependency via a separate tier. Just as aorist agreement references the AGREEMENT TIER, morphological neutralization targets the IMPERFECTIVE tier. The tier is projected from the morphological tree based on scope. The tier contains only theme vowels and the imperfective. We show the projected tier in (57) for the imperfective and negated imperfective. Over this tier, the theme vowel and imperfective affix are adjacent.

(57) a. *Tier for imperfective*   b. *Tier for negated imperfective*
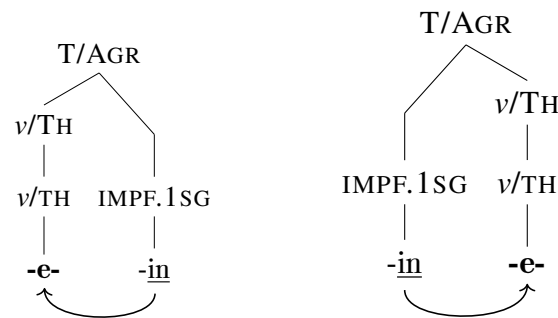
Further evidence for long-distance comes from coordination. Two example I-Class verbs are *xos-i-l* and *barg-i-l* (58a). When coordinated with the conjunction *gam* 'or', both verbs have their own T/Agr marking in the past imperfective (58b). Both likewise show *i*-neutralization. The verbs use the indicative prefix *gə-* to mark mood in the positive. When negated, the negated auxiliary takes all T/Agr marking (58c). It appears before the first verb. The second verb still undergoes *i*-neutralization, and the imperfective trigger is substantially far from the target theme vowel.[33]

(58) a. xos-i-l,   barg-i-l
          speak-TH-L sleep-TH-L
          'To speak, to learn'
      b. jerp vor urax e-ir,   gə-xos-**e**-i̠r   gam gə-barg-**e**-i̠r
          when that happy was-2,   I-speak-TH-2 or   I-sleep-TH-2
          'When you were happy, you were speaking or sleeping'
      c. jerp vor neɣvadz͡ e-ir,   t͡ʃ-e-i̠r xos-**e**-r   gam sorv-**e**-r
          when that upset   was-2, N-C-2 speak-TH-NP or   sleep-TH-NP
          'When you were upset, you weren't speaking or sleeping?'

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[33]The gloss is abbreviated with I (indicative), N (negation), C (copula), 2 (past 2SG), NP (negative participle). Curiously, if the negated auxiliary is repeated before the second verb, the interpretation is more of an exclusive-or interpretation. Furthermore, the negated auxiliary must be repeated for the conjunction *jev* 'and'. These effects are likely due to interaction between the semantics of negation and conjunction. Our gratitude to Sabine Laszakovits, Nazila Shafiei, and Mai Ha Vu for elicitations, and to Nikita Bezrukov and Tabita Toparlak for refinement.

To sum up, neutralization has two classes of triggers: phonological and morphological. The phonological triggers involve a morpheme-specific phonological rule which changes unstressed theme vowel *-i-* to *-e-*. This rule applies after stress is assigned. The morphological triggers require that the imperfective affix replaces the *-i-* theme vowel *-e-*. The dependence between the theme vowel and imperfective is captured via tier-based locality over the morphological tree.

5 Computational aspects of Armenian morphology

Armenian conjugation classes participate in three types of allomorphy: the choice of theme vowel, the choice of aorist agreement, and the application of *i*-neutralization. We established multiple descriptive generalizations on which morphemes can trigger which type of allomorphy. The main takeaway from this paper is the different processes show different directionality and locality constraints. We summarize these factors below.

(59) *Summary of conditioning factors for allomorphy*

	Theme-selection	**Aorist agreement**	***i*-neutralization**	
			Phonologically-based	Morphologically-based
Target :	Theme vowel	Perfective agreement	*-i-* theme vowel	*-i-* theme vowel
Trigger:	Roots and valency affixes (= class-bearing morphemes)		Lack of stress	Imperfective morpheme
Locality:	Strictly adjacent Strictly local	Not strictly adjacent Tier-based local	N/A	Long-distance over linear order Tier-based local over tree
Direction:	Trigger is inward	Trigger is inward	N/A	Trigger is outward

Among these types of allomorphy, phonologically-based *i*-neutralization is difficult to categorize in terms of locality and directionality. The trigger is the absence of stress on the theme vowel itself; this suggests a locality window of size 1 (just the theme vowel). However, stress is assigned on the rightmost full vowel; thus stress assignment necessarily has a larger locality window.

In this section, we discus our data in the light of different theoretical and computational issues issues. The first issue is the role of locality in morphology, and the need for tiers in Armenian (§5.1). The second issue is about the computation of tiers (§5.2). The third issue is about the computational consequences of combining multiple allomorphy rules into a single rule. For all of these issues, we synthesize work in computational and theoretical morphology in order to provide a larger foundation for the use of tiers in morphology.[34]

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[34]We briefly discuss a fourth issue. In this paper, we chose to model conjugation classes by using morphological features for different classes. An alternative is to lexically store each root with its theme vowel, e.g., *ker-e-*. This analysis uses *stem storage* (Bermúdez-Otero 2013). In order to model how different conjugation classes behave, we would utilize redundancy rules across the paradigm. We did not use this alternative for two reasons. First, it is unclear to us if stem storage makes any different predictions for Armenian. Second, it is unclear to use if a stem-storage analysis would still display tier-based locality. Computationally, a stem-storage analysis would require more enhanced machinery in order to reference multiple cells in a paradigm, such as a relational database (Blevins 2006:570), a

5.1   Locality, tiers, and phases

There is a wide range of work that argues that morphologically-conditioned allomorphy obeys strict adjacency (Siegel 1974; Allen 1979). The need for adjacency can manifest in terms of linear adjacency (Ostrove 2018, 2020), structural adjacency (Gribanova 2015), or cyclic locality (Embick 2003, 2010). Local conditioning can operate over concatenative or non-concatenative morphology (Arad 2003; Embick 2013; Kastner 2019). Locality can be used as a diagnostic to distinguish different types of morphological or phonological processes Embick and Shwayder (2018). Computationally, this means that most allomorphy obeys strict locality in terms of finite-state calculus (Chandlee 2014, 2017) or quantifier-free logic in terms of formal logic (Dolatian 2020a).

In Armenian, class assignment is local, however class-based allomorphy is not. The conjugation classes displayed two types of allomorphy which are long-distant. Although not local over morphemes, we argued that these long-distance dependencies show tier-based locality. The use of tiers is common in phonological theory, especially in autosegmental representations (Goldsmith 1976; McCarthy 1981). There is however little use of tiers in contemporary morphological theory. Strictly-separated morpheme-level tiers were proposed in McCarthy (1981), but were soon found to be problematic (Ussishkin 2011).

For the Armenian data, we utilize *multiple* tiers, each responsible for a different type of long-distance dependency. These were the AGREEMENT tier and the IMPERFECTIVE tier. These tiers are not identical. We summarize their elements below. The AGREEMENT tier handles aorist agreement, and it includes class-bearing roots, valency suffixes, and agreement. The IMPERFECTIVE tier contains only the theme vowels and imperfective morpheme.

(60)   *Elements of the tiers for Armenian allomorphy*

		AGREEMENT tier	IMPERFECTIVE tier
Main triggers	roots with class-markers	✓	
	valency-affixes	✓	
	imperfective		✓
Main targets	theme vowels		✓
	aorist agreement	✓	

We argue that the use of tiers formalizes multiple separate strands of work in morphological theory: relativized adjacency, root-outwards search, structural adjacency, and phase-based locality.[35]

The closest analogue to tier-based locality is Toosarvandani (2016)'s model of 'relivized adjacency' for Northern Paiute. In Northern Paiute, verbs show suppletion based on the number feature

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unification-based system (Calder 1989), an inheritance-based system (Corbett and Fraser 1993), or recurrent neural network (Malouf 2017). But for any of these options, it's unclear if they can directly capture the tier-based locality.

[35] Another possible analog is feature percolation (Lieber 1989) whereby the features of the root can percolate up the morphological tree in order to license long-distance dependencies. Computationally though, feature percolation has been a difficult phenomenon to explicitly formalize (Ritchie et al. 1992:ch4), see Dolatian (2020a:303) for discussion.

of the closest noun, whether it is is an object, subject, or applicative (cf. with more stringent lo-
cality requirements in similar languages Bobaljik and Harley 2017; Harley et al. 2017; Duncan
2019).[36] Crucially, intervening adverbs are ignored. In our tier-based formalization, the tier for
suppletion-computation includes all nouns but excludes adverbs.

The second analogue is root-outwards search (Choi and Harley 2019). In Korean, there are
two root suppletion patterns in verbs: one based on negation, the other on honorifics. When the
verb contains both types of triggers, only the structurally closest trigger will trigger allomorphy.
For Korean, this is the honorific. Choi and Harley (2019) analyze the data and argue for a model
of spell-out which is bottom-up, such that the root will supplete by searching for the structurally
closest allomorphy trigger. In our tier-based analysis, Korean suppletion simply uses a tier made
up of the root, honorific, and negation. The root suppletes based on the tier-local trigger. Japanese
shows virtually the same set of suppletion patterns (Oseki and Tagawa 2019). The main difference
is that Japanese has tier-based competition among 3 sets of triggers: object honorific, potential,
and subject honorific (in that order).

The third analog is Structural Adjacency (Gribanova 2015). It is cross-linguistically common to
have a morphological construction where the trigger X and target Z of allomorphy are not linearly
adjacent, but separated by adjoined material Y: $[[X\ Y]_X\ Z]_Z$. In terms of tree structure, Y is
adjoined to X; this means that X's projection $[X\ Y]_X$ is still adjacent to Z. Computationally, this
tier-based locality such that the tier consists of all elements except for adjoined material.

The fourth analogue is phase-based locality. In Distributed Morphology, it is commonly argued
that derivational suffixes are category nodes (little *n, a, v*) and that they constitute phases (Newell
2008; Embick 2010, 2015; Samuels 2011, 2012). These phase nodes block any allomorphy pro-
cesses which operate across them. That is, a morpheme cannot undergo allomorphy if its trigger is
found across a phase node. Computationally, we argue that phase nodes are present on all morpho-
logical tiers. By being present on tiers, they can intervene and block any allomorphy process. This
is what we found in Armenian aorist agreement. The agreement suffix showed suppletion based
on the closest class-bearing morpheme. These morphemes all arguably constitute phases as little *v*
nodes (causative, passive, inchoative) and as a verbalized roots ($\sqrt{} \frown v$ constructions).[37] [38]

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[36]Though see Thornton (2019) who re-analyzes these data as due to syntactic agreement affecting an word-internal
number morpheme. In this reanalysis, the ultimate trigger of allomorphy is still long-distant, but it is analyzed as tier-
local *syntactic* agreement. The relevant properties of the word-external trigger is then recapitulated into a word-internal
morpheme which then locally triggers the suppletion.

[37]If we assume that class features are part of little *v* instead of roots (Acquaviva 2009), then the phase-tier would
consist of only *v* nodes.

[38]We are the first to propose an *explicit* connection between phases and tier-based locality. Some argue that phases
are "universal intereveners' to every possible process (Abels 2003). They are interveners because they carry all possi-
ble features. In formal terms, this amounts to saying that phase morphemes are present on all possible tiers. We thank
Omer Preminger for bringing this into our attention.

5.2   Computation of tiers

Although tiers are an uncommon instrument in morphological theory, they are widespread in computational and mathematical morphology. In this section, we go over the literature on tier-based computation in order to connect our theoretical work with the existing mathematical work.

Computationally, one model tier-based analyses is the use of tier-based subclasses of regular langauges and functions, i.e., the **Tier-based Strictly Local** grammars (TSL, Heinz et al. 2011). Tier-based computational models have wide empirical coverage across multiple modules. As with theoretical phonology, tier-based computational models have been used for long-distance phonological processes, such as consonant harmony (McMullin 2016; McMullin and Hansson 2016), vowel harmony (Aksënova and Deshmukh 2018; Mayer and Major 2018; Andersson et al. 2020), and stress (Hao and Andersson 2019). There is some work within the realms of computational morphology (Aksënova et al. 2016), semantics (Graf 2019), and syntax (Vu 2018, 2019; Vu et al. 2019; Graf and Shafiei 2019). There are many extensions to tier-based models, based on the need to handle locality domains and blockers over phonological (Graf 2017; Graf and Mayer 2018; De Santo 2018; De Santo and Graf 2019; Karakaş 2020), prosodic (Baek 2018; Hao 2020), and morphological structure (Aksënova and De Santo 2019; Moradi et al. 2019). Besides descriptive adequacy, these tier-based models are likewise learnable (Jardine 2016b; Jardine and Heinz 2016; Jardine and McMullin 2017; McMullin and Hansson 2019; Burness and McMullin 2019; Lambert and Rogers 2020). Importantly, tier-based models are implementable (Aksënova 2020).

For Armenian, we modeled long-distance allomorphy by using *multiple* tiers: one for aorist agreement and one for morphologically-based *i*-neutralization. The AGREEMENT tier can be projected from either the string of morphemes or from the morphological tree. In contrast, the IMPER-FECTIVE tier must be projected from the morphological tree. Computational representations with multiple tiers have been proposed in the past for various harmony patterns, i.e., **Multi-TSL** grammars. These grammars are designed for languages with multiple harmony patterns, such as with both vowel and consonant harmony or with two types of vowel harmony (Aksënova and De Santo 2019). Typologically, most multiple-harmony patterns can be modeled with MTSL grammars that have restrictions on the relationship between the multiple tiers. The multiple tiers tend to either fall into a strict subset-superset relationship or they are mutually exclusive. This restriction is the basis for learning algorithms of MTSL langauges (McMullin and Hansson 2019). Laxer restrictions are needed to learn MTSL functions (Burness and McMullin 2020). For Armenian, the AGREEMENT and IMPERFECTIVE tiers are mutually exclusive, and are thus learnable.

In sum, our use of tiers is relatively novel in theoretical morphology. However, it is a well-formalized practice in computaitonal morphology. Our analysis of Armenian thus has a strong computaitonal and mathematical foundation.

5.3   Locality of combining multiple rules

In §4.3-4.4, we treated the rules for theme-vowel selection and morphologically-based *i*-neutralization as separate. In this section, we discuss what would happen if the rules were combined. Briefly put, it would have some problems in locality and learnability. But these problems are mitigated by the fact that the class-marker is always adjacent to the theme vowel. The same problems and potential solutions are relevant to computing either over a string or tree.

If the rules for theme-vowel selection and morphologically-based *i*-neutralization were combined, then the IMPERFECTIVE tier would be responsible for both processes. The tier would include all class-bearing morphemes. It would be more appropriately called the THEME tier. But because of unification, the AGREEMENT and THEME tiers would now be overlapping but not identical. They would not show a strict subset-superset relationship. This is typologically uncommon in phonology (Aksënova and Deshmukh 2018). Some learning algorithms cannot work on langauges with overlapping tiers (McMullin et al. 2019). However, The assigning class-marker is always adjacent to the theme vowel, so this could lower the complexity for a potential learning algorithm. Furthermore, to learn tier-based functions, Burness and McMullin (2020) require the laxer restriction that only the *targets* of the allomorphy are sensitive to different tiers. This would be the case for Armenian: theme vowels are sensitive to the THEME tier, while agreement is sensitive to the AGREEMENT tier.

Furthermore, by unifying *i*-neutralization and theme-vowel selection, the interaction between class-markers and the imperfective would lead to multiple factors triggering the choice of theme vowel (cf. rules with enriched contexts, Merchant 2015; Moskal and Smith 2016). Over a linear string for positive imperfectives, this interaction is local because the class marker and imperfective are adjacent to the theme vowel.

In contrast, for a negated imperfective, the computation cannot be local over the linear string because there is no limit on the distance between the negated auxiliary (which bears the imperfective marker) and the theme vowel. This long-distance dependency is computationally interesting. Over strings, non-local dependencies can cause a blowup in network size in finite-state models. In fact, prefix-suffix dependencies are a common issue when claiming that morphology is computationally local (Bjorkman and Dunbar 2016; Aksënova and De Santo 2019) or even finite-state definable (Langendoen 1981; Carden 1983; Hammond 1993; Oseki 2018; Oseki et al. 2019). This is because such dependencies can create structures that resemble center-embedding; see Dolatian (2020a:301ff) for discussion. In this paper, we analyzed this dependency by using tiers over strings (AGREEMENT tier) and tiers over trees (IMPERFECTIVE or THEME tier). An open question is exploring the computational consequences of using multiple tiers for allomorphy and prefix-suffix dependencies.

6   Conclusion

Western Armenian verbal morphology shows several dependencies that are relevant to models of locality in morphological allomorphy. We discussed three patterns: class-assignment, aorist agreement, and *i*-neutralization. Of these 3 processes, only class-assignment is a fully local process that respects strict adjacency. The other two display long-distant morphologically-triggered allomorphy. These processes instead display tier-based locality. Tier-based locality is a computational property (Aksënova et al. 2016). It is an alternative formalization for phase-based locality.

For aorist agreement, the target of allomorphy is subject agreement in the past perfective. The trigger of allomorphy is the closest root or valency affix. The target and trigger are not adjacent. The agreement pattern is sensitive to the class features of the trigger. This feature must be part of the long-distant root or valency suffix, and not on any closer morpheme. For *i*-neutralization, a theme vowel *-i-* is replaced with the theme vowel *-e-* in a disparate set of morphological and phonological environments. Crucially, the morphological triggers of i-neutralization are not local to the theme vowel. They are not local linearly, structurally, nor based on span-adjacency.

These patterns are not amenable to an account of locality which is defined by morpheme position (either linearly or structurally). However, we propose that these patterns do indeed obey locality in a tier-based framework. Using separate tiers for distinct features allows us to retain local interaction among the trigger and target of allomorphy. We believe that a tier-based framework is likely able extendable to other complex morphological patterns in Western Armenian. We suspect that tiers are also able to account for apparent cases of non-local morphologically-conditioned allomorphy in other languages.

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