A novel argument for cyclicity from the (non-)transparency of infixes at morpheme junctures: Bottoms up!

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Abstract

Infixation is characterized by the intrusion of one morphological element inside of another, and so infixes are by their very nature disruptors of LOCALITY, which will be the focus of this paper. Canonical examples of infixes involve an *intra*morphemic position for the infix, in particular, with the infix appearing inside of a root, e.g., *k<ni>akri* 'act of crying' (root *kakri*, nominalizer *-ni-*; Leti, Blevins 1999). But, since infixes are generally positioned relative to a phonological "pivot" (see, e.g., Yu 2007), and since infixes should in principle be able to—and indeed do!—combine with multimorphemic stems, infixes can sometimes, incidentally, appear inside of an affix or even at a morpheme juncture, *inter*morphemically. In this paper, I ask: When an infix (incidentally) appears between two morphemes in its stem, does the infix disrupt relations at/across that morpheme juncture that we otherwise would expect to be strictly local? To answer this question, I investigate the cross-context transparency vs. non-transparency of 7 infixes (from 6 languages; 5 language families) that can appear at a morpheme juncture. I find that these infixes never interrupt semantic, morphosyntactic, allomorphic, or morphophonological interactions/relationships in their stems, but *do* disrupt (late/surface) phonological interactions/relationships in their stems. These findings shed significant light on the derivational timing (or representational levels) of different grammatical relationships/interactions and constitute a strong novel argument for the bottom-up cyclicity of both exponence (choice and insertion of an exponent) and morphophonology.

1 Introduction

Locality plays a fundamental role throughout the grammar, constraining everything from syntactic selection to phonological assimilation. But sometimes, relationships and interactions that are otherwise strictly local survive in apparently non-local configurations. A classic example comes from the domain of idioms—the survival of the idiomatic meaning of *the shit hit the fan* in (1a) is taken to diagnose a raising environment (*the shit* originates as the embedded subject, local to the rest of the idiom), as opposed to the failure of the idiomatic interpretation in (1b), a control environment (*the shit* originates as the matrix subject, non-local to the rest of the idiom).[1]

(1) a. [The shit]$_i$ continued t_i to hit the fan. (idiom survives)
b. #[The shit]$_i$ decided PRO$_i$ to hit the fan. (idiom fails)

As in (1a), the survival of a local relationship or interaction in an apparently non-local configuration is a useful diagnostic tool, indicating that the local relationship holds at some relevant earlier derivational point or at some relevant level of representation.

Infixes are affixes that, by their nature, disrupt locality. In canonical cases, what they disrupt is the linear integrity of another morph(eme), taking two parts of an exponent that are nearly always local to each other and pushing them apart. Consider the nominalizing infix -*ni*- in Leti (Blevins 1999)—in (2), we can see the infix pushing apart the (independently meaningless) phonological substrings *k* and *akri* of the root *kakri* (Blevins 1999:386):[2]

(2) <**ni**> (NMLZ) + kakri (cry) → k<**ni**>akri 'act of crying'

The location of an infix in a string can be described with respect to a phonological or prosodic PIVOT (Ultan 1975, Moravcsik 2000, Yu 2007, *i.a.*). In Leti, the nominalizing infix -*ni*- always precedes the first vowel of its stem (Blevins 1999). Other common pivots include the first consonant of the infix's stem, the last vowel of the stem, and the last syllable of the stem (Yu 2007:67).

For most linguists, the word "infix" conjures up the type of case seen in Leti in (2), where an infix is properly contained within (i.e., flanked by substrings of) a root. However, given the phonological/prosodic nature of infix placement, it should come as no surprise that an infix—when combining with a complex (multimorphemic) stem—can appear within an affix or even at a juncture between morphemes in its stem, simply by virtue of its pivot happening to be there. This is true in Leti, too: when a root bearing the reciprocal prefix *va*- is nominalized, the infix shows up inside this prefix (Blevins 1999:400):

(3) <**ni**> (NMLZ) + va-kini (RECP-kiss) → v<**ni**>a-kini ('reciprocal kissing')

The nominalizer -*ni*- appears before the first vowel of its stem, whether that vowel is found in a root, (2), or an affix, (3); the infix is totally oblivious to the morphological structure in its stem, caring only about the phonological string.

Along similar lines, consider the Palauan past tense infix, -*il*-, which appears after the first segment of its stem. In (4a), the infix combines with a simplex stem, just a root, and appears inside that root; in (4b), the infix combines with a complex stem consisting of a

[1]On locality and idioms, see, e.g., Chafe 1970, Bach 1974, Chomsky 1995, O'Grady 1998.
[2]As is conventional, I enclose infixes in angled brackets.

prefixal "verb marker" and the root, and the infix appears *between* the prefix and the root (Flora 1974:74):[3]

(4) a. <**il**> (PST) + dasaʔ (carve) → d<**il**>asaʔ 'carved (past part.)'
 b. <**il**> (PST) + m-dasaʔ (VM-carve) → m-<**il**>dasaʔ 'carved (past mid.)'

The intermorphemic location of *-il-* in (4b) is entirely incidental: *-il-* appears after the first segment of its stem (a phonologically-defined location) without regard to morphological boundaries; *-il-* therefore appears inside a root when the stem is just the root, but intermorphemically when the stem includes a prefix consisting of a single segment.

In this paper, I investigate issues of LOCALITY in conjunction with Palauan-like cases of infixation, where a language furnishes the right conditions for a canonical infix to (occasionally) appear between morphemes in its stem. I ask: when an infix surfaces (incidentally) at a morpheme juncture in its stem, does the infix disrupt relations at/across that juncture that we otherwise expect to be strictly local? I bring 7 infixes from 5 language families to bear on this question, and I will show that the answer sheds significant light on the derivational timing of different grammatical relationships/interactions as well as on the timing and nature of infixation. In a nutshell, the findings constitute a strong novel argument for the bottom-up cyclicity of both exponence (choice and insertion of an exponent) and (morpho)phonology.

1.1 Roadmap and an overview of the findings

The paper will start in §2 with some background, including a brief discussion of infixation and an introduction to the data set I'll be drawing on.

In §3, I survey different cross-morpheme relationships and interactions, on a cline from more syntactic/semantic to more phonological:

(5) a. Semantic relationships (§3.1)
 b. Morphosyntactic relationships (§3.2)
 c. Allomorphic (suppletive) relationships (§3.3)
 d. Morphophonological interactions (§3.4)
 e. Phonological interactions (§3.5)

For each type of relationship/interaction, I'll examine what happens when an infix intrudes (linearly) in such a relationship in its stem—does the relationship survive, or not? In brief, the core finding is that the intrusion of an infix only disrupts some phonological interactions in its stem (namely, regular word-level phonology), and never disrupts morphophonological, allomorphic, morphosyntactic, or semantic relationships/interactions in its stem. This result is thoroughly unsurprising in some cases, e.g., the survival of idiom interpretation across an infix (see §3.1), and very notable for others, e.g., the survival of phonologically-conditioned suppletive allomorphy across an infix (see §3.3).

[3] It is Embick (2010:104-107) who first brought the theoretical significance of this Palauan case study to light. I will return to it at length in §2.3.

The paper turns in §3 to the theoretical implications of these findings. I argue that the findings support a model where the syntax precedes (and thus feeds) morphology, à la Distributed Morphology and other post-syntactic approaches to exponence; further, exponents (morphs) are chosen/inserted starting from the bottom of the (morpho)syntactic structure and proceeding upwards (Bobaljik 2000, Embick 2010, Myler 2017, *i.a.*), with at least some (morpho)phonology interleaved along the way (Chomsky and Halle 1968, Kiparsky 1982, Wolf 2008, Bermudez-Otero 2012, Inkelas 2014, *i.a.*). I also argue along the way that the findings pose a serious challenge to theories of exponence that take the morphemes within a phase/domain to all be exponed simultaneously (e.g., Prince and Smolensky 1993, Mester 1994, Mascaró 2007, Svenonius 2012, Rolle 2018) and to non-/pre-syntactic theories of morphology in general (e.g., Anderson 1992, Wunderlich 1996, Stump 2001, 2016, Müller 2021).

2 Background: Defining infixation and identifying case studies

As a working definition of infixation, I adapt the formulation of Blevins 2014:

(6) A definition of infixation: Under infixation a bound [exponent] whose phonological form consists minimally of a single segment is preceded and followed in at least some word-types by non-null segmental strings which together constitute a relevant form-meaning correspondence of their own, despite their non-sequential phonological realization.

What this definition says is that an infix is a morph that (i) is minimally the size of a complete segment, (ii) is bound (affixal), and (iii) can interrupt another morphological constituent, be that a root, as in (2) and (4a), or a larger stem, as in (3) and (4b).

Another core property of infixes, mentioned in the introduction (but not included in Blevins' definition above), is that the location of an infix in a string can be described as preceding or following a particular phonological or prosodic pivot (e.g., C, V, syllable, foot). For example, two common infix placements are "before the first vowel" and "before the final syllable" (Yu 2007). For my purposes, to be sure I'm identifying truly uncontroversial, canonical cases of infixation, I will therefore take two additional aspects of infixes to be definitional: (i) the ability to appear *inside* a root (which is compatible with (6), but not strictly required by it), and (ii) a placement that can be described phonologically or prosodically.

The focus in this paper is on a very particular subcase of infixation, namely, cases where an infix incidentally lands *between* morphemes in its stem. It is important to make completely clear that I am not talking about hypothetical infixes that *seek out* an intermorphemic position; I am also not talking about infixes that *always* have an intermorphemic position. Rather, the infixes I am investigating are run-of-the-mill infixes, conforming to all the criteria laid out above. What is special about the infixation cases at hand here is just that a number of happy coincidences within a language bring about the right conditions for an infix to be able to combine with a complex stem, and land incidentally at a morpheme juncture. Palauan in (4) exemplifies a case like this.

I have found 7 morphs that (i) are infixes according to the definition in (6), (ii) have classic infixal distributions (phonologically or prosodically defined; can appear inside roots), and (iii) *also* can appear between morphemes in their stems under the right morphological/phonological circumstances. The 7 corresponding abstract morphemes (which have these infixal realizations) are listed in Table 1 by language and family.

Table 1: Language sample

Family	**Language**	**Morpheme(s)**	**Source(s)**
Austroasiatic	Katu	NOM	Costello 1998
	Nancowry	CAUS, INOM	Radhakrishnan 1981, Kalin 2023
Austronesian	Palauan	PST	Josephs 1975, Embick 2010
Movima (isolate)	Movima	IRR	Haude 2006
Niger-Congo	Eton	G-FORM	Van de Velde 2008
Northeast Caucasian	Hunzib	VPL	van den Berg 1995, Kalin 2022b

Although the paper will draw primarily from the case studies listed above, there are 3 further potentially relevant case studies that I have come across and excluded from the sample. The first excluded case study is that of the past tense morpheme in Turoyo (Kalin 2020). Past tense marking in Turoyo is realized in a variable position that can be described mainly phonologically; it also shows up between morphemes, making it a potential candidate for inclusion. But, as noted by Kalin (2020:165-166), the positioning of the tense marker is sensitive to morphological boundaries as well as phonological factors, and it never surfaces inside a root. It therefore is not a canonical infix according to the strict inclusion criteria I am using.

The second excluded case study is the well-known case of Cibemba applicative causatives (Hyman 1994), where the applicative morpheme intrudes (counter-scopally) between the causative morpheme and the root. This case study is famous for displaying cyclic phonological effects, since the intruding applicative morpheme surprisingly does *not* disrupt a particular (morpho)phonological interaction between the causative and the root. Although this has been analyzed by some as involving infixation (see e.g. Orgun 1996, Yu 2007), the applicative never appears within a root, nor does it have a phonological/prosodic pivot that is driving its intrusion.

The final excluded case study is that of so-called expletive infixation in English, e.g., as seen in *uni<fucking>versity*. Simplifying somewhat, these expletives have a prosodic placement, preceding the foot bearing main stress in their stem (for discussion, see e.g. Siegel 1974, Aronoff 1976, McCawley 1978, McCarthy 1982). And, these expletives can indeed appear intermorphemically, e.g., *in<fucking>edible*. The reason for their exclusion here is that the expletives that can be "infixed" are free (not bound) and are often morphologically complex; this—along with several other unusual properties, like a requirement for many

English speakers that they both follow *and* precede a stressed syllable—means they do not fit my definition of a canonical infix.

Although I largely put these 3 case studies aside, I will return to them occasionally below, as they actually do still conform to the larger findings about locality that are supported by the 7 case studies of canonical infixes (see Table 1). This suggests that the criteria I have laid out for identifying infixes are perhaps too stringent, or, that infixation belongs to a larger morphological phenomenon that can subsume all of these cases.

3 When does(n't) an infix disrupt local relationships?

In this section, I survey different types of cross-morpheme relationships/interactions, and consider what happens when an infix intrudes between morphemes in its stem that have this type of relationship/interaction. For each type of relationship/interaction, I give a few representative examples to illustrate the findings, and I consider the immediate implications. The headings anticipate the overall findings of each subsection, which—putting it all together—are that all local relationships/interactions except word-level phonology survive infixation, i.e., persist across an intruding infix.

3.1 Semantic relationships (in the stem of an infix) survive infixation

Semantic interpretation—both compositional and idiomatic—is well-known to be sensitive to interruption. Consider, for example, the contrast between (7a) and (7b).

(7) a. un-re-lock
b. re-un-lock

The relative closeness of *re-* and *un-* to the root determines which semantically composes with the root first—in (7a), *re-* has the closest relationship with the root, and so the meaning 'relock' is part of the overall meaning of the word (*un-* + 'relock'); but, 'relock' is *not* a part of the meaning of the word in (7b), since *un-* intervenes between *re-* and *lock* (the meaning is instead *re-* + 'unlock').

Along similar lines, intervention in a word-level idiom destroys idiomaticity:

(8) Idiom: unearth (≈ 'discover')
a. re-un-earth (idiomatic reading possible)
b. #un-re-earth (idiomatic reading impossible)

The word in (8a) can have the meaning 'discover again', as *un-* and *earth* are immediately local. In (8b), the 'discover' reading is impossible, and instead this can only mean something like 'take something out of the earth after having put it back in the earth again'. In the usual type of case, then, exemplified by (7) and (8), interpretation is sensitive to constituency and thus is highly interruptible.

What happens to semantic composition when the element intruding within a constituent is an infix? The case study that I will focus on in this section is the irrealis morpheme in Movima, and the core finding is that semantic interpretation of the stem of an infix is *not* interrupted by the infix, whether that interpretation is compositional or idiomatic.

Movima, a language isolate of Bolivia, is a highly synthetic language with a rich variety of morphology (Haude 2006; henceforth H06). The irrealis morpheme (H06:§3.6.2) is realized infixally and has a prosodically-defined position that frequently lines up (incidentally) with a morpheme juncture. This case study will feature centrally throughout the paper, and so I will lay out the core properties of the irrealis morpheme here before turning back to the main question at hand.

The irrealis morpheme in Movima can combine with a verb, (9a-b), or a predicate nominal, (9c), and conveys irrealis mood or existential negation. Note that with predicate nominals the irrealis is *always* interpreted as existential negation, like in (9c), regardless of the overt presence of the negative morpheme *kas* (H06:112,439-440).[4]

(9) a. sal<**a'**>mo ∅
<IRR>return 1SG
'I'll be back.' (H06:438)

b. kas loy dej<**a'**>-na =∅
NEG INTENT <IRR>cook-TRANS =1SG
'I won't cook anything.' (H06:439)

c. (kas) en<**a'**>ferme:ra
NEG <IRR>nurse
'There is no nurse.' (H06:80)

The irrealis morpheme can be realized inside a root, (9a,c), or (incidentally) between morphemes, (9b).

In terms of its placement, the infix appears after the first iambic foot of its stem, i.e., after an initial foot consisting of a single heavy syllable, (10a) (as well as all the examples in (9)), after an initial foot with two light syllables, (10b), or after an initial foot with a light syllable followed by a heavy syllable, (10c); I use a period to indicate the boundary after the first foot in the stems in (10).[5]

(10) a. IRR + sal.mo (return) → sal<**a'**>mo (H06:438)

b. IRR + aro.so (rice) → aro<**ka'**>so (H06:80)

[4]When glossing infixes, in order to make it clear that the infix is displaced, I put the infix's gloss at the edge of the stem it is combining with—at the left edge of its stem if the infix's position is defined from the beginning of the stem (e.g., after the first foot), and at the right edge of its stem if the infix's position is defined from the end of the stem (e.g., after the final consonant). Note that my gloss-placement convention means that in cases of an intermorphemic infix, like in (9b), the gloss is not found at the juncture where the infix is, but rather still at the stem edge.

[5]Placement of the infix is often opaque, as the stem undergoes footing and (in the case of predicate nominals) penultimate lengthening prior to infixation, both of which may be obscured after post-infixation processes of (re-)footing and vowel shortening. The implications of this will be briefly discussed in §4.2.1.

c. IRR + tivij.-ni (pain-PRC) → tivij<**a’**>-ni (H06:79)

Post-consonantally, the infix has the form *-a’-*, as in (10a,c) (as well as all the examples in (9)), and post-vocalically, it has the form *-ka’-*, as in (10b).[6]

The irrealis infix can combine with many different types of complex stems, and is frequently found at a juncture between morphemes in its post-first-foot location. For example—relevant to this section—the infix may intervene between members of a compound. For a compositionally-interpreted compound, like that in (11a), it's clear from (11b) that the interpretation of the compound remains intact when the infix intrudes (H06:81).

(11) a. bilaw-chi:-ya
fish-excrements-POSS
‘fish excrements’
b. bilaw<**a’**>-chi:-ya
<IRR>fish-excrements-POSS
‘there are no fish excrements’

If the infix were to semantically (and not just linearly) intrude in the compound, we might expect (11b) to have a meaning something like ‘there are excrements of no fish’, where the negative existential meaning scopes over just one member of the compound. Instead, we find the irrealis clearly scoping over the whole compound.

The interpretation of a compound that is idiomatic equally survives the intrusion of the irrealis infix. The example in (12a) shows a compound that consists of the verb ‘work at’ and the noun ‘utensils’, producing the regular way to express the verb meaning ‘work’ in Movima. This idiomatic interpretation, ‘work,’ persists when the compound combines with the irrealis morpheme, (12b).

(12) a. tij-ka:rim
work.at-utensils
‘work’ (verb) (H06:351)
b. kas tij<**a’**>-ka:rim
NEG <IRR>work.at-utensils
‘nobody is working/at work’ (H06:439)

If the infix were to semantically (and not just linearly) intrude in the compound, we would expect the idiomatic meaning to be lost, like in (8b), but it is not.

The survival of semantic interpretation (idiomatic and compositional) in the stem of infixation is consistent throughout the sample of infixes in this study, and will be evident in many of the examples in the remainder of the paper. Importantly, this finding holds true not just for intruding inflectional morphemes like the irrealis in Movima (above), but also for intruding derivational morphemes, as will be seen e.g. in Nancowry and Hunzib below.

[6] The two forms *-ka’-* and *-a’-* are arguably derived from a single underlying form, *-a’-*; the appearance of the initial consonant serves to avoid vowel hiatus, and exemplifies a larger pattern of vowel-initial affixes taking an initial consonant (usually *k*) when following a vowel (H06:39).

The core implication of the finding in this section is that infixes, even when appearing intermorphemically, are not semantically interpreted in their phonological location; rather, they are interpreted as *external* to their stem. As noted in the introduction, this particular result is not very surprising (after all, there's a reason we call them infixes!), but it is still an important part of the full picture that I will build.

3.2 Morphosyntactic relationships (in the stem of an infix) survive infixation

In the usual case, morphosyntactic relationships of selection and compatibility are highly local and sensitive to interruption. With respect to compatibility, consider the comparative suffix *-er* in English, which is picky, combining only with certain adjectives.[7] One such compatible adjective is *simple*, (13a). If, however, *simple* is embedded in a more morphologically complex adjective, like *simplified*, then the *-er* suffix is no longer compatible, (13b).

(13) a. simpler
b. *simplifieder (cf. ✓more simplified)

Another compatible adjective is *green*, (14a), and again, acceptability of *-er* is lost across an intervening adjectival suffix, *-ish*, (14b).

(14) a. greener
b. *greenisher (cf. ✓more greenish)

The point being made here is that when other morphemes intervene between *-er* and a root that is compatible with *-er*, this compatibility is voided.

A similar point can be made with respect to category selection, which requires morphosyntactic adjacency. Take a word like *falsifiable*, which contains two suffixes, *-ify* (which selects for an adjective and derives a verb) and *-able* (which selects for a verb and derives an adjective). Both suffixes satisfy their selectional needs under adjacency, (15a)—*-ify* under adjacency with its adjectival stem *false*, and *-able* under adjacency with its verbal stem *falsify*. The important (though also banal) observation here is that the suffix *-able* cannot appear between *false* and *-ify* (**false-able-ify*) as this would both disrupt the selectional relationship between *-ify* and *false* and fail to satisfy *-able*'s selectional restrictions. Morphosyntactic selection and compatibility require locality.

[7]Note that while it is true that *-er* generally combines with mono- or disyllabic adjectives, this is neither a necessary nor sufficient condition for predicting its compatibility with a given adjective, cf. the ungrammatical **iller* or **pinker*, but the grammatical *unhappier*. See discussion in Bobaljik 2012:Ch. 5.5.

Charles Yang points out (p.c.) that *-er* sometimes seems to "select for" complex stems like *lucky*. A quick perusal of adjectives derived with *-y* suggests (by my intuition) that all are compatible with *-er*, even infrequent ones, e.g., *soapy/soapier, milky/milkier*, and novel ones, e.g., *carroty/carrotier*. I would therefore suggest that the compatibility of these derived adjectives with *-er* stems from *-er*'s compatibility with suffix *-y*, rather than with the complex form as a whole.

The question I'll now pose is as follows: what happens when the relevant local morphosyntactic relationship is in the stem of an infix, and it's the infix that appears between the morphemes that are a part of that relationship? The answer is that—just as with semantic interpretation (§3.1)—morphosyntactic relationships are unaffected by an intruding infix.

Let's return to Movima, before considering examples from other languages. Recall from §3.1 that in Movima the irrealis morpheme has an infixal realization, *-(k)a'-*, which appears after the first (iambic) foot of its stem. I'll focus on two examples of the irrealis intruding, linearly, between morphemes in its stem that stand in a relevant sort of relationship. First there is the multiple event (MLT) suffix *-ka*, which *only* combines directly with roots (H06:78), e.g., as it does in (15a). (In this example, MID is a middle voice morpheme that is realized as infixing reduplication before the final syllable of the stem (H06:§8.3.3), and *ba* 'round' is a classifier indicating the shape of an internal argument (H06:§9.2.6).) The example in (15b) shows that the irrealis can surface between MLT *-ka* and the root, without inducing ungrammaticality.

(15) a. sul-ka-<ba:>ba
entangle-MLT-round<MID>
'be all entangled' (H06:153)
b. ɬok<**a'**>-ka-<ba:>ba
fall<IRR>-MLT-round<MID>
'may fall down (by themselves)' (H06:79)

In fact, the irrealis infix is the *only* morpheme that can appear in an intervening position between MLT and a root; in all other cases, MLT *must* be immediately local to the root.

This same persistence of compatibility/selection can be seen across the irrealis infix in "process verbalizations" in Movima, where the derivational suffix *-ni* (PRC) takes a noun and derives a process verb (H06:109), as seen in (16a). Importantly, PRC *only* combines with nouns, never with verbs. Nevertheless, the irrealis infix can in fact intervene between PRC and the noun it selects, (16b).

(16) a. jo'me:-ni
bird-PRC
'turn into a bird' (H06:493)
b. kas tivij<**a'**>-ni
NEG pain<IRR>-PRC
'Nothing hurts.' (H06:440)

Both the MLT and PRC suffixes, (15)-(16), are picky in different ways, and both are able to satisfy their selectional/compatibility requirements across an intervening irrealis infix. This, in turn, shows that selection/compatibility is established *prior* to the intrusion of the infix, or at a level of representation where the infix does not intervene.

Another morphosyntactic process that survives infixation in Movima is object incorporation. Movima has a productive process where a transitive verb "incorporates a nominal element that would represent [the internal argument] if occurring outside the verb" (H06:§7.7). This process is illustrated in (17) (H06:368), where the bolded internal argument in (17a) is incorporated into the verb in (17b).

(17) a. wul-na =n **kis** **sani:ya**
sow-TRANS =2ERG ART.PL melon
'You sow melon.'
b. ij wul-a-**sani:ya**
2ABS sow-TRANS-melon
'You sow melon.'

Object incorporation is undisturbed when the irrealis infix intervenes between the incorporating object and the verb (H06:79):

(18) a. iń jiɨ-a:-pa
1ABS grate-TRANS-manioc
'I grate manioc.'
b. iń jiɨ-a<**ka'**>-pa
1ABS <IRR>grate-TRANS-manioc
'I'll grate manioc.' (H06:79)

The example in (18a) shows a simple incorporated object, while (18b) shows the persistence of this incorporation across the infix. (I will have more to say about the nature of object incorporation, and its timing with respect to infixation, in §4.1.)

The findings illustrated by Movima above are systematic across the sample: morphosyntax is undisturbed by the intrusion of an infix. Consider the Niger Congo language Eton (Van de Velde 2008; henceforth V08). In Eton, there is a morpheme called the "G" morpheme (its name being a reference to the presence of a *g* in all its phonological forms) that derives the verb stem in a number of tense/aspect combinations (V08:Ch. 7.2.2).[8] There are several allomorphs of the G morpheme, and we'll be interested in the one that combines with stems of shape CVCV. This allomorph is an infix of the form *-Lg-*, where L is a floating low tone that docks to the left;[9] the infix appears before the final vowel of the stem, (19).

(19) a. bèbè (look.at) + <Lg> (G) → bèb<**g**>è (V08:246)
b. kódò (leave) + <Lg> (G) → kôd<**g**>ò

While stems of the shape CVCV (i.e., stems that take the *-Lg-* infix) may be monomorphemic, like those in (19), they may also be bimorphemic. In particular, they may consist of a CVC root with the causative suffix *-à*. The causative suffix, in turn, is very picky—the synthetic

[8] "The G-form of the verb is used in the Hesternal past perfective, in the Past imperfective, the Relative imperfective, and in the participial involved in the formation of past imperfective verb forms" (V08:245).

[9] The tonal changes that happen upon the addition of the G morpheme are predictable from general tonal rules in the language (V08:57-58). In (19a), the floating L of the infix is deleted when it follows an identical tone. In (19b), the low tone docks to the left to create a falling tone on the first syllable; if *kódò* were uninflected, it would surface as *kódô*, with high-tone spreading to the final syllable (V08:59).

(suffixal) causative strategy is limited to a restricted (and arbitrary) class of roots (V08:Ch. 4.3.1-2). One such compatible root is *sùz* ('diminish'). For all other verbs, the causative must be expressed periphrastically. Notably, when the G morpheme combines with a stem that includes this picky causative suffix, the infix appears between the root and the suffix; nevertheless, the infix does not disrupt the root+suffix compatibility, as seen in (20).

(20) sùz-à (diminish-CAUS) + <Lg> (G) → sùz<**g**>-à (V:246)

If the infix were to disrupt the root+causative compatibility, we'd expect a retreat to the periphrastic strategy (similar to *more greenish, *greenisher* from (14)), counter to fact.

The same phenomenon could be illustrated with nearly every case study in the sample: morphosyntactic relationships in the stem of an infix always survive the intrusion of the infix. Further examples that will be seen below include a nominalizer intervening between a causative morpheme and its stem (Nancowry, §3.3), and a verbal plural marker intervening between a verbalizer and its non-verbal stem (Hunzib, §3.4-5). The excluded case studies (see §2) bear on this as well, and all are in line with the findings in this section. One interesting example that bears mentioning—in terms of morphosyntactic idiosyncracy surviving across an infix—emerges with expletive infixation in English: Ahn and Kalin 2018 show that the exceptional accusative case that is found in some Mainstream English reflexives (e.g., accusative *him* in *himself*, cf. genitive *my* in *myself*) survives in the presence of the expletive (e.g., *him-fucking-self*). The survival of the accusative in such cases is crucially unlike other (non-infixal) disruptions of the reflexive, where the exceptional accusative is lost (e.g., *his sweet self*, **him sweet self*).

The implication across the board is that infixes intervene only at a phonological level, and *not* at a structural level, even when they have an (incidental) intermorphemic position. Like the finding in §3.1, this finding is again solidly in the realm of "not suprising"—indeed, it's a relief that canonical infixes *do* behave this way, because the operation of infixation is often invoked when trying to explain morphosyntactic non-disruption or counter-scopal orders (see, e.g., Rice 1987, Orgun 1996, Crysmann 2000).

3.3 Suppletive allomorphy (in the stem of an infix) survives infixation

Suppletive allomorphy describes a situation where a given abstract morpheme can be realized with distinct phonological forms (that are not phonologically related to each other), with the choice of allomorph depending on the environment. (See, e.g., discussions in Mel'čuk 1994, Veselinova 2006, Bobaljik 2012, Kalin 2022a.) Suppletive allomorphy is found, for example, in English plural marking, which is usually *-s* (phonologically /-z/), but has a number of lexically-conditioned suppletive alternatives like *-ren* (in *children*), -∅ (in *fish*), and *-i* (in *alumni*).

Just like semantic interpretation (§3.1) and morphosyntactic compatibility (§3.2), usually (i.e., putting aside infixes) suppletive allomorphy is disrupted under intervention. Consider again lexically-conditioned suppletive allomorphy of the English plural morpheme, described in the preceding paragraph. If we take a noun root that conditions a special form of the plural, (21a)/(22a), and derive a more complex noun from it (adding e.g. *-y* or *-let*), plural marking then retreats to the default *-s*, (21b)/(22b):

(21) a. one fish, two fish
b. one fishy, two fishies (*two fishy)

(22) a. one ox, two oxen
b. one oxlet, two oxlets (*two oxleten)

The suppletive allomorphs of the plural seen in (21a) and (22a) (-∅ and *-en*) do not survive across intervening affixes. The same is true of grammatically-conditioned suppletive allomorphy: consider the alternation between *good* and *bett*, triggered by the presence of comparative morphology (*-er*), (23a); the *good/bett* alternation is blocked by any intervening morphology (*-ly* here), with *good* surfacing both in the non-comparative and comparative forms, (23b).

(23) a. good, better
b. goodly, goodlier (*bettlier)

And finally, phonologically-conditioned suppletive allomorphy is also disrupted under intervention. We can observe this in the alternation of the indefinite article between *a* and *an*, shown in (24a). If anything intervenes between the indefinite article and the noun root, it is always the *closest* phonological material that conditions the choice between *a* and *an*, (24b). (For more on *a/an* allomorphy, see Pak 2016.)

(24) a. a banana, an apple
b. an un-banana, a non-apple[10]

Suppletive allomorphy is conditioned locally, and is generally interrupted under intervention. (For discussions of what the relevant locality condition on suppletive allomorphy is, which may vary by type of allomorphy, see e.g. Embick 2010, Bobaljik 2012, Merchant 2015, Moskal 2015, Choi and Harley 2019, Paparounas To appear.)

Does the intervention of an infix have the same disruptive effect on suppletive allomorphy? The finding, consistent across the sample, is that infixes are transparent for suppletive allomorphy within their stem. In other words, infixes are *not* interveners in the locality required by suppletive allomorphy.

To begin, we'll return to the Palauan example from the introduction of this paper. Embick (2010:104-107) offers a case study of Palauan infixation and allomorphy. The discussion here largely follows Embick's, though the examples are drawn from other works. What Embick shows is that intervention of the past tense infix does not block allomorphy of the "verb marker". I'll introduce both morphemes in turn below.

[10]These are obviously odd words, but it's not too hard to cook up a context where they'd be interpretable.

As mentioned briefly in the introduction, the past tense marker in Palauan is an infix, *-il-*. Its infixal nature is clear from observing bare verb roots that combine with the past tense, like those in (25) (Josephs 1975:190):[11]

(25) a. <il> (PST) + siik (look.for) → s<**il**>iik
     b. <il> (PST) + ker (ask) → k<**il**>er

The past tense marker therefore fits the profile of a canonical infix, in that it can appear intra-morphemically.

Verbs in Palauan usually overtly bear a "verb marker" (VM). As put by Josephs (1975:148), "It is very difficult to define or specify the meaning of the verb marker; rather, the best we can do is to say that the verb marker simply functions to mark or identify a particular word as a verb." Nuger 2010 analyzes this affix as instantiating *v* (which has a number of other flavors and realizations). The verb marker has two suppletive allomorphs, *m(ə)-* and *o-*. The overwhelming majority of verbs take *m(ə)-*, (26a). All bilabial-initial verb stems take *o-*, (26b), as do a small list of other verbs, like that in (26c) (see Josephs 1975:Ch. 6).

(26) a. VM + dasaʔ (carve) → **mə**-dasaʔ (Flora 1974:99)
     b. VM + baloʔ (shoot) → **o**-baloʔ (Flora 1974:100)
     c. VM + siik (look.for) → **o-**siik (Josephs 1975:133)

While the appearance of *o-* in (26b) is phonologically-conditioned (and may even be due to (morpho)phonology rather than suppletion), the appearance of *o-* in (26c) is surely suppletive, and the choice of *o-* in such cases must be lexically-conditioned.

Of course the question now—and the question that Embick 2010 asked—is what happens when a VM-marked verb takes the past tense infix. What is found is that the VM allomorph that appears in the non-past form (without the intrusion of the infix) survives in the past tense, across the infix, (27) (cf. these same verb roots in (26)):

(27) a. **m**-<il>dasaʔ (PST + VM-carve) (Flora 1974:100)
     b. **o**-<il>baloʔ (PST + VM-shoot)[12] (Flora 1974:101)
     c. **o**-<il>siik (PST + VM-look.for) (Josephs 1975:133)

The relevant generalization is as follows. If the elsewhere allomorph of the verb marker, *m(ə)-*, would have appeared in the un-infixed form (like it does in (26a)), then this allomorph continues to appear in the presence of the past tense infix (as in (27a)); if *o-* would have appeared due to phonological conditioning or lexical conditioning in the un-infixed form (like it does in (26b-c)), then this allomorph persists as well in the past tense (as in (27b-c)). The overall observation here is that allomorph choice—whether phonologically-conditioned or lexically-conditioned—survives the intrusion of the infix.[13]

[11] Palauan verb morphology is incredibly complex, and I cannot do justice to this complexity here. I refer the interested reader to Josephs 1975:Ch. 5-7 and Nuger 2010 for extensive discussions.

[12] Sequences of *o* followed by *i* merge to *u*, producing *ulbaloʔ, ulsiik* (Josephs 1975:590).

[13] If it turns out that cases like (26b) are better treated (morpho)phonologically, then this would still be compatible with my overall findings; see §3.4.

A second case comes from the Austroasiatic language Nancowry (Radhakrishnan 1981, henceforth R81; Kalin 2023). We'll be interested here in the interaction between the causative morpheme—which has suppletive allomorphs—and the instrumental nominalizer infix *-in-*, the intruder. First, an overview of the causative: the causative morpheme has two prosodically-conditioned suppletive forms (one of which is itself an infix), *ha-* and *-um-*, determined by the size of its stem; *ha-* appears with monosyllabic stems, (28a), and *-um-* with disyllabic stems, (28b).

(28) a. CAUS + kuãt (curve) → **ha-**kuãt 'to hang, to hook' (R81:96)
b. CAUS + paloʔ (loose) → p<**um**>loʔ 'to loosen' (R81:150)

Notice in (28b) that *-um-* seems to swallow up the first vowel of the stem it combines with. Kalin (2023) proposes that this is because *-um-*'s pivot is actually the first vowel; when the infix takes a post-first-vowel position, it creates vowel hiatus—this is disallowed in unstressed syllables in Nancowry, and so the stem vowel deletes. I assume that this analysis is correct.

Next, the intruder: The instrumental nominalizer infix *-in-* is a derivational affix that combines with verbs and derives instrument nouns:[14]

(29) a. <in> (INOM) + calɯak (swallow) → c<**in**>lɯak 'a throat' (R81:146)
b. <in> (INOM) + tikoʔ (prod) → t<**in**>koʔ 'a prod' (R81:97)

Just like with *-um-* in (28b), the first vowel of the stem disappears under infixation; this can be accounted for in the same way—*-in-* is placed after the first vowel, and that vowel is subsequently deleted.

Verbs bearing a causative prefix can be nominalized by the instrumental nominalizer. When this happens, the choice of suppletive allomorph for the causative (see (28)) is unaffected. So, for example, *ha-* survives in (30):[15]

(30) **h**-<in>kuãt (INOM + CAUS-curve; 'a hook') (R:96)

Recall that *ha-* only appears with monosyllabic stems, (28). In (30), looking naively just at the surface form, it *looks* as though the stem that follows *h(a)-* is disyllabic (*inkuãt*). But, nevertheless, the causative allomorph *ha-*—the one that would have been chosen in the absence of the nominalizing infix—persists. Nancowry thus furnishes another example of suppletive allomorphy surviving across an infix.

In my sample, there are two other cases of an infix intruding in an allomorphic relationship in its stem. A second case from Nancowry comes from the survival of the causative morpheme's allomorphy, (28), across a second causative (i.e., in a double causative); see Kalin 2023. And in Katu (Austroasiatic; Costello 1998), lexically-conditioned allomorphy of

[14] The instrumental nominalizer exhibits suppletive allomorphy, but this will not be of interest here.

[15] I do not show the *-um-* allomorph, (28b), surviving infixation of the nominalizer because infixation of *-um-* followed by infixation of *-in-* actually results in the surface-disappearance of *-um-*; Kalin (2023) shows that this can be explained by completely predictable phonological/phonotactic processes within the language.

the causative morpheme survives the intrusion of a nominalizing infix. In all cases, suppletive allomorphy survives infixation.

Since my sample does not furnish many examples of suppletive allomorphy in the relevant environments for testing (non-)survival across an infix, I will briefly comment on the other infix-adjacent case studies that I excluded in this paper (see discussion at end of §2). Two of these excluded case studies are relevant: so-called expletive infixation and the Turoyo past tense morpheme. For Turoyo's infix-like past tense morpheme, it can intervene in two relevant places: (i) between a dative marker that undergoes grammatically-conditioned suppletive allomorphy and the trigger of this allomorphy, and (ii) between an agreement morpheme that undergoes phonologically-conditioned suppletive allomorphy and the trigger of this allomorphy. In both cases, the past tense marker does *not* disrupt the allomorphy, in line with the findings above. For details, see Kalin 2020.

With respect to the excluded case of so-called expletive infixation, there is one potentially relevant environment where *fucking* can surface, namely, when it intervenes between a prefix expressing negation (*in-, un-, non-, a-*) and its adjectival stem. Assuming that these negative morphs can be treated as lexically-conditioned suppletive allomorphs of a single abstract negative morpheme,[16] then this provides another example of such allomorphy surviving across an infix-like element:

(31) a. uncomfortable, un<**fucking**>comfortable
b. nonsensical, non<**fucking**>sensical
c. amoral, a<**fucking**>moral
d. invariant, in<**fucking**>variant

For all the examples in (31), the idiosyncratic pairing of negative morph and adjectival stem survives across the expletive.

In all relevant (and potentially relevant but excluded) cases that I have been able to find, infixes consistently fail to interrupt relationships of suppletive allomorphy in their stems; in other words, suppletive allomorphy (in the stem of an infix) survives infixation. This is the first truly surprising result of this study—under some models of morphology (to be discussed in §4), the intervention of an infix *should* block allomorphic relationships, especially phonologically-conditioned ones. Since, to the contrary, these allomorphic relationships uniformly *survive* infixation, this suggests that infixation must happen *after* the infix's stem has been fully exponed, i.e., after the morphemes in the stem of the infix have been given phonological forms. (Or, equivalently, what this shows is that exponents must be present at a representational level where the stem of an infix excludes the infix.) This conclusion is strengthened by the findings in the next section.

[16] This analysis is not totally straightforward to defend, as these morphs are not in complementary distribution for all stems, and (with some lexical items) they seem to convey slightly different meanings. For extensive discussion and relevant citations, see Bauer et al. 2013.

3.4 Morphophonology (in the stem of an infix) survives infixation

The next type of relationship/interaction that I'll investigate is a set of phenomena I'll put under the umbrella of "morphophonology", a term I use to pick out a class of phenomena that sits in between suppletive allomorphy (§3.3) and regular, word-level phonology (§3.5). I clarify my use of this terminology and then turn to the question of locality and intervening infixes.

I use the term morphophonology for a situation where there is a sound alternation that can be described straightforwardly as a phonological change (rather than a replacive/suppletive one, cf. §3.3), but that is morphologically idiosyncratic in some way. As Inkelas (2014:Ch. 2) puts it, "morphologically conditioned phonology is the phenomenon in which a particular phonological pattern is imposed on a proper subset of morphological constructions [...] and thus is not fully general in the word-internal phonological patterning of the language." An example of morphophonology given by Inkelas (p. 10) comes from Mam Maya (Inkelas cites England 1983, Willard 2004): roots with long vowels undergo vowel shortening in the context of a few particular suffixes. The idea that there can be morphologically-conditioned and/or morphologically-restricted phonology is a controversial one—some embrace it (e.g., Embick and Shwayder 2018, Sande et al. 2020) while others are committed to relegating all apparent cases of morphophonology to either regular phonology (e.g., Newell 2021) or suppletive allomorphy (e.g., Merchant 2015). Regardless of its theoretical treatment, though, morphophonology is still a useful descriptive category for the apparent behavior of a set of "in between" empirical phenomena, and it is this descriptive category that I appeal to here.

Morphophonology, as defined above, generally obeys strict locality.[17] As a simple example, consider the fricative voicing alternation found in plural environments for some noun roots in English:

(32) (33) a. lea[f], lea[v]es
b. hou[s]e, hou[z]es
c. mou[θ], mou[ð]s

This alternation is not general to all noun roots (cf. no voicing for the root *reef*: *ree[f]-s, *ree[v]-es*),[18] and is also conditioned only in a plural environment (cf. no voicing in the environment of possessive *-s*: *the lea[f]'s stem*, **the lea[v]'s stem*). The phonological process of voicing is therefore doubly morphologically restricted. Turning to intervention: in the usual case, when another morpheme intervenes between the plural marking and a relevant noun root, voicing of the root-final consonant no longer occurs:

(34) a. lea[f]let, lea[f]lets (*lea[v]lets, cf. (33a))
b. mou[θ]ful, mou[θ]fuls (*mou[ð]fuls, cf. (33c))

[17]See Embick and Shwayder 2018 for a discussion of locality and how it might be somewhat different for different types of morphophonological processes.

[18]There is also cross-dialectal variation in terms of which noun roots undergo this alternation; see e.g. MacKenzie 2018.

The special roots that undergo voicing of their final fricative only do so when the plural suffix is immediately local, as in (33). Put another way, morphophonology is generally bled by intervention.

So far, we have seen that semantic interpretation, morphosyntactic compatibility/selection, and suppletive allomorphy all survive the intrusion of an infix (see §3.1–3.3). What about morphophonology? Does this, too, survive, or will it be our first case of disruption? The significant finding is that morphophonology *does* survive the intrusion of an infix.

Let's start with Movima, the case study introduced in §3.1: recall that Movima has an irrealis morpheme that is realized as an infix, *-(k)a'-*, which follows the first (iambic) foot of its stem (Haude 2006). Movima is also a language rich in morphophonological processes, one of which will be of interest here: reduplication. While reduplication sometimes clearly realizes a morpheme in Movima, reduplication also appears to be morphophonological in some cases, i.e., triggered as a phonological process rather than being due to insertion of a segmentally-empty exponent (see H06:§3.7). For example, in nominal compounds built from verb roots, the verb root—which is always the left member of the compound—undergoes prefixing reduplication of its first two moras (H06:200-202), (35) (reduplicants underlined).

(35) a. dan (chew) + so (chicha) → <u>dan-</u>dan-so ('chicha made of chewed maize')
b. jo: (warm.up) + mi (water) → <u>jo:-</u>jo:-mi ('warm water')
c. sam (twist) + di (long.thin) → <u>sam-</u>sam-di ('rope')

Since it is not clear what the reduplicant would be *realizing* in such compounds, I take reduplication here to be plausibly morphophonological, following Haude.

Another context for morphophonological reduplication is when a relational noun root is used non-relationally, i.e., without an inalienable possessor (H06:208-212). To use a noun root non-relationally, the absolute state suffix *-kwa* is required, e.g., (36).

(36) tolej (branch) + -kwa (ABS) → tolej-kwa ('branch')

For roots larger than one syllable, like that in (36), this is all that is involved in deriving a non-relational nominal. However, for some (lexically-arbitrary) monosyllabic roots, they must undergo prefixing CV-reduplication in this context, in addition to taking the *-kwa* suffix (p. 209), (37) (reduplicants underlined).[19]

(37) a. ba (fruit[20]) + -kwa (ABS) → <u>ba-</u>ba:[21]-kwa ('fruit')

[19]In some cases, this reduplication seems to occur to satisfy prosodic minimality constraints—nouns must minimally have 3 moras, with moras added by penultimate lengthening (see fn. 21) counting towards this minimum—but it does not *only* happen when this is prosodically necessary (H06:45). Further, different monosyllabic roots trigger different prosodic augmentation/repair strategies in different contexts (H06:205), and so reduplication here must involve some morphological idiosyncrasy.

[20]Haude glosses this as 'round' because in other contexts it serves as a shape classifier, but, as she discusses (p. 212), it may be that the shape classifier is actually a semantically bleached version of a noun meaning 'fruit', and so this is how I gloss it here for transparency.

[21]Lengthening here is due to a regular phonological process of penultimate lengthening (H06:47-49).

b. di (grain) + -kwa (ABS) → di-di-n[22]-kwa ('seed')

Because *-kwa* can occur with or without accompanying reduplication, and the set of roots undergoing reduplication is (to some degree) lexically arbitrary, I take reduplication to be morphophonological in these cases as well.

For the purposes of the current investigation, the question is what happens when morphophonological reduplication—e.g., of the type found in certain compounds, (35), or in deriving non-relational nouns, (37)—is triggered in the stem of the irrealis infix. And the answer is that this reduplication—including the form of the reduplicant—remains intact, i.e., undisturbed by intrusion of the infix. Sometimes the post-first-foot location of the infix places it between the reduplicant and its base, as in (38a), and other times after the reduplicant+base, (38b) (H06:80).

(38) a. <(k)a'> (IRR) + sam-sam-di ('rope', (35c))
→ sam-<**a'**>sam-di ('there is no rope')
b. <(k)a'> (IRR) + ba-ba:-kwa ('fruit', (37a))
→ ba-ba<**ka'**>-di ('there is no fruit')

Importantly, in both cases, it's clear that morphophonological reduplication in the stem is oblivious of the infix: first of all, reduplication must have already happened for the infix to find its correct (attested) location; and second, infixation does not disrupt the reduplication or affect the shape of the reduplicant in any way.

A second case study featuring morphophonology is found in the Northeast Caucasian language Hunzib (van den Berg 1995; henceforth B95), as discussed in detail by Kalin 2022b. In Hunzib, there is a verbal plural infix, *-á-*, that appears before the final consonant of its stem, (39); this infix has a number of non-suppletive allomorphs, including *yá, wá*, and *á*. (All data and observations about Hunzib in this paper come from Kalin 2022b, who draws on van den Berg 1995, henceforth B95.)

(39) a. ɑhu (take) + <ɑ́> (VPL) → ɑ<**ɑ́**>hu 'take (pl)' (B95:284)
b. ek (fall) + <ɑ́> (VPL) → e<**yɑ́**>k 'fall (pl)' (B95:295)
c. šoše (bandage) + <ɑ́> (VPL) → šo<**wɑ́**>še 'bandage (pl)' (B95:334)

The verbal plural infix combines with verbs, as should be clear from (39), where the infix combines with (monomorphemic) verb roots. There is also a productive derivational suffix in the language that forms verbs, *-k'(e)*, a causativizer (underlined below).

(40) a. haldu (white) + -k'(e) (CAUS) → haldu-k' ('make white') (B95:301)
b. uƛ' (end) + -k'(e) (CAUS) → uƛ'-k'e ('make end') (B95:337)

The alternation between *-k'*, (40a), and *-k'e*, (40b), is morphophonological in nature: *e* is epenthesized to prevent a complex coda in cases where stem ends in a consonant, like (40b);

[22]This is a morphophonologically-inserted nasal, which will be discussed in §3.5.

however, which vowel is inserted, and where, is idiosyncratic to the specific affix creating the illicit cluster. (See more detailed discussion in Kalin 2022b:17.)

When the verbal plural infix combines with a derived verb like that in (40), the infix shows up (incidentally) in between the root and the derivational suffix. What happens to morphophonologically-conditioned vowel epenthesis, like that in (40b), when the infix intrudes? The answer is that epenthesis proceeds as though the infix weren't there: if there would not have been vowel epenthesis, there still is not, (41a) (compare with (40a)); if there would have been vowel epenthesis, there still is, (41b) (compare with (40b)).[23]

(41) a. haldu (white) + -k'(e) (CAUS) + <á> (VPL) → hald<á>-k' (B95:301)
b. ɨx (warm) + -k'(e) (CAUS) + <á> (VPL) → ɨx<á>-k'e (B95:308)

Importantly, because the infix is vocalic, it could potentially *bleed* the need for vowel epenthesis in (41b), since there would be no illicit word-final consonant cluster post-infixation. But, what (41b) shows is that morphophonological vowel epenthesis must have been determined *prior to* (or in the absence of) the infix, since there is "superfluous" vowel epenthesis nevertheless.

What these case studies from Movima and Hunzib show is that infixes do not disrupt morphophonology in their stems. This finding also holds in two of the excluded case studies (see §2), Cibemba's applicative "infixation" and English expletive "infixation". In Cibemba, morphologically-conditioned lenition (triggered by the causative morpheme) famously persists across an intruding ("infixed") applicative morpheme (see Hyman 1994, Orgun 1996, Myler 2017, *i.a.*). And in English, many speakers allow the persistence of *im-* (an assimilated version of the negative prefix *in-*) across an intruding ("infixed") expletive, as in forms like *im<fucking>possible*. (Other speakers prefer *in<fucking>possible*. I hypothesize that this contrast is due to whether a speaker has analyzed the *im-/in-* alternation as morphophonological or phonological, in line with the survival of morphophonology (this section) but not phonology (§3.5). This of course needs further investigation.)

Assuming that morphophonology is strictly local, all of this means that the stem must have undergone some phonological processes—namely, those that are morphologically idiosyncratic in some way—*before* the intrusion of the infix (or at a representational level that excludes the infix).

You might now be wondering whether there is *anything* that fails to survive the intrusion of an infix, and the answer is yes, word-level phonology is interrupted by infixation, as we will see in the coming section.

3.5 Phonology (in the stem of an infix) is lost under infixation

Finally, we turn to "pure" phonology, which I take to mean phonological processes that are regular in a language, that are not morphologically idiosyncratic, and that apply at the word level and potentially above the word level. (In §4.2.1 I will return to the question of

[23]The final vowel of the root in (41a) is deleted due to a predictable phonological process of hiatus resolution. See discussion in Kalin 2022b:8-9.

how regular phonology that is "cyclic", i.e., that seems to apply multiple times during the formation of a word, can also fit into the picture.)

Phonological processes are generally conditioned locally. Consider, for example, the well-known case of flapping in many dialects of English, where a *t* or *d* is realized as a flap when it follows a vowel, *r*, or *w* (i.e., following a non-lateral approximant) and precedes an unstressed vowel, as in *hard/harder*, (42a) and *wet/wetter*, (42b).

(42) a. har[d], har[ɾ]er
b. we[t], we[ɾ]er

If a consonant-initial affix were to intervene between the unstressed vowel and *d/t* in the flapping cases in (42), this would bleed (disrupt) flapping. Consider the addition of the suffix *-ly* in (43), intended to contribute the adjectival meaning "in a X way".

(43) a. har[d]ly, har[d]lier (*har[ɾ]lier)
b. we[t]ly, we[t]lier (*we[ɾ]lier)

Although *hardlier* and *wetlier* are marginal words, and while there may be other allophones of *t/d* in this context, the point here is just that flapping would clearly not happen when the unstressed vowel of *-er* does not immediately follow *d/t*. Another example showing the disruption of phonology across an intervening affix comes from assimilation: in fast speech, *n* assimilates to a following dental (*θ, ð*; bolded below), e.g., as seen in (44a). If an affix like *re-* (i.e., that is not dental-initial) intervenes between the dental and the *n*, assimilation does not happen, (44b).

(44) a. u[n̪]**th**inkable
b. u[n]re**th**inkable (*u[n̪]re**th**inkable)

Phonological processes are—in the usual case—bled under intervention. (This is so automatically assumed to be true that the above illustrations might seem ridiculously obvious, and therefore unnecessary to even exemplify.)

To see what happens when an infix interrupts a purely phonological relationship, let's turn to new facets of the case studies from the previous section, Movima and Hunzib. In both cases, phonology *is* disrupted by the intrusion of an infix, in contrast to all previous types of relationships/interactions considered in this paper, including morphophonology.

In Movima, one aspect of the regular phonology of the language is nasal assimilation: "the alveolar nasal phoneme /n/ always assimilates to the following consonant with respect to its place of articulation" (H06:34): the alveolar nasal surfaces as [m] (orthographic *m*) before bilabials and [ŋ] (orthographic *n*) before velars, while surfacing as [n] (also orthographic *n*) before alveolars and vowels. This is illustrated in (45) for the positional root *en* ('stand'). (The relevant nasals are bolded throughout all the Movima examples below. I use orthography except when needing to indicate the presence of a velar nasal.)

(45) a. en ('stand') + -to (side) → e**n**to 'stand obliquely' (H06:34)
b. en ('stand') + -u'-ni (INT-PRC) → e**n**u'ni 'still standing' (H06:578)

c. en (‘stand’) + -poj (CAUS) → e**m**poj ‘make stand’ (H06:34)
d. en (‘stand’) + -ki (IMP) → e[**ŋ**]ki ‘stand up!’ (H06:34)

Another context where nasal assimilation is evident is with the so-called “linking nasal”: Nominal roots/bases that end in one of a set of specific open syllables (*wa, kwa, pa, da, ra, di, ri, kwi, ’i, ti, chi*) require insertion of a nasal when followed by another morphological element. The examples in (46) show complex nouns that feature the right environment for insertion of the linking nasal (H06:58-60):

(46) a. maropa-di (papaya-grain, ‘papaya seed’) → maropa-**n**-di (H06:59)
b. towa-eɬ (path-APPL, ‘one’s path’) → towa:-**n**-eɬ (H06:240)
c. ariwa-maj (top-VLC, ‘to be on top’) → ariwa-**m**-maj (H06:59)
d. lora-kwa (leaf-ABS, ‘leaf’) → lora-[**ŋ**]-kwa (H06:59)

What (46) shows is that the linking nasal assimilates in place to an immediately following consonant, and surfaces as [n] elsewhere (e.g., before a vowel). Nasal assimilation is local and purely phonological in Movima.

When the irrealis infix intervenes between an *n* and a following consonant, it bleeds (prevents) the place assimilation of *n*. In (47a), an idiomatic compound places an alveolar nasal before a bilabial, and the nasal predictably assimilates, surfacing as [m]. When the irrealis infix intervenes between the two elements of this compound, (47b), assimilation is bled, and underlying *n* surfaces instead.

(47) a. jan (who/which) + pa (hand) → ja**m**-pa (‘do’) (H06:124)
b. ja**n**<a’>pa (<IRR> + (47a)) (H06:447)

Similarly, when the irrealis infix intervenes between a linking nasal and a following consonant, assimilation is bled. In (48a), there is a compound whose form conditions the addition of the linking nasal (bolded), which assimilates to the following *p*; (48b) shows that the linking nasal surfaces as underlying *n* when the irrealis infix intervenes.

(48) a. kweya-**m**-poy (woman-LINK-animal, ‘female animal’) (H06:81)
b. kweya-**n**<a’>-poy (<IRR> + (48a)) (H06:81)

The intrusion of an infix bleeds phonological assimilation in Movima.

Another case of phonology being interrupted by the irrealis infix in Movima comes from glottalization: before another consonant (i.e., in coda position), *k* is always realized instead as a glottal (*’* orthographically) (H06:28), e.g., (49a). When the irrealis infix intervenes between *k* and a following consonant, *k* remains *k*, (49b).

(49) a. yok (catch) + -na (TRANS) → yo’na (‘catch’) (H06:123)
b. yok<**a**’>na (<IRR> + (49a)) (H06:543)

Importantly, there is no restriction on glottal stop appearing intervocalically, whether root-internally or at a morpheme juncture, so there is no plausible “Duke of York” pathway from *k* to glottal stop (à la (49a)) back to *k* in (49b). Consistently, then, regular phonology *is* disrupted by the intrusion of an infix in Movima (in stark contrast to morphophonology in Movima, §3.4).

A second case study of phonology being disrupted by an infix comes from the verbal plural marker in Hunzib. We saw in §3.4 that infixation of the verbal plural marker does *not* disrupt morphophonologically-conditioned vowel epenthesis, (41), i.e., vowel epenthesis proceeds as though it can't see the infix. It turns out that the epenthesized vowel has even more to tell us, as it subject to a language-wide word-internal process of vowel harmony: this vowel is underlyingly *e*, (50a), but harmonizes to ə when it follows a central non-low vowel (i.e., *ɨ* or ə), as it does in (50b). (The discussion here again follows Kalin 2022b, who draws on data from van den Berg 1995.)

(50) a. uƛ' (end) + **-k'(e)** (CAUS) → uƛ'-**k'e** ('make end') (B95:337)
b. ɨx (warm)+ **-k'(e)** (CAUS) → ɨx-**k'ə** ('warm up') (B95:308)

When the verbal plural infix intervenes between the harmonizing suffix vowel and the root vowel, the following question arises: will vowel harmony ignore the infix (predicting ə in the suffix when the root vowel is a central non-low vowel), or will vowel harmony "see" the infix, which crucially does *not* have a central non-low vowel (thereby predicting the suffix vowel to be *e*). The latter prediction is borne out: vowel harmony does see the infix, i.e., is fed/bled by infixation: underlying *e* surfaces, (51) (B95:308).

(51) ɨx<á>**-k'e** (<IRR> + (50b)) (*ɨx<á>**-k'ə**)

In Hunzib too, like Movima, regular phonology in the stem of an infix does not survive the intrusion of the infix.

There is a variety of further evidence for the sensitivity of regular phonology to the presence of an infix. In one of the excluded case studies, Turoyo (Kalin 2020), the mobile past tense marker feeds/bleeds all regular phonology, including shortening of geminates, feature-spreading to an empty consonant slot, and vowel lowering. With English expletive infixation (another excluded case study), the surface-level assimilation of *n* to a following velar in a word like *i[ŋ]competent* is bled by the intrusion of an expletive (*i[n]-fucking-competent*, **i[ŋ]-fucking-competent*). Similarly, for some speakers (cf. the end of §3.4), there is a retreat to underlying *in-* in *impossible*, when the expletive intrudes, giving rise to *in-fucking-possible*. Finally, putting aside cases of intermorphemic infixes, infixes in their canonical intramorphemic positions also feed/bleed regular phonology (see Kalin 2022a). An example of this comes from one of the languages in the current sample: in Eton (see §3.2), a regular process of high tone spread (Van de Velde 2008:58-60) is bled by the intrusion of an infix that contributes its own tone (Van de Velde 2008:246, (49)).

Regular, word-level phonology is *not* impervious to the intrusion of an infix, and behaves instead like the infix *is* visible in its intruding position. What this suggests is that this type of phonological process applies only over a domain that already includes the infix, unlike all the other processes/relationships we saw in previous sections.

3.6 Interim summary

We can finally put it all together. Morphophonological, allomorphic, morphosyntactic, and semantic relationships/interactions in the stem of infixation all survive the intrusion of an infix, i.e., behave as though the infix isn't there. Word-level phonological relationships/interactions do not survive the intrusion of an infix, i.e., behave as though the infix is there. What this establishes is a sort of minimal derivational "timeline" (which could be recast as representational levels):

(52) a. **Step 1:** Within the stem of infixation, establish semantic relationships and morphosyntactic relationships; expone all morphemes; apply morphophonological processes
b. **Step 2:** Add the infix
c. **Step 3:** Apply phonological processes

The relationships that feed or are a part of morphophonology, morphology, syntax, and semantics in the stem of infixation are established *prior to* infixation (Step 1 above), while phonological relationships/interactions are established *after* infixation (Step 3 above). Of course, it would be very strange for only infixation to trigger derivational steps (or separate representational levels), as the minimal "timeline" above seems to suggest. In the following section, I will get more precise about what the architecture of the grammar must look like to naturally give rise to the steps above.

4 Implications

When considering phenomena that interface with multiple parts of the grammar, an inevitable big question that arises is *how* the parts of the grammar fit together. In this section, I will discuss how the data presented in this paper bears on this question, going from less to more fine-grained. But first, I need to lay out two assumptions that the remainder of the argumentation rests on, namely, that morphology is realizational, and that infixation is a part of realization.

My first assumption is that morphology is realizational, in the sense that the form of a word is at least in a metaphorical sense *after* or *secondary to* the abstract morphological elements (features, roots) in a word; put another way, the form of a word reflects meaning/features that are independently given. This involves a separation of the classical morpheme—conceived as a pairing of sound and meaning/function—into two independent parts, the sound part (the *exponent*) and the meaning/function-related part (e.g., a root or morphosyntactic feature). The basic arguments for the realizational nature of morphological forms come from the observation that correspondences between meanings/functions and forms are commonly *not* one-to-one, e.g., one meaning/function can correspond to multiple forms, and one form can appear in the context of multiple meanings/functions. Non-one-to-one mappings are straightforward to capture when forms are divorced from meanings/functions. On arguments for realizational morphology, see, e.g., Halle and Marantz 1993, Stump 2001, Kalin and Weisser To appear.

My second assumption is that infixation is a part of realization, and more specifically, that the property of being an infix is an idiosyncratic property of individual exponents. This assumption rests on extensive data/argumentation by Kalin 2022a, who shows that it is not morphosyntactic features that are designated as infixes, but rather only specific realizations of those features. In other words, the property of being an infix is encoded at the exponent level, not the abstract featural level. A core piece of data that supports this assumption is that there may be a number of suppletive allomorphs (exponents) for a given morphosyntactic feature, and these allomorphs can differ in terms of whether they're an infix or not, as well as what their phonological pivot is (if more than one is an infix). It follows that infixation must be a part of realization, as realization is when exponents are chosen/licensed for abstract elements.

Building on these assumptions and the data in §3, I argue for a post-syntactic model of realization/morphology (§4.1), and for bottom-up realization (§4.1).

4.1 Realization is post-syntactic

Even starting from a realizational morphology (as laid out above), there are many different theories as to how the phenomena that are a part of morphological realization relate to syntax. Three basic possibilities have been extensively explored, namely that realization is (i) pre-syntactic, in the sense of feeding the syntax (e.g., Kiparsky 1982, Müller 2021), (ii) post-syntactic, in the sense of being fed by the syntax (e.g., Halle and Marantz 1993, Caha 2020), and (iii) non-syntactic, in the sense of being parallel to (neither pre- nor post-) syntax (e.g., Stump 2001, 2016).

How does the behavior of infixes at morpheme boundaries, as explored at length in §3, bear on the question of where morphological realization fits into the grammar? While the literature already furnishes a variety of evidence for a "late insertion" (post-syntactic) view of realization, the data presented here furnish a novel argument for lateness. In particular, this evidence comes from the diversity of morphosyntactic units into which infixes can lodge themselves. The basic arc of the argument is as follows: given that infixation is an aspect of realization, anything that feeds the infixation process itself must precede realization; there are syntactic operations that feed infixation; therefore, syntax precedes realization.

In §3, infixes were seen combining with many different types of complex stems, including (i) compounds (Movima, §3.1, §3.4, and §3.5), (ii) stems formed with derivational morphology (Movima, §3.2, §3.4, and §3.5, Palauan and Nancowry, §3.3, and Hunzib, §3.4 and §3.5), (iii) stems formed with inflectional morphology (Movima, §3.2, §3.4, and §3.5), (iv) stems that are synthetic but vary with a periphrastic structure (Eton, §3.2), and (v) object incorporation structures (Movima, §3.2). Since theories differ as to which of the first four types of morphological structures are formed syntactically, I'll focus on just the last—object incorporation.

Recall from §3.2 that the irrealis infix in Movima—which appears after the first (iambic) foot—can infix into object incorporation structures, as seen in (53b) (example repeated from (18)):

(53) a. iń jiɨ-a:-pa
1ABS grate-TRANS-manioc
'I grate manioc.'

b. iń jiɨ-a<**ka'**>-pa
1ABS <IRR>grate-TRANS-manioc
'I'll grate manioc.' (H06:79)

There is a variety of evidence that the process of object incorporation itself is syntactic in Movima (à la Baker 1996): the transitive active voice marker *-(n)a* (H06:323) is obligatory on the verb even when the object is incorporated and the agent is marked absolutive; it is only the underlying patient that can be incorporated into the verb; and the incorporation structure does not look like compounds do in Movima, which are generally right-headed and nominal in nature. If object incorporation is syntactic, and the stem of the infix in (53b) is the verb plus the incorporated object, then it follows that realization must be *post*-syntactic.

A careful reader might notice that the position of the infix in (53b) is, hypothetically at least, compatible with infixing the irrealis marker into a stem that consists *just* of the verb and transitive marker (*jiɨ-a* → *jiɨ-a<ka'>*), and then incorporating the object at the end of this stem; such an analysis would open the door for infixation/realization to be *pre*-syntactic (pre-object incorporation) or *non*-syntactic (fully independent of object incorporation). However, a quirk of Movima morphophonology rules out this possibility, and shows that infixation really must happen *after* object incorporation, i.e., after the full structure (*jiɨ-a:-pa*) has been formed. The illuminating morphophonological process (which I'll illustrate in more detail below) works as follows: whenever the irrealis infix incidentally lands word-finally (i.e., when its stem in its entirety is an iambic foot), this triggers infixing CV reduplication before the final syllable of the word (H06:82). In object incorporation cases, like that in (52b), there is no infixing CV reduplication, and so it must be that the infix is not word-final at any relevant derivational point or level of representation.

To illustrate the morphophonological process at play here, consider the following examples: when the irrealis marker combines with the verb *joy* ('go') or the noun *michi* ('cat') bearing no other affixes, the infix—in taking its usual placement after its pivot, the first iambic foot—will appear at the end of the word (*joy<a'>*, *michi<ka'>*). Since the infix is word-final in this infixed position, this triggers reduplication of (the initial CV of) the final syllable of the resultant verb form (*ya* for *joya'* and *ka* for *michika'*); this CV reduplicant is itself infixed before the final syllable.[24] These pieces come together in (54a–b), where the final form features a verb-final irrealis marker and an infixed CV reduplicant. (In the

[24] I make no claims here about the relative ordering between reduplication and infixation of the reduplicant, as the data are compatible with either ordering—reduplicate, then infix the reduplicant before the final syllable, or, infix the (empty) reduplicant before the final syllable, then reduplicate.

examples below, the irrealis marker is bolded, and the reduplicant is underlined; note that vowel length in the reduplicant is the result of fully predictable penultimate lengthening.)

(54) a. <**(k)a'**> (IRR) + joy (go) → jo<ya:>y<**a'**> (H06:274)
b. <**(k)a'**> (IRR) + michi (cat) → michi<ka:><**ka'**> (H06:83)

Infixing reduplication is thus an unmistakeable morphophonological indicator of cases where the irrealis infix lands word-finally.

Let's now turn back to the object incorporation cases and how this morphophonological process sheds light on derivational timing (or representational levels). If infixation is post-syntactic, i.e., takes place after object incorporation, then the stem of the irrealis infix will include the incorporated object (see (53a)) and no infixing reduplication is predicted, because the irrealis marker will never be word-final. If, on the other hand, infixation were pre-/non-syntactic, i.e., were to take place before or independent of object incorporation, then the stem of the infix would lack the incorporated object (for the example in (53), *jiɨ̵-a*), and so the irrealis marker would end up in a word-final position after infixation at this pre-/non-syntactic point (*jiɨ̵-a<ka'>*). Importantly, since infixing reduplication (see (54)) is clearly morphophonological in nature, we would expect this process to also be triggered in the pre-/non-syntactic morphology, and to therefore be triggered at this stage (*jiɨ̵-a<ka><ka'>*). Putting this all together: an account where realization is post-syntactic predicts the final verb form in (55a), lacking infixing reduplication; an account where realization is pre-syntactic or non-syntactic predicts the final verb form in (55b), which has infixing reduplication preceding the incorporated object. (As above, the irrealis marker is bolded, and the reduplicant is underlined.)

(55) a. jiɨ̵-a<**ka'**>-pa (excerpted from (53b))
b. *jiɨ̵-a<ka><**ka'**>-pa

Since there is no infixing reduplication in object incorporation cases (only (55a) is attested), and since object incorporation is syntactic in Movima, it must be that infixation of the irrealis marker is post-syntactic.

Generalizing from the Movima case, and recalling again that infixes can infix into complex stems of all kinds, this paper provides a novel argument for the post-syntactic timing of realization. Infixation into at least certain kinds of complex stems, like those formed by syntactic object incorporation, is a challenge for pre-syntactic models of morphology/realization (e.g., Wunderlich 1996, Müller 2021) and non-syntactic models of morphology/realization (e.g., Paradigm Function Morphology).

4.2 Realization proceeds from the bottom up

The core data in this paper, §3, established that infixation fails to disrupt local interactions/relationships in its stem, with the notable exception of surface phonology. How can this data inform a more fine-grained understanding of *how* realization takes place? Put another way, what can we learn from these findings about the sorts of operations that realization breaks down into, and their relative timing with respect to each other? Note that these questions are largely orthogonal to the argument from §4.1 and are compatible with a variety of morphological models.

There are two basic competing types of theories of how realization proceeds: (i) all-at-once, i.e., simultaneous across a domain, or (ii) step-wise and bottom-up, involving small derivational steps or many representational levels, starting from the bottom of a domain and working upwards (or, largely equivalently here, starting from the innermost component of a domain and working outwards).[25] Step-wise bottom-up realization is a property of many pre-syntactic, post-syntactic, and parallel/non-syntactic models of morphology, for example: the post-syntactic "late insertion" model Distributed Morphology (see in particular Bobaljik 2000, Embick 2010, Myler 2017), as well as other syntax-based models of morphology (e.g., Starke 2009, Caha 2020, and Bruening 2017); pre-syntactic models like that of Müller 2021; and non-syntactic models like Paradigm Function Morphology (Stump 2001, 2016).[26,27] Simultaneity, on the other hand, is popular within a number of OT-based models (e.g., Prince and Smolensky 1993, Mester 1994, Mascaró 1996) and other constraint-based models (e.g., Bonami and Crysmann 2016, Crysmann and Bonami 2016). Simultaneity has also been argued for in some varieties/offshoots of Distributed Morphology that centrally incorporate OT, for example Svenonius 2012 and Rolle 2018.

The data in this paper provide strong novel evidence for a step-wise, bottom-up model of realization, where step-wise realization includes not only exponence but also infixation and some limited amount of phonology. The relevant data are *not* compatible with simultaneous or top-down realization. The most crucial evidence revolves around suppletive allomorphy (§3.3), morphophonology (§3.4), and surface phonology (§3.5), as semantic interpretation (§3.1) and morphosyntactic selection/compatibility (§3.2) are not directly relevant to the inner-workings of realization.

In the sections below, I carefully walk through the predictions that different types of models make, and argue that bottom-up realization comes out on top. I begin with a discussion of bottom-up realization, §4.2.1, then turn to 2 different versions of a simultaneous model, §4.2.2-3, with other models discussed very briefly in §4.2.4.

4.2.1 Infixation in a bottom-up model of realization

In a bottom-up model, realization starts from the most embedded component of a morphosyntactic structure (usually the root) and proceeds upward. An alternative but similar string-based formulation would hold that this is an inside-out process, assuming that there is some mechanism for determining what is the innermost element, be that through a desig-

[25] As a modified version of the bottom-up model, it might be that step-wise realization can be bidirectional, with both top-down (or outside-in) and bottom-up (or inside-out) ordering possible.

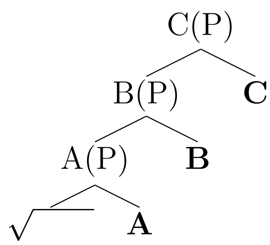
[26] Bottom-up steps are also essentially built into "incremental" (non-realizational) theories, e.g., Lieber 1992, Wunderlich 1996.

[27] Hybrid/bi-directional models differ only minimally, even potentially holding that bottom-up realization is the default ordering, just not the only *possible* ordering. See e.g. Carstairs 1990, Carstairs-McCarthy 2001, Wolf 2008, and Deal and Wolf 2017, though cf. Adger et al. 2003, Kiparsky 2021.

nation like “root” or “stem” or through a flat representation that encodes embedding in some way. For illustration here, I will stick with a structural representation where it is syntactic terminal nodes that are involved in realization.

In a morphosyntactic structure like (56), the terminals are the root and the bolded heads A, B, and C. (I abstract away from the question of whether the non-terminal nodes are phrasal or not, hence the Ps are in parentheses.)

(56)



A standard embeddedness calculation (see, e.g., Myler 2017 for a formalization) would take the root to be the most embedded, followed by A, then B, then C as the least embedded terminal. Bottom-up realization would thus start with the root and proceed step-wise up the structure, terminating at C.

Let’s assume for this toy model that the root is exponed as the phonological form *root*, A is exponed as the suffix -*a*, B is exponed as the infix -*b*-, and C is exponed as the suffix -*c*. The relevant rules of exponence are given in (57):

(57)
- a. $\sqrt{\ }$ $\leftrightarrow$ root
- b. A $\leftrightarrow$ -a
- c. B $\leftrightarrow$ -b-
- d. C $\leftrightarrow$ -c

Since we’re interested in cases of intermorphemic infixes, let’s further assume that the infixal exponent -*b*- can (incidentally) surface between the root and -*a*, giving rise to the surface linear order *root<b>-a-c*.

Exponence—the choice/insertion of a phonological form for a terminal—is a core operation of realization. Focusing on exponence, in the step-wise bottom-up realization of (57) there will be four derivational steps (or representational levels), producing four distinct strings of exponents; these four strings are shown in (58a–d), starting from exponence of the root in (58a) and then working upwards, with the exponence of A in (58b), B in (58c), and C in (58d), each adding to the string produced by the previous step.

(58) Bottom-up exponence

a.	root	($\sqrt{\ }$ $\leftrightarrow$ root)
b.	root-a	(A $\leftrightarrow$ -a)
c.	root<b>-a	(B $\leftrightarrow$ -b-)
d.	root<b>-a-c	(C $\leftrightarrow$ -c)

I assume that infixation of the infixal exponent *-b-* is immediate upon the exponence of B in (58c), i.e., there is no step where B has been exponed and *-b-* sits after A/*-a* (*root-a-b*). See §4.2.3 for a discussion of the (undesirable) consequences of delaying infixation.

Stepwise, bottom-up exponence makes the following predictions. First of all, infixation of *-b-* in between *root* and *-a* should not affect the choice of exponent for A or the root, because exponence of A and the root, (58a-b), both precede the exponence/infixation of B/*-b-*, (58c). This is crucially a correct prediction—exponent choice in the stem of an infix is unaffected by the intervention of the infix, as seen in a variety of suppletive allomorphy case studies in §3.3. Recall that the non-intervention of the infix holds even for phonologically/prosodically-conditioned suppletive allomorphy in its stem. This, too, is straightforwardly predicted under bottom-up exponence, because at the point where A is exponed, (58b), the root already has a phonological form from (58a), making phonologically/prosodically-conditioned exponent choice for A possible *and* impervious to later intervention at steps (58c-d). Thus in Nancowry, for example, prosodically-conditioned allomorphy of the causative morpheme (corresponding to A in the toy model) survives across the intrusion of the outer nominalizing infix (B in the toy model), as was shown in §3.3, (30).

A second prediction of bottom-up exponence is that, given the four distinct strings in (58), there is the possibility for each distinct string to undergo a cycle of (morpho)phonology. Most relevantly here, it is possible via the step in (58b) for *root* and A/*-a* to interact (morpho)phonologically, prior to the intrusion of the infix in (58c). This too is crucially a correct prediction, as shown in §3.4, where the intrusion of an infix in its stem fails to interrupt (morpho)phonological interactions in its stem. Elaborating on this finding, what the data in this paper shows is that some amount of phonology—perhaps just morphophonology, but arguably also other "early" or cyclic phonological processes as well (which I'll return to below)—must be interspersed with exponence during bottom-up realization. In other words, it is not *just* exponence that is taking place from the bottom-up in steps, like in (58), but other aspects of realization as well. This is represented in the elaborated bottom-up realization in (59).

(59) Bottom-up exponence and (morpho)phonology

a.	Exponence: *root*	($\sqrt{}$ $\leftrightarrow$ root)
b.	Cycle of (morpho)phonology	
c.	Exponence: *root-a*	(A $\leftrightarrow$ -a)
d.	Cycle of (morpho)phonology	
e.	Exponence: *root<b>-a*	(B $\leftrightarrow$ -b-)
f.	Cycle of (morpho)phonology	
g.	Exponence: *root<b>-a-c*	(C $\leftrightarrow$ -c)
h.	Cycle of (morpho)phonology	

This elaborated model accounts for the data in §3.4. In Movima, (38b) for example, the absolute state suffix (corresponding to A in the toy model, exponed at step (59c)) triggers morphophonological reduplication (corresponding to step (59d) above); this reduplication survives intact across the intrusion of the outer irrealis infix (B in the toy model, exponed at step (59e)).

Finally, bottom-up exponence produces a surface string, (58d)/(59g), representing the realized form of the whole structure. Given the findings in §3.5, which show that surface phonology in the stem of an infix does *not* survive infixation, it must be that some phonological interactions are "late", applying only over larger domains rather than interspersed with exponent choice. This motivates the addition of step (60i) to the toy model:

(60) Bottom-up exponence and (morpho)phonology, with late surface phonology

a. Exponence: *root* ($\sqrt{} \leftrightarrow$ root)
b. Cycle of (morpho)phonology
c. Exponence: *root-a* (A $\leftrightarrow$ -a)
d. Cycle of (morpho)phonology
e. Exponence: *root<b>-a* (B $\leftrightarrow$ -b-)
f. Cycle of (morpho)phonology
g. Exponence: *root<b>-a-c* (C $\leftrightarrow$ -c)
h. Cycle of (morpho)phonology
i. Surface phonology

Drawing from the present data, the lateness of surface phonology accounts (for example) for Hunzib, (51): the causative suffix (A in the toy model) undergoes both morphophonological vowel epenthesis and purely phonological vowel harmony; vowel epenthesis takes place cyclically (at step (60d) above), and therefore survives the intrusion of the verbal plural infix (B in the toy model, exponed in step (60e) above); harmony of the epenthesized vowel takes place as part of surface phonology (at step (60i) above), and so *does* see the infix in its surface position, i.e., does not "survive" (apply across) the intrusion of the infix.

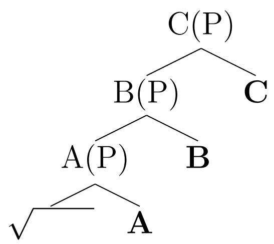
The addition of a step of late/surface phonology to the model is in line with theories that posit a distinction between the timing of different types of phonological processes, with some applying cyclically/early and others not (e.g., Kiparsky 1982, Booij and Rubach 1987, Stump 2001, Bermudez-Otero 2012, Inkelas 2014). Beyond the evidence for this split from what does/does not survive the intrusion of an infix (compare §3.4 to §3.5), there is other evidence from the domain of infixation for the need for at least some phonology (including prosody) to take place cyclically, from the bottom up. Consider, for example, that it is not uncommon for infixes to have a prosodic placement (Yu 2007). For infixes to have a prosodic placement that is based on regular prosodic processes of a language, it must be that these prosodic processes have already applied prior to infixation. Since infixation is exponent-specific and applies immediately upon exponence, it must be that at least some prosodic structure is built cyclically, from the bottom up. Drawing from the sample of case studies in this paper, such cyclic prosodic structure-building is crucial for Movima—where the infix is placed after the first iambic foot of its stem—and for Nancowry—where exponent choice for both morphemes under consideration is prosodically-conditioned. Further, as discussed in fn. 5, infix placement is often opaque in Movima, as it is fed by prosodic structure and penultimate lengthening (in an early cycle) that may be overwritten in the surface form (in a later cycle).

In sum, bottom-up realization straightforwardly provides a fine-grained level of differentiation among strings/steps that can accommodate the finding that most relationships/interactions in the stem of an infix are undisturbed by the linear intrusion of the infix. More specifically, to explain the findings, it's necessary to recognize three operations as part of realization that apply cyclically from the bottom up—exponence, infixation (which I take to be simultaneous with exponence), and early (morpho)phonology—and one type of operation that applies over larger strings, surface/late phonology.

4.2.2 Infixation in a fully-simultaneous model of realization

A simultaneous model of realization would hold that (at least) exponence proceeds all-at-once across a structure within a given domain. Assuming that C(P) is the minimal relevant domain in (61) (repeated from above), such an account would hold that the terminal nodes—root, A, B, and C—are all exponed at the same time in one fell swoop, none before any other.

(61)



I'll continue to assume that in this toy model, as per (57), the root is exponed as *root*, A as *-a*, B as *-b-* (which can incidentally surface between *root* and *-a*), and C as *-c*. This section and the following section will argue that simultaneous models of realization make a number of undesirable predictions with respect to interactions between infixes and their environment.

There are two ways to fit infixation into a simultaneous model of realization. One possibility is that simultaneous realization includes exponence but does *not* include infixation, i.e., infixation is delayed; I put this possibility aside to explore in detail in §4.2.3. Another possibility, which I explore in detail in this section, is that simultaneous realization includes both exponence and infixation, such that realization of (61) results in just one surface string, that in (62), where *-b-* is in its infixed position:

(62) root<b>-a-c

In this type of model, which I'll call fully-simultaneous realization, there is only one string of exponents that is generated (vs. four strings in the bottom-up model, §4.2.1); in other words, there is no derivational point (or representational level) at which exponents are ordered in any other way than their surface order, and there is no derivational point (or representational level) at which a subset of the exponents are present. The single string in (62) is identical to the final derivational stage (or representational level) from the bottom-up model, (58d).

The predictions of a fully-simultaneous model—where exponence and infixation happen in one fell swoop—are as follows. First, suppletive allomorphy arising between the root/*root* and A/-*a* should be disrupted by the infix, because in the string over which appropriateness of different allomorphs would be evaluated, (62), the infix is already in an infixed (disrupting) position. Second, *root* and A/-*a* should not interact (morpho)phonologically in any capacity, again because the one available string over which such interactions could apply, (62), already has *root* and A/-*a* non-local to each other.[28] Both predictions follow from the fact that in this type of model, the root—in its exponed form, at least—is never adjacent to A/-*a*.

There is a variety of evidence against a fully-simultaneous model from the data presented in this paper, and from infixation more generally. Perhaps most obviously, both predictions described above are incorrect, as shown in §3.3-4, where both suppletive allomorphy and morphophonological interactions in the stem of an infix in fact *do* survive despite the intrusion of the infix. In contrast, the bottom-up model, §4.2.1, handles this data very naturally.

Two other prior findings, from Kalin 2022a, also speak to the inadequacy of a fully-simultaneous model. From a survey of 32 case studies of morphemes that exhibit suppletive allomorphy, where at least one allomorph is infixal, Kalin finds that such allomorphy is always determined from the stem edge, and never from the surface position of an infix. This is very surprising if exponence and infixation take place all at once across a domain, since (62) is the only string available for evaluating suppletive allomorph choice. Another piece of evidence comes from the direction of infixation—Kalin finds that infixes only ever move inward into more (morphosyntactically) embedded exponents, and never outwardly into less-embedded exponents. In a fully-simultaneous model, there is no a priori reason why an infix wouldn't be able to lodge itself into less embedded material, since that material is available simultaneous with inner material. Both of these findings from Kalin 2022a are naturally dealt with in a bottom-up model (§4.2.1): at the point of exponent choice for B in the toy model, B is structurally at the edge of the previously-exponed string, and, the only previously-exponed phonological material (within which the infix can find its pivot) is that material which is more deeply embedded than the infix itself.

I therefore conclude that a fully-simultaneous model fails to capture the data at hand, and faces additional problems with respect to infixes and infixation. But, what about a model of simultaneous exponence that *delays* infixation? We will see that this sidesteps some of the issues discussed above, but runs into others.

4.2.3 Infixation in a simultaneous model of realization with delayed infixation

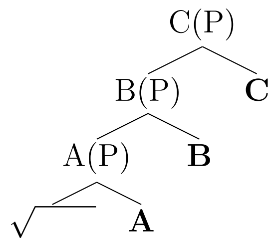
There are a number of optimality-theoretic proposals in the literature that argue for locating infixation entirely in the phonological component of the grammar, with infixation driven by purely phonological constraints and/or by morphologically-indexed phonological alignment constraints (see, e.g., Prince and Smolensky 1993, McCarthy and Prince 1993, Hyman and Inkelas 1997). Within such theories, it would be natural to assume that exponence takes

[28] An exception, of course, would be if the suppletive or (morpho)phonological process at hand is one that happens exceptionally at-a-distance, which should be evident from other environments.

place *prior to* (surface) phonology,[29] and therefore also prior to infixation of an infixal exponent. This, in turn, opens up the possibility for maintaining simultaneous exponence (à la §4.2.2) while separating out infixation as being part of a different derivational step or representational level. Does this type of account—simultaneous realization with delayed infixation—fare better on the data at hand, as compared to fully-simultaneous realization?

Turning back to the toy model: separating infixation from simultaneous exponence would mean that the root, A, B, and C in (63) (repeated from above) are all exponed at the same time, *but* with no infixation, producing the string in (64a). At a separate step/level, infixation takes place, producing the string in (64b).

(63)



(64) a. root-a-b-c (exponence)
b. root<b>-a-c (infixation)

There are thus two relevant exponent strings under this model, as compared to one string in a fully-simultaneous model (§4.2.2) and four in a bottom-up model (§4.2.1). The string in (64b) is the surface string, after both exponence and infixation have taken place; this string is the one-and-only string generated under a fully-simultaneous model, cf. (62), and is also identical to the final derivational stage (or representational level) from the bottom-up model, cf. (58d). It's crucial to note that the pre-infixation string in (64a)—which maps the morphosyntactic ordering in (63) to a transparent/faithful linear order—is a string that is not generated under either other model considered in the previous sections; it is this string that will both sidestep some of the empirical problems with full-simultaneity, while also creating some new problems.

At a first glance, a model that incorporates simultaneous exponence with delayed infixation fares better than the fully-simultaneous model (§4.2.2). Since there is a string—(64a), *root-a-b-c*—where there is adjacency between the root/*root* and A/-*a*, the two terminals in the stem of infixation can interact in terms of suppletive allomorphy and (morpho)phonology, without the intrusion of the infix. This is, of course, a desirable prediction (see §3.3-4), and one that differentiates this model from the fully-simultaneous model.

However, in order to allow such interactions—namely, allomorphic and (morpho)phonological interactions—between root/*root* and A/-*a* to take place, it must be that the *whole* string in (64a) (*root-a-b-c*) is visible for these types of interactions, with -*b*- crucially in its non-infixed position; there is no principled way to delimit allomorphic and (morpho)phonological interactions to just a subpart of the string in (64a). As a direct result, the two-step ac-

[29] There are OT proposals that locate exponence (at least of certain types) in the phonology as well. This would essentially lead back to a fully-simultaneous model, which was already considered in §4.2.2.

count in (64) makes a number of undesirable predictions. First of all, *-b-* should be able to undergo, or trigger, (morpho)phonological alternations in its pre-infixation position. This prediction, crucially, is incorrect. As discussed in both Yu 2007 and Kalin 2022a, infixes do not look like they live any kind of exponed/phonological life in their underlying (non-infixed) position—infixes are *only* visible for (morpho)phonology in their infixed (surface) positions. In addition, the string in (64a) predicts that suppletive allomorphy of C could be phonologically-conditioned by the adjacent *-b-*, when in fact relevant case studies show that infixes must be in their infixed position already for the purposes of phonologically-conditioned suppletive allomorphy of further-out morphemes, like C in (63) (Kalin 2023). And of course, the argument against simultaneous exponence from the inward directionality of infixation (see the end of §4.2.2) also speaks against simultaneous exponence with delayed infixation—if infixation is delayed, there is no reason an infix should not be able to find its pivot inwardly or outwardly. A bottom-up model with immediate infixation (§4.2.1) does not make any of these incorrect predictions.

There is final reason, drawn from Kalin 2022a, to be skeptical about generating a pre-infixation string like (64a) at any derivational step (or representational level). When a morpheme has multiple allomorphs, and at least one of these allomorphs is infixal, the choice among allomorphs takes into account material that is accessible *inwardly* relative to that morpheme (more embedded, in a morphosyntactic sense) but not outwardly. Stated concretely using the above model, suppletive allomorphy of B can be conditioned by A/*-a* and the root/*root*, but not by C/*-c*.[30] If exponence is simultaneous and generates a string where an infix is in its underlying morphosyntactically-expected position, like in (64a), then it should be the case that exponent choice for the morpheme with the infixal realization (B in the toy model) could be sensitive to material (even phonological material) both inwardly and outwardly. Yet again, a bottom-up model does not make this prediction, because B is exponed at a point where the only already-exponed phonological material is inward relative to B.

I therefore conclude that a simultaneous model, even with delayed infixation, is not viable.

4.2.4 Interim summary: How different models fare

In this section, I compared two opposing models of realization, one where realization proceeds in steps, from the bottom (or innermost) morphosyntactic component to the highest (or outermost), and one where realization (at minimum, exponence) is simultaneous across a domain. Of these two basic types of models, only bottom-up realization is able to capture

[30]It is in fact surprising that Kalin 2022a found that (referring to the toy model here) C could not affect exponence of B, though not surprising that the exponent *-c* could not affect exponence of B. (See, e.g., Bobaljik 2000.)

the core data discussed in this paper, while also accounting for other recent empirical findings about infixation more generally.[31]

More specifically, the data in this paper support a model where realization is post-syntactic (§4.1) and proceeds cyclically from the bottom of a morphosyntactic structure upward (§4.2.1). Further, each step of realization itself must include at least exponence, infixation (of infixal exponents), and some limited (morpho)phonology. Finally, even under such a model, some phonological interactions must be "late" (non-cyclic), applying only over larger realized domains and crucially *not* at each step. Models that involve simultaneous exponence—whether including (§4.2.2) or delaying (§4.2.3) infixation—make a number of incorrect predictions about the data at hand and other data related to infixation.

5 Conclusion

In this paper, I have reported novel cross-linguistic findings related to the transparency vs. non-transparency of infixes when they appear (incidentally) at a morpheme juncture in their stem. The relationships/interactions that *survive* the intrusion of an infix must be established *prior to* infixation (or stem from such relationships/interactions). The relationships/interactions that *do not survive* the intrusion of an infix must be established *after* infixation. The data therefore afford us a novel way to probe at interactions among phonology, morphology, syntax, and semantics.

I have argued that the findings provide evidence for the following specific architectural aspects of morphology and realization: (i) morphology is post-syntactic (à la Halle and Marantz 1993, 1994); (ii) exponent choice proceeds from the bottom of a structure upward (Bobaljik 2000, Embick 2010, Myler 2017, Kalin 2020, *i.a.*); and (iii) bottom-up exponence is interleaved with some (morpho)phonological processes, but not others (Kiparsky 1982, Booij and Rubach 1987, Stump 2001, Bermudez-Otero 2012, Inkelas 2014, *i.a.*). Other findings in this paper relate to the need to recognize a derivational step or level of representation that establishes semantic relationships (§3.1) and morphosyntactic relationships e.g. of selection (§3.2) separately from the phonological location of an infixal exponent; since this is a possibility afforded across all models discussed in §4, it does not help us to differentiate theories of the architecture of the grammar, but nevertheless is an important result to have established as a sort of proof of concept of the methodology pursued in this paper.

Of all of the findings, I take bottom-up realization to be the central, most robust finding. Indeed, there is converging evidence for (at least) bottom-up exponence from a variety of domains, including suppletive allomorphy (Carstairs 1987, 1990, Dolbey 1997, Paster 2006, Embick 2010), infixation more generally (Kalin 2022a), replacive grammatical tone (Rolle 2018), non-local phonological interactions in Mirror-Principle violating structures (Myler 2017), and portmanteau formation (Banerjee 2021). Despite this converging evidence, there are of course always exceptional cases that seem to break the generalization, and I leave it

[31] While I did not consider in detail the possibility that realization could be top-down in addition to bottom-up, all evidence from infixation points to a uniform bottom-up model, including the data presented in this paper. See Kalin 2022a for a discussion of bidirectional models.

as an open question whether all such cases can be reanalyzed as due to (e.g.) exceptional morphosyntax (see, e.g., Kalin 2020) or exceptional phonology (see, e.g., Kiparsky 2021), rather than an exceptional direction of realization.

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