Phonology (2022), **39**:2 293–343
doi:10.1017/S0952675723000088

PHONOLOGY

ARTICLE

Phonology cannot transpose: evidence from Meto

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Received: 24 January 2021; **Revised:** 22 April 2022; **Accepted:** 21 September 2022; **First published online:** 13 October 2023

Keywords: metathesis, spreading, coalescence, Austronesian, prosody

Abstract
Metathesis poses challenges for a typologically constrained theory of phonology: despite being simple to describe, its distribution is highly restricted, making it difficult to create analyses that make predictions while not overgenerating. Here, I investigate metathesis in Uab Meto (Austronesian; Indonesia), an understudied language with CV metathesis that is synchronic and productive. Drawing on original fieldwork, I argue that metathesis is not transposition, but instead a serial delete-and-spread mechanism (cf. Takahashi 2018, 2019). To support this, I present a deep case study into the language's phonology, showing that metathesis arises from spreading, deletion and epenthesis patterns. I propose that synchronic metathesis systems like Uab Meto's can only emerge from the successive application of these mechanisms, and hypothesise that true transposition, if it exists, only arises through morpheme-specific operations. This study thus presents a new look onto the typology of synchronic metathesis, and offers an explanatory account of its typological rarity.

Contents

1. Introduction

Metathesis, the local transposition of two segments, has long been an area of debate in phonological theory: whether it exists at all, given its typological rarity (Webb 1974; Montreuil 1985; Powell 1985), or whether it simply does not exist as a single transposition mechanism, and instead is the serial application of smaller copy-and-delete or coalescence operations (Besnier 1987; Hume 1991; Blevins & Garrett 1998; Takahashi 2018, 2019). Although recent work has confirmed the existence of metathesis as a surface phonological alternation (Hume 1998, 2001; Canfield 2016, among others), there is still considerable debate over how to analyse such alternations – are they best analysed as transposition, coalescence, successive copy-and-delete mechanisms or feature spreading?

In generative grammar, the choice of how to analyse metathesis has robust implications for phonological typology. If transposition is an operation in the phonology proper, then we may expect for it to arise in similar frequency and distribution to better-known patterns like epenthesis or deletion. Yet the typology of metathesis is far more restricted, as metathesis is often limited to only certain segments or only a few morphemes in a given language (Hume 2001; Horwood 2004, among others). Furthermore, generative grammars will often predict multiple transpositions to be possible, creating long-distance metathesis patterns that have been argued to be synchronically unattested (Poser 1982; McCarthy 2000; Horwood 2004; see potential counterexamples in Blevins & Garrett 1998; Mielke & Hume 2001; Chandlee *et al.* 2012). In models like Optimality Theory (OT), the observed typology is unexpected, and yet few proposals have addressed how to eliminate these broad predictions.

In this article, I introduce novel data from original fieldwork on Uab Meto (West Timor, Indonesia), an Austronesian language with robust CV metathesis. While detailed descriptive work on the language exists (Edwards 2016, 2018, 2020; Culhane 2018), Meto metathesis has not yet figured into these theoretical discussions. Meto metathesis is both common and productive, occurring with almost all segments in the language, and shows robust interactions with many aspects of the language's phonology. Through an in-depth case study, I investigate how metathesis interleaves with other phonological processes in the language like epenthesis and deletion, and conclude that metathesis only surfaces where multiple phonological patterns interact.

Based on these data, I argue that there is no transposition in phonology. I analyse Meto metathesis as covert spreading along a CV skeleton, where a timing slot deletes and then a vowel feature spreads leftwards. This view explains why Uab Meto metathesis has such rich interactions with epenthesis, deletion and spreading

https://doi.org/10.1017/S0952675723000088 Published online by Cambridge University Press

in the language – these processes are the precursors to phonological metathesis, and so metathesis can only surface where these processes interact. True transposition, if it exists, must be analysed as a morphophonological operation that is driven by morpheme-specific requirements rather than the global phonology. I cast the analysis in Harmonic Serialism (McCarthy & Pater 2016), a relative of OT.

The article is organised as follows: §1 introduces the analysis and discusses some initial alternatives. §2 then turns to the full set of CV → VC metathesis alternations and shows how Meto metathesis occurs in complementary distribution with other coalescence operations like diphthongisation and deletion. §3 discusses epenthesis in the language and how this relates to locality restrictions on spreading. §4 discusses alternatives and predictions for the typology of metathesis, and §5 concludes.

1.1 Introducing the pattern: metathesis under suffixation

Uab Meto is a dialect chain spoken in West Timor, Indonesia. The Molo dialect of Meto has 7 vowels /a, i, ɪ, e, o, ɔ, u/ and 12 consonants /p, f, b, t, s, k, h, ʔ, m, n, l, ɟ͡j/.[1] Unless otherwise indicated, all generalisations and data apply to the Molo dialect, collected in Bijaepunu, North Molo in 2018 and 2019. Data on Kotos Amarasi (from Oekabiti) and Amanuban (from Noenoni) were also collected in Kupang, West Timor at that time. Previous work on the language has focused on Amarasi (Edwards 2016, 2018, 2020) and Amfo'an dialects (Culhane 2018). Although they are not mutually intelligible with Molo, I offer comparisons with these dialects as the opportunity arises.

Uab Meto has apparent metathesis in CVCV(C) roots when they combine with a vowel-bearing suffix. The end effect is that stress, which is fixed on the penult of a root (e.g. CV́CVC [ˈkokɪs] 'bread'), then aligns with the penult of the word (e.g. /ˈkokɪs-e/ → [ˈko͡ɪks-e] 'the bread'). Apparent metathesis occurs only when it improves the prosodic output.[2] Examples of this pattern are shown in (1).

(1) *Coalescing metathesis (suffixation)*

a.	[ˈkokɪs]	σ́σ	'bread'	*[ko͡ɪks]	*σ́
	[ˈko͡ɪks-e]	σ́σ	'the bread'	*[ˈkokɪs-e]	*σ́σσ
b.	[baˈkaseʔ]	σσ́σ	'horse'	*[baˈka͡es]	*σσ́
	[baˈka͡esʔ-e]	σσ́σ	'the horse'	*[baˈkaseʔ-e]	*σσ́σσ
c.	[ˈmepo]	σ́σ	'to work'	*[ˈme͡op]	*σ́
	[ʔa-ˈmepo-t]	σ́σ	'worker'	*[ʔa-ˈme͡op-t]	*σσ́
	[ʔa-ˈme͡op-t-in]	σσ́σ	'workers'	*[ʔa-ˈmepo-t-in]	*σσ́σσ
	[ʔa-ˈme͡op-t-in-e]	σσ́σσ	'the workers'	*[ʔa-ˈmepo-t-in-e]	*σσ́σσσ

I propose that apparent metathesis in Meto is not transposition, but instead the serial application of deletion and spreading mechanisms, as in (2). In Step 0, suffixation

[1] Edwards (2016, 2020) treats the front vowels slightly differently, positing /i, e, ɛ/ rather than /i, ɪ, e/ in Kotos Amarasi. The rationale behind the present /i, ɪ, e/ contrast is to capture the fact that /i, ɪ/ pattern together as high vowels in consonant epenthesis (see §3.2), and that the /ɪ/ vowel is higher than the English /e/. I discuss the issue of vowel length in §1.5. Dialects also differ slightly in their sonorants: Amarasi has /r, gʷ/ and Amanuban has glides /j, w/.

[2] Edwards (2016, 2020) analyses metathesis as a type of transposition-based allomorphy, not as a prosodic effect; see §1.5.

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makes stress antepenultimate. This creates a marked right-edge stress lapse in the phonological word. To correct this, in Step 1, the root-final V-slot deletes through prosodic truncation. Prosodic truncation reduces the post-tonic syllable count at the cost of delinking vowel melody features. In Step 2, the floating vowel melody spreads to the preceding V-slot, giving the surface appearance of transposition even though the features remain in their original order.

(2) a. *Step 0: Stress assignment*

```
C V́ C V C - V
| | | | |     |
k o k ɪ s     e        [ˈkokɪs-e]
```

b. *Step 1: Prosodic truncation*

```
C V́ C   C - V
| | |   |     |
k o k ɪ s     e        [ˈkokɪ̯s-e]
```

c. *Step 2: Spreading*

```
C V́ C   C - V
| | |   |     |
k o k ɪ s     e        [ˈko͡ɪks-e]
```

d. *Step 3: Convergence*

```
C V́ C   C - V
| | |   |     |
k o k ɪ s     e        [ˈko͡ɪks-e]
```

The core intuition behind this approach is that Meto metathesis is a way of compressing two syllables into one, whereby the final syllable of a root coalesces with the preceding stressed syllable.

I cast this type of coalescence as autosegmental line-crossing. Although the No Crossing Constraint (NCC; Goldsmith 1976) has been previously thought of as a universal, here I allow line-crossing between consonants and vowels. Despite appearances, this approach is not deeply at odds with many spreading-based accounts to vowel harmony (cf. Kimper 2011, 2017). Avoiding violations of the NCC is a major issue for almost all spreading-based accounts of vowel harmony, requiring elaborate representational moves such as assuming planar segregation of consonants and vowels (McCarthy 1979, 1981; Steriade 1986, among others), extensive feature geometries (Clements 1980, 1991; Sagey 1988) or other ways of limiting the NCC to only apply between legitimate targets (see review in Odden 1994; Ní Chiosáin & Padgett 2001). By casting this as line-crossing, I table the issue of representational choice, and contend that the universal prohibition on line-crossing applies only for like spreading over like (cf. Archangeli & Pulleyblank 1994).

That said, Uab Meto still bears restrictions on non-local spreading. For one, only vowels may spread, and spreading is limited to post-tonic environments within morphemes. Parallels to this exist in vowel harmony as well, where some languages only allow harmony to apply in post-tonic environments (e.g. Grabo metaphony; Walker 2005, 2010). In the analysis, I prevent spreading from creating a full-scale

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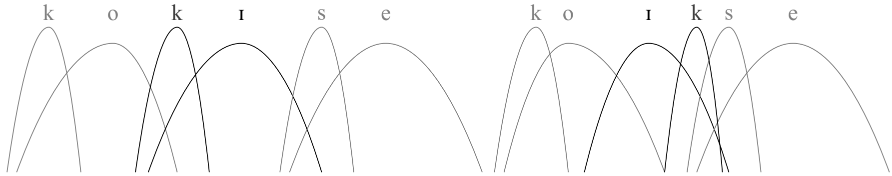

Figure 1. *Gestural score for Uab Meto metathesis.*

vowel harmony system within morphemes by only relaxing the restriction against line-crossing for delinked features (see §3.1). If features have no associated timing slot, they may spread non-locally, but if associated, spreading must be strictly local. This means that non-local spreading will only occur when a V-slot deletes. I introduce further locality restrictions on spreading as needed.

Line-crossing has been argued to pose conceptual issues for phonetic implementation, and I attempt to resolve these here before moving on. In early work in Autosegmental Phonology, line-crossing was argued to be illicit because it would create segments that must simultaneously precede and follow an intervening segment (see Sagey 1986, 1988). To resolve this, I reinterpret association lines as indicators of gestural overlap rather than simultaneity (Bird & Klein 1990, Gafos 1999; contra Goldsmith 1976). If there is an association line between a feature F_x and slot X_i, then some phonetic portion of F_x must overlap a phonetic portion of the slot X_i. When a slot X_i precedes a slot X_j, the midpoint of X_i must precede the midpoint of X_j. The order of features also encodes weak precedence:[3] if F_x directly precedes F_y, then there must be some phonetic portion of F_x that precedes all given portions of F_y *or* some portion of F_y that follows all portions of F_x. The result is that when association lines cross, the segment with the crossing association line must fully overlap the crossed segment.

To illustrate, take the gestural score for metathesis of /kokɪs-e/ → [ko͡ɪks-e] 'the bread' in Figure 1. Under metathesis, the [ɪ] vowel spreads across the intervening [k], overlapping it entirely. The core precedence relations among features are unchanged, because the offset of [ɪ] still follows all portions of [k]. If this were a VC sequence with no line-crossing, we would expect for the [ɪ] offset to precede the [k] offset.

This type of overlap is distinct from strictly local spreading, where the vowel would spread first to the intervening consonant and then to the preceding vowel. A strictly local spreading model may predict that conflicting gestural values will be overwritten, but in metathesis they are not. In §3.2, I provide a phonological argument in favour of treating this overlap as line-crossing rather than strictly local spreading based on a diphthongisation pattern in the language.

[3]Sagey (1988) had slots and features encode strict precedence, and so line-crossing was ill-formed, e.g. if $F_x \prec F_y$, then *all* phonetic portions of F_x must precede *all* phonetic portions of F_y. I redefine the consequences of slot and feature precedence to be more in line with work in Articulatory Phonology (Browman & Goldstein 1990 et seq.): even if a consonant slot directly precedes a vowel slot or *vice versa,* they should be able to overlap slightly instead of having to strictly precede each other.

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In the next section, I introduce the formal implementation of the analysis in Harmonic Serialism. Stress alignment constraints trigger prosodic truncation, and so the resulting floating vowel spreads leftwards to preserve itself.

1.2 Analysis

I cast the analysis in Harmonic Serialism (McCarthy & Pater 2016). Harmonic Serialism is a relative of OT that combines aspects of rule-based and constraint-based frameworks. Derivations are serial, with the optimal output for one cycle becoming the input to the next. Derivations converge when the faithful candidate wins; this winning candidate then becomes the output for the entire derivation. Harmonic Serialism also imposes a gradualness restriction on Gen, the phonological component that applies changes to forms. The consequence of this gradualness restriction is that each candidate may only differ from the input by at most one change. Exactly what constitutes one change is an open area of research for Harmonic Serialism. I follow McCarthy (2008) in assuming that deletion involves two steps: deletion of a timing slot and deletion of features. To simplify derivations, I assume that syllabification and delinking come for free, even though spreading does not.

The derivation in (2) showing /kokɪs-e/ → [ˈko͡ɪks-e] 'the bread' involves three main steps: stress assignment, prosodic truncation and spreading. For stress assignment, Uab Meto stress invariably falls on the penultimate or only syllable of a root. The addition of suffixes does not cause stress to shift, which I assume is because metrical structure cannot be modified after assignment (the assumption that Pruitt 2010 calls Strict Inheritance). Without fully formalising the analysis, I encode the stress system with the cover constraint RootStress. I also assume that, because stress is penultimate, NonFin ≫ Align(X,R):[4]

(3) a. NonFin: 'Stress does not fall on the final syllable' (Gordon 2002: 501)
b. Align(X,R): Assign one violation for each syllable that separates primary stress from the right edge of a prosodic word/phrase (cf. McCarthy & Prince 1993; Gordon 2002: 498)

After stress assignment to the root, suffixes and additional phrasal material are added.[5] Suffixation creates additional violations of Align(X,R) in (4). To reduce these Align(X,R) violations, the V-slot associated with the [ɪ] vowel deletes and leaves

[4]I assume a grid-based model of cyclic stress assignment (Prince 1983 et seq.). Each root receives an X_1 mark on its penultimate or only vowel. Words will promote a root stress to X_2 and phrases will promote a word stress to X_3. To simplify derivations, I assume that alignment constraints only evaluate the highest-ranked (i.e. primary) stress in each word or phrase.

[5]This assumption may not be needed depending on the formal implementation of RootStress. If RootStress is simply a requirement for roots to receive stress (cf. Parse constraints in Elfner 2009), this assumption is needed to ensure that alignment is evaluated relative to root edges (e.g. /kokɪs/ → [ˈkokɪs] → [ˈkokɪs-e]), not word edges (e.g. /kokɪs-e/ → *[koˈkɪs-e]). An alternative is to assume that RootStress has an alignment component that penalises roots if they are stressless or if they bear final stress. However, this presents a technical issue: if RootStress penalises roots with final stress, then it should also block truncation in (4c). To avoid this complication, I simply assume that root stress assignment precedes affixation.

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the vowel features floating. Full deletion of features and V-slot would violate the gradualness restriction on GEN, and so candidates like it are not considered. From this point on, floating vowel features are written with the non-syllabic subscript (e.g. V̯), and featureless slots are written as C or V in tableaux.

(4) *Step 1: Prosodic truncation*

/ˈkokɪs-e/	ROOT STRESS	MAX$_F$	ALIGN(X,R)	*FLOAT	*XSPR	MAX$_V$
a. ˈko.kɪ.s-e			**!			
b. ˈko.kV.s-e		*!	**	*		
☞ c. ˈkokɪ̯.s-e			*	*		*
d. ˈko͡ɪ.kɪ.s-e			**!		*	
e. ko.ˈkɪ.s-e	*!		*			

Structure of candidate (c):

```
C  V́  C     C  -  V
|  |  |     |     |
k  o  k  ɪ  s     e
```

In principle, the suffix vowel [-e] could also be a candidate for deletion, but Meto has positional restrictions on truncation that prevent this. A V-slot can only delete when it is (a) the last V-slot of a root and (b) unstressed. In §4.1, I discuss a similar restriction on deletion for C-slots: only word-final C-slots delete. Intuitively, these restrictions follow from the fact that initial segments of words tend to be protected, whereas word-final segments are more prone to undergo alternations (Steriade 1994; Beckman 1998). From here on, I omit candidates that violate these restrictions and assume that they are ruled out by a positional cover constraint on morpheme-initial deletion, MAX-INITIAL.

After prosodic truncation, the derivation has a marked floating vowel melody that is unassociated with any slot. I introduce the constraint *XSPREAD, which militates against consonant–vowel line-crossing, and *FLOAT, which militates against unassociated features and slots:

(5) *XSPREAD: Assign one violation for each pair of association lines that cross (cf. *SKIP, Uffmann 2006: 1096)

(6) *FLOAT: A feature bundle must be associated with at least one slot, and *vice versa* (cf. HAVEPLACE, Padgett 1995; see also Zoll 1994)

In this scenario, Meto prefers to spread rather than delete (MAX$_F$ $\gg$ *XSPREAD), even though that involves crossing a consonantal association line. The vowel coalesces onto the preceding syllable, overlapping the intervening consonant.[6]

[6] Rightwards spreading (e.g. *[koks-i͡e]) is ruled out by a constraint MORPH*XSPR that prohibits spreading across morpheme boundaries; see §3.

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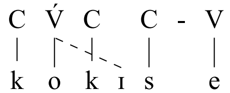
(7) *Step 2: Spreading*

/ˈkokɪ̯s-e/	MAX$_F$	ALIGN(X,R)	*FLOAT	*XSPR	MAX$_V$
a. ˈkokɪ̯.s-e		*	*!		
☞ b. ˈko͡ɪk.s-e		*		*	
c. ˈkok.s-e	*!	*			
d. ˈko.kɪ.s-e		**!			

Structure of candidate (b):



After this, the faithful candidate (7b) [ˈko͡ɪks-e] wins and the derivation converges. There are no floating features, and no further prosodic truncation is possible.

To sum up, I claim that Meto metathesis is prosodically triggered, and acts as a way of preserving vowel features during prosodic reduction. Meto metathesis is not transposition, but instead prosodic truncation of a V-slot followed by spreading.

Before continuing on to more Meto metathesis data, I discuss some salient alternatives: metathesis using transposition (§1.3), coalescence without spreading (§1.4) and allomorphy-based approaches (§1.5). As I will show, the core problem with each of these approaches is that they treat Meto metathesis as the complete transposition of two segments, rather than as gestural overlap.

1.3 Alternative 1: Transposition

In this section, I discuss alternatives that derive metathesis using transposition, a single operation that changes the precedence relations of two segments. While transposition is easy enough to formulate, I argue that analysing metathesis in this way comes at the expense of gross overgeneration and lack of explanatory adequacy for the known typology. I review some broad typological problems with transposition in SPE-style rules and OT, and then introduce specific data from Uab Meto that also suggests metathesised segments do not transpose.

In early work in generative phonology, the transposition operation required a new form for SPE-style phonological rules: 1 2 3 → 1 3 2 (see Chomsky & Halle 1968 on English and Kenstowicz 1971 on Lithuanian). These rules were not only exceptionally powerful, but also gave the impression that transposition should be like any other operation in phonology, a primitive that should be equally available from language to language. While descriptively adequate, these rules do not successfully predict the restricted typology of metathesis, nor do they easily predict where metathesis occurs in complementary distribution with other processes like deletion or epenthesis (e.g. Rotuman; McCarthy 1995, 2000).

Contemporary OT (Prince & Smolensky 1993, 2004) also usually treats metathesis as transposition, most commonly with the constraint LINEARITY (McCarthy & Prince 1995). However, just like rewrite rules, transposition-based accounts of metathesis in OT tend to overgenerate. For one thing, LINEARITY must be ranked low in order

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for metathesis to occur, and so we expect transposition to be a preferred operation throughout the entire phonology of a language. Yet many languages restrict metathesis to only occur between particular morphemes (e.g. Georgian; Butskhrikidze & van de Weijer 2003), particular segments (e.g. Faroese and Lithuanian; Hume & Seo 2004) or at the ends of roots (e.g. Kwara'ae; Sohn 1980). These restrictions have led to new families of Linearity-based constraints, which imply a richer typology of metathesis than is actually attested (Horwood 2004).

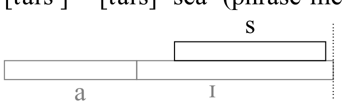
A greater problem for Parallel OT accounts using Linearity is that the degree of violation should not matter for a dominated constraint – if one transposition is not sufficient, the derivation should still prefer a candidate with multiple transpositions over other operations (cf. McCarthy 2000). However, this often over-predicts metathesis: metathesis occurring in words of the wrong templatic shape, or long-distance metathesis moving a segment too far. This led to numerous proposals for how to fix this overgeneration issue, ranging from adjacency-preservation constraints (e.g. IO-Adjacency, Carpenter 2002; Contiguity, Heinz 2005b) to constraint conjunction of Linearity (Horwood 2004) or positional faithfulness constraints (Canfield 2016). None of these proposals adequately explains why the typology is the way it is: Why should transposition be rare? Why should multiple transpositions be unattested, when multiple applications of other phonological processes (like deletion or epenthesis) are fine? The core problem seems to be with transposition itself: as long as transposition is in Gen, OT models will predict a broader typology for metathesis than what actually exists.

On a narrower level, analysing metathesis as transposition also tends to make a number of incorrect predictions for individual metathesis patterns. In Meto, for instance, phonetic and phonological data support the conclusion that metathesised vowel features do not perfectly transpose. In my analysis, I capture this imperfect transposition by proposing that metathesised vowel features remain *in situ.*

For example, transposition-based models treat metathesis as a complete reordering of two segments. Metathesis under transposition is therefore expected to be phonetically perfect: a metathesised /CVCV/ → [CVVC] form should have identical surface phonetics to an underlying [CVVC] form. However, Meto metathesis is not phonetically perfect in this sense, and instead generates phonetically exceptional forms: metathesised VC sequences have greater consonant–vowel overlap than underlying VC sequences. To illustrate, take the Meto metathesised word [ta͡ɪs] 'sea' and the non-metathesised word [taɪ-s] 'sarong', schematised in (8):

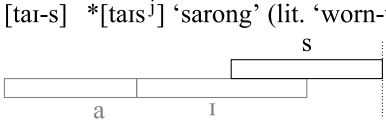
(8) *Metathesis colours intervening consonants*

a. [ta͡ɪsʲ] ~ [ta͡ɪs] 'sea' (phrase-medial) cf. [tasi] 'sea' (phrase-final)



[ɪ] offset follows [s]

b. [taɪ-s] *[taɪsʲ] 'sarong' (lit. 'worn-thing') cf. [taɪ] 'to wear'



[s] offset follows [ɪ]

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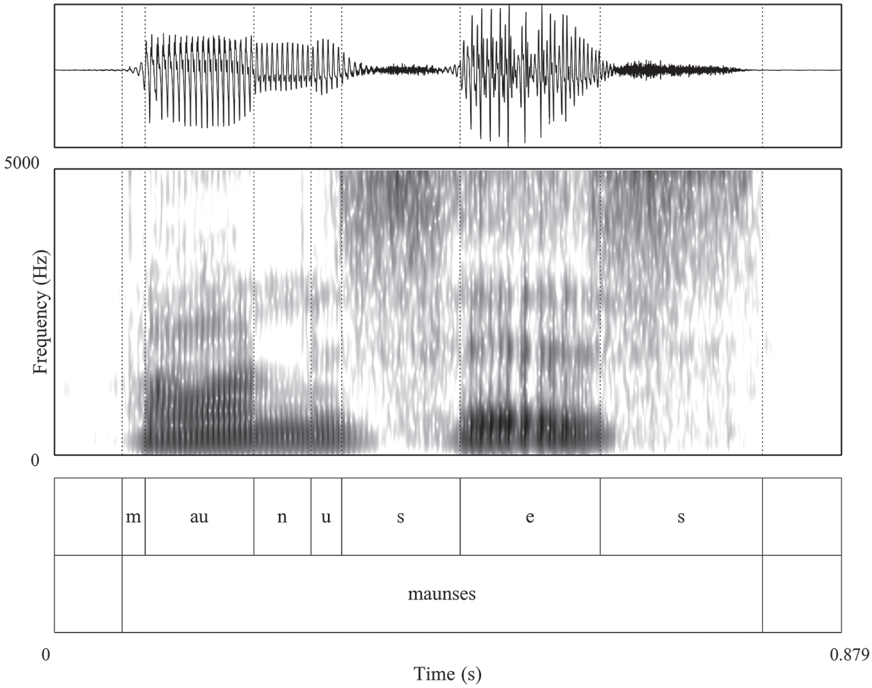

Figure 2. *Spectrogram of overlap during metathesis: /manus-es/ → [ma͡ʊnu̯s-es] 'a betel vine'.*

Although these words have the same set of gestures, the precedence relations are not exactly the same. In the metathesised word [ta͡ɪs] 'sea', the [ɪ] vowel fully overlaps the [s], palatalising it to [sʲ]. In contrast, the underlying CVVC word 'sarong' does not palatalise [s], showing that the offset of [ɪ] precedes the offset of [s].

Similar types of increased overlap are also seen in fast, casual speech, where metathesised C͡VVC forms can sometimes be pronounced as C͡VVCV̯, with an excrescent vowel remaining on the right-hand side. For instance, Figure 2 shows a waveform and spectrogram of /manus/ → [ma͡ʊnu̯s-es] 'a betel vine', where an excrescent vowel surfaces after the [n]. In my account of Meto metathesis, this behaviour is expected. During spreading, the core precedence relations among features are unchanged, and so even when a vowel spreads across a consonant, the vowel offset will remain after the consonant offset. In fast speech, sloppy gestural coordination in metathesised forms will yield excrescent vowels as a purely phonetic effect (cf. Hall 2003), since the offsets were temporally closer to begin with.

From a phonological perspective, treating metathesis as transposition also fails to predict how templatic word shape determines the surface output. In Meto, CVCV and CVVC words have different phonological behaviour. In small phonological phrases, CVCV roots metathesise to C͡VVC to reduce stress lapses at the left edge of the phonological phrase (see §2). However, CVVC roots do not simply diphthongise to

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CV͡VC, but also delete their word-final consonant to become CV͡V. This is shown in (9):

(9) *CVCV and CVVC words do not have the same alternations*

a. *CVCV words metathesise to become CV͡VC*:

i.	/tasi metan/	[ta͡ɪs ˈmetan]	'black sea'
ii.	/lolɪ moloʔ/	[lo͡ɪl ˈmoloʔ]	'yellow sweet potato'
iii.	/belo metan/	[be͡ol ˈmetan]	'black monkey'

b. *CVVC words will diphthongise and delete a coda to become CV͡V*

i.	/tais metan/	[ta͡ɪ ˈmetan]	'black sarong'	*[ta͡ɪs ˈmetan]
ii.	/loit mate/	[lo͡i ˈmate]	'green money'	*[lo͡ɪt ˈmate]
iii.	/peob mutiʔ/	[pe͡o ˈmutiʔ]	'white onion/garlic'	*[pe͡ob ˈmutiʔ]

In an OT analysis with transposition, it is unexpected that the root CV shape should determine whether we get metathesis or some other phonological alternation. Intuitively, this is because dominated LINEARITY implies that precedence relations are not important in determining the phonological output. A transposition-based analysis would therefore predict that CVCV and CVVC words should either both surface as CV͡VC or both surface as CV͡V. This is not the case in Meto, and this behaviour of CVVC words is challenging for any OT account that fully transposes the output. In §4.1, I show how this pattern leads to ranking paradoxes in Parallel OT and Harmonic Serialism, and sketch an analysis that allows us to circumvent these issues by treating metathesis as non-local spreading.

1.4 Alternative 2: Coalescence without spreading

In response to the overgeneration issues with transposition, Takahashi (2018, 2019) also argues against transposition in GEN. Takahashi dispenses with LINEARITY entirely, and argues that all metathesis stems from successive fission and coalescence, cast in a serial OT framework. In this way, Takahashi is able to (a) remove several long-distance predictions and (b) derive complementary deletion and metathesis patterns in Rotuman, where templatic word shape determines the alternations present. In contrast, these alternations posed persistent challenges for transposition-based analyses for reasons already discussed – dominated LINEARITY overgenerates, both by distance and by templatic word shape.

While Takahashi's approach is conceptually similar to the delete-and-spread model I propose here, there are some formal differences. Takahashi (2019) casts Rotuman metathesis as a copy-and-delete pattern that uses indices. Under this account, Rotuman has highly ranked stress-to-weight principle (SWP), and so phrase-medial words will coalesce into heavy, diphthongised syllables. First, the vowel copies leftwards to form a diphthong, and then the original copy of the vowel deletes to satisfy INTEGRITY, e.g. /ˈpu$_1$re$_2$/ → ˈpu$_1$e$_2$re$_2$ → [ˈpu$_1$e$_2$r]. In Takahashi's account, the two instances of [e$_2$] are separate segments, not a single vowel [e] overlapping the [r] as in my account.

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(10) *Rotuman metathesis via copy-and-delete* (Takahashi 2019)

a. *Step 1: Diphthongisation* /ˈpu$_1$re$_2$/ → [ˈpu$_1$e$_2$re$_2$]

/ˈpu$_1$re$_2$/	MAX	DEP	SWP	FINAL STRESS	INTEGRITY	UNIFORMITY
a. ˈpu$_1$re$_2$			*!	*		
☞ b. ˈpu$_1$e$_2$re$_2$				*	*	
c. ˈpu$_1$r	*!					

b. *Step 2: Deletion* /ˈpu$_1$e$_2$re$_2$/ → [ˈpu$_1$e$_2$r]

/ˈpu$_1$e$_2$re$_2$/	MAX	DEP	SWP	FINAL STRESS	INTEGRITY	UNIFORMITY
a. ˈpu$_1$e$_2$re$_2$				*!	*	
☞ b. ˈpu$_1$e$_2$r						*

The overall prediction Takahashi's account makes is that the metathesised CVVC output, [ˈpu$_1$e$_2$r], should be identical to a faithful CVVC sequence. In Meto, this does not appear to be the case: metathesised CVVC sequences are both phonetically and phonologically exceptional. Phonetically, metathesised CVVC sequences have different gestural alignment, resulting in greater consonant–vowel overlap (§1.3) and shorter VV duration (§1.5). From a phonological standpoint, metathesised and underlying CVVC sequences are also distinct. Later on, I present data on diphthongisation (§2.4) and consonant deletion (§4.1) that support giving different representations to each of these CVVC sequences.

Another point of difference between Takahashi's account and mine is the prosodic constraints driving metathesis. In Takahashi (2018, 2019), metathesis is driven by the SWP, whereas here they are driven by ALIGN(X,R). Gradient alignment constraints of this type have been challenged on the grounds that they overgenerate midpoint-seeking stress patterns (the 'Midpoint Pathology'; Eisner 1997; Hyde 2008; Kager 2012). However, there may be multiple reasons for this gap. For one, midpoint stress systems are expected to be difficult to learn. Stanton (2016) argues that to distinguish a midpoint system from an edge-oriented system, learners will need to see many long polysyllabic words (upwards of five syllables). Long words of this type are rare in the world's languages, and so learners are unlikely to select a midpoint stress system over other alternatives.

The second concern is that theoretical work on the Midpoint Pathology has focused almost exclusively on midpoint-assigning stress systems. However, the Midpoint Pathology could also be understood more broadly as ruling out any phonological pattern that involves high-ranked ALIGN(X,R) and ALIGN(X,L) constraints (Brett Hyde, p.c.). If we take this broader view, it is less clear that the Midpoint Pathology is truly a typological gap. For instance, coalescence patterns like we see in Meto could be an example of the Midpoint Pathology, because ALIGN(X,R) and ALIGN(X,L) conspire together to minimise the length of compounds and phonological phrases (see §2.1).

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By contrast, a stress-to-weight analysis of Molo is unsuccessful because it will predict diphthongisation or lengthening even when there is no suffixation. For example, the stress-to-weight analysis might predict lengthening in isolation, e.g. /baˈkaseʔ/ → *[ba.ˈka:.seʔ] 'horse', instead of [ba.ˈka.seʔ].[7] In Takahashi (2019), these candidates are eliminated by FinalStress, but this is not a valid option in Meto since stress is penultimate. In my analysis, these candidates are ruled out because they do not improve violations of Align(X,R).

To summarise, Takahashi's analysis does not involve transposition in Gen, but still encounters many of the same pitfalls as a transposition-based account. In particular, it predicts that metathesised CVVC sequences should have the same phonetic and phonological behaviour as faithful CVVC sequences. By contrast, I argue that spreading across a CV skeleton better represents the exceptional temporal relations found in metathesised sequences.

1.5 Alternative 3: Allomorphy-based accounts (Edwards 2016, 2020)

Recent accounts of Meto metathesis have argued against prosodic analyses, instead contending that metathesis is a form of allomorphy (Steinhauer 1996; Edwards 2016, 2018, 2020). Under this analysis, metathesised allomorphs are formed by fully transposing the CV segments. Edwards (2016, 2018, 2020) claims that this allomorphy is variably conditioned by phonology, syntax, or discourse conditions. Edwards (2020: 209, 257, 331) lists eight types of constructions, each conditioned by one of these three factors. No general theory is offered for associating construction types with conditioning factors.

The main difference between prosodic and allomorphy-based accounts is the status of vowel length in metathesised CVVC sequences. In the prosodic analysis proposed here, metathesised CVVC sequences are monosyllabic diphthongs (C$\underline{\widehat{VV}}$C) that improve the prosodic output. By contrast, in Edwards (2016 et seq.), they are disyllabic vowel hiatus (C$\underline{\text{V.V}}$C) that do not improve the prosodic output. If metathesis is not prosodically improving (following Edwards), it must be allomorphy with non-phonological conditions. If metathesis is prosodically improving (as I propose), then it can be derived by the phonological grammar.

In this section, I lay out my assumptions for vowel length and present a supporting phonetic study in §1.5.1. In §1.5.2, I then contrast these results with Edwards (2016, 2020) claims about vowel length in the language, and discuss several key issues with Edwards's phonetic study. Lastly, §1.5.3 reviews the implications of vowel length for Edwards's analysis. Readers who wish to proceed to the analysis may skip this section, moving directly to §2.

1.5.1 Vowel length in Molo

In this article, I assume Uab Meto has three main categories of vowels: monophthongs, diphthongs and vowel hiatus. Of these, monophthongs and diphthongs are monosyllabic, whereas vowel hiatus is disyllabic. Metathesis will coalesce a disyllabic

[7] In other Meto dialects such as Ro'is Amarasi (see §3.1), there is evidence of diphthongisation in isolation (e.g. /hunik/ → [huinik] 'turmeric'; Edwards 2016: 106), which suggests a stress-to-weight analysis may be the better fit for that dialect.

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Table 1. *Molo vowel duration data, elicited in isolation*

Vowel type	Form	Example	Duration (ms)			Tokens
			Mean	St. dev.	Range	
Monophthong	CV$_1$CV$_2$(C)	tasi 'sea', kokɪs 'bread'	143	19	87–211	35
Diphthong (metathesis-derived)	CV$_1$V$_2$CC-V	ko͡ɪks-e 'the bread'	156	25	112–199	25
Diphthong (hiatus-derived)	CV$_1$V$_2$C-V	ta͡ɪs-e 'the sarong'	176	32	121–228	20
Hiatus	CV$_1$.V$_2$(C)	ta.ɪ-s 'sarong'	262	47	200–333	7

Table 2. *Comparison of durations of different vowel types*

Comparison	*t*	*df*	*p*-value
Hiatus *vs.* Monophthong	6.66	6.45	≤0.001***
Hiatus vs. Diphthong			
(metathesis-derived)	5.76	6.98	≤0.001***
(hiatus-derived)	4.54	8.00	≤0.005**
Monophthong *vs.* Diphthong			
(metathesis-derived)	–2.35	44.66	≤0.05*
(hiatus-derived)	–4.28	27.92	≤0.001***
Diphthong (metathesis-derived) *vs.* Diphthong (hiatus-derived)	–2.24	35.58	≤0.05*

CVCV word into a monosyllabic CV͡VC word. Additionally, I argue there is a diphthongisation pattern in the language (see §2), in which disyllabic CVV(C) words coalesce to monosyllabic CV͡V.

In this section, I present a phonetic study that offers supporting evidence in favour of these three categories. The main finding is that vowel hiatus is durationally distinct from diphthongs. I elicited 36 roots in prosodically matched contexts (isolation, short nominal phrases and sentential), for a total of 248 tokens from a single speaker. Data were segmented in Praat (Boersma & Weenink 2018), and duration measurements were extracted from text grids with a script. The data were analysed in R (R Core Team 2021). I report only on the isolation forms here, summarising the results in Table 1. The duration column provides the mean duration and its standard deviation, with the range column showing the raw duration range.

The data from Table 1 were then compared using a Welch's unequal variances *t*-test, summarised in Table 2. The first factor in each comparison is the baseline.

If duration is apportioned per syllable (Broselow *et al.* 1997), these results are compatible with treating monophthongs and diphthongs as monosyllabic, and vowel

Table 3. *Durations of underlying and derived monophthongs*

Vowel type	Form	Example	Duration (ms)		Tokens
			Mean	St. dev.	
Monophthong	$C\underline{V}CV(C)$	ʔbi̱bi 'goat', ki̱baʔ 'ant'	142	20	35
Monophthong (from CV_1CV_2)	$C\underline{V}CC_2$-V	ʔbi̱bɟ͡j-e 'the goat'	148	28	22
Monophthong (from CV_1Ca)	$C\underline{V}CC$-V	ki̱bʔ-e 'the ant'	148	36	24

Table 4. *Comparison of durations of underlying vs. derived monophthongs*

Comparison	*t*	*df*	*p*-value
Monophthong *vs.* Monophthong (from CV_1CV_2)	−0.746	32.98	0.461
Monophthong *vs.* Monophthong (from CV_1Ca)	−0.886	34.47	0.382

hiatus as disyllabic. Vowel hiatus is substantially longer than any other category. In particular, the fact that vowel hiatus is different from both metathesis-derived and hiatus-derived diphthongs supports separating these V_1V_2 sequences into different categories.[8] By contrast, Edwards assumes that Meto has no distinction between diphthongs and hiatus.

That said, metathesised diphthongs are still significantly longer than monophthongs, despite both being monosyllabic. From a phonetic standpoint, this is expected: diphthongs have multiple gestural targets, and so they need more time to reach those targets (e.g. diphthongs in American English; Lehiste & Peterson 1961). We therefore expect metathesised sequences to be long only when they contain a diphthong.

Using the same recordings, I tested this prediction by comparing the penultimate vowels in underlying CVCV words to the penults in words that metathesise into monophthongs (e.g. CV_1CV_2 and CV_1Ca roots, which metathesise to $CV_1C(C_2)$). An example of this is the word [ʔbi̱bi] 'goat', which metathesises to a monophthong in [ʔbi̱bɟ͡j-e] 'the goat'. Applying a Welch's unequal variances *t*-test, I found no significant differences in length between penults of these types, as shown in Tables 3 and 4.[9] This again supports treating metathesised sequences as monosyllabic. If metathesis were transposition with no coalescence (e.g. /CVCV/ → [CV.VC]), we would expect the vowel to be phonetically long under metathesis.

[8]For phonological evidence that diphthongs derived from hiatus and metathesis are distinct, see §2.4.

[9]Upon examining the data, an anonymous reviewer claims there is a difference between forms like [ʔbi̱bi] 'goat' and [ʔbi̱bɟ͡j-e] 'the goat'. This difference emerges only when durations from multiple elicitation frames (isolation, NP and sentential) are averaged together. If only matching elicitation frames are compared, there is no difference in vowel length.

To sum up, I treat Meto as having monosyllabic monophthongs and diphthongs, and disyllabic vowel hiatus. I claim that metathesis always coalesces a disyllabic CVCV sequence into a monosyllabic C͡VVC sequence. Similarly, diphthongisation coalesces a disyllabic CVV(C) sequence into a monosyllabic C͡VV sequence. In the next section, I contrast these results with the data reported in Edwards (2016, 2020).

1.5.2 Vowel length in Edwards (2016, 2020)

In contrast to my account, Edwards (2016, 2020) treats metathesised CVVC sequences as disyllabic vowel hiatus. To support this, Edwards (2020) presents a phonetic study tracking vowel length in metathesised CVVC words and ‘U-form’ CVVC words (e.g. *hiut* ‘seven’ (from *hitu*) *vs. kuan* ‘village’). In the study, 628 tokens were extracted from four naturalistic texts by a single speaker. Edwards compared the duration of the vowels in metathesised CVVC forms (e.g. *hiut*) to the duration of the vowels in the U-form CVVC words (e.g. *kuan*), and found no significant differences in length according to a two-tailed *t*-test. Edwards (2020: 189) thus concluded that metathesised CVVC and hiatus CVVC forms are both disyllabic.

There are two core problems with the phonetic study in Edwards (2020). The first is that the U-form CVVC category used in the study is not expected to contain only vowel hiatus, but also some hiatus-derived diphthongs. Edwards (2020) analyses all lexical roots as having two allomorphs, an M-form and a U-form. In /CVVC/ roots, the U-forms and M-forms are identified by their alternation between CVVC and CVV (e.g. [kuan] *vs.* [kua] ‘village’, Edwards 2020: 171). Both are claimed to have vowel hiatus. When measuring the vowel hiatus category, the phonetic study used U-forms like [kuan], which can be identified by the presence of a word-final consonant. However, this M-form/U-form distinction does not perfectly line up with where we would expect vowel hiatus *versus* diphthongisation. For instance, under suffixation I would expect a diphthong for [k͡uan-e] ‘the village’, but Edwards would treat this as a U-form with hiatus because the final consonant is present. These assumptions are expected to artificially lower the mean duration of vowel hiatus in Edwards’s phonetic study, as some diphthongs may be included in the hiatus category.

The second issue is how the data were analysed. The data from Edwards (2020) phonetic study come from texts, and so none of the tokens are controlled for speech rate, phrasal position or prosody. These factors are expected to dramatically affect vowel length (cf. Edwards 2020: 189), and so a more robust model is needed to evaluate these data. However, Edwards’s phonetic study used a *t*-test, which cannot account for these factors. As a result, Edwards’s phonetic study is inconclusive: the data are expected to contain meaningful variation that is simply being averaged over. By contrast, in my study, all tokens were elicited in a frame, and so these factors were controlled.

Edwards (2016, 2020) also claims that Meto has phonetically long vowels in various metathesis environments. For example, Edwards treats metathesis as transposition, and so /CV_1CV_1/ words are expected to metathesise to [CV_1V_1C] with a phonetically long vowel. In a phonetic study, Edwards (2020: 98) claims that this is precisely what happens in Amarasi: /ʔbibi/ ‘goat’ metathesises to a lengthened [ʔbiːb͡ɪj-es] ‘a goat’ under suffixation. However, this phonetic study bears similar problems to the one previously discussed. The data were not elicited in prosodically controlled environments, and then it was analysed using a *t*-test. Ideally, the analysis would

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have used a statistical method capable of incorporating phrasal position and stress as independent variables. As is, neither of the phonetic studies in Edwards (2020) can be considered conclusive.

Outside of these metathesis contexts, Edwards also claims that CV(C) roots have a phonetically long vowel. To account for this, Edwards (2020: 135) claims that the minimal word in Meto is CVV(C), so all apparent CV(C) words are underlyingly CVV(C). However, the phonetic studies presented do not substantiate this. For instance, Edwards (2020: 98) presents a study comparing the duration of single vowels, V_1V_1 vowels and V_1V_2 vowels extracted from polysyllabic words in texts. Edwards reports that V_1V_1 sequences are 30 ms longer than single vowels, and again uses a *t*-test to assess significance.

However, this study does not tell us much about the proposed word minimality effect. For one, this V_1V_1 category is not well defined. It is unclear if these V_1V_1 tokens all come from putative CV or CVC roots, metathesised /CV_1CV_1/ → [CV_1V_1C] words or some mixture of the two.[10] To convincingly assert that no CV(C) words exist, these cases should have been separately reported on. We also have no indication that durations in this V_1V_1 category were evaluated to see if their distribution was bimodal, which would indicate that CV(C) and CVV(C) roots were being averaged together. Since there is no convincing evidence to the contrary, I assume henceforth that Molo has monosyllabic CV(C) words.

1.5.3 Implications of vowel length for Edwards (2016, 2020)

In Edwards's analysis, metathesis is transposition without coalescence, where /CVCV/ → [CV.VC]. Edwards (2020: 188) argues that because metathesised CVVC forms are disyllabic, there is no clear way metathesis improves the prosodic output.

In §1.5, I examine these claims in the Molo dialect through a small phonetic study, and found different results. Unlike Edwards, I found no evidence that /CV_1CV_1/ words metathesise into a disyllabic [$CV_1.V_1C$] sequence. I therefore treat all metathesised VV sequences as monosyllabic diphthongs, and predict that metathesised VV sequences should only be long when V_1V_2 qualities are different.

Upon examining the phonetic studies in Edwards (2020) more closely (§1.5), it appears there are significant methodological errors in the design and analysis. Therefore, Edwards's claim that there is no coalescence in the language cannot be considered conclusive. Further work is needed on Amarasi to see if there is truly no coalescence in the language. On the other hand, the preliminary data from Molo are compatible with a prosodic account, and so I proceed here assuming that Meto metathesis and diphthongisation coalesce disyllables into monosyllables. If these durational data hold up in future studies, this would provide significant support for a prosodic analysis, because only a prosodic analysis can explain why metathesis and diphthongisation occur in the same environments. On an allomorphy-based account, this connection must be either denied or stipulated.

[10]To make matters worse, Meto does have certain roots that are indisputably CV_1V_1, such as [bi.ˈfe.e] 'woman' or [ˈʔo.o] 'bamboo'. These vowels can be confirmed as underlyingly /V.V#/ with data from plural allomorphy, because the plural has the allomorph [-nu] following VV#, but [-n] following CV#. As expected, both of these nouns take [-nu]. It is therefore possible that Meto does have CV(C) words, but that they are being collapsed into the same category as true CVV(C) words.

In the next section, I introduce further data on Meto metathesis and coalescence. I contend that the spreading-based account offers a more robust treatment of Meto phonology as a whole, since it is able to derive a variety of alternations (metathesis, diphthongisation and deletion) under a unified analysis.

2. Coalescence beyond suffixation

In this section, I present an analysis of Meto coalescence alternations. As we saw in §1.1, apparent metathesis reduces right-edge lapses created by suffixation (11a). In this section, I show how metathesis also reduces lapses at the left edge in compounds (11b) and phonological phrases (11c).

(11) *Coalescing metathesis* (CV → VC)

a. *Suffixation: metathesis reduces right-edge lapses*

i.	/kokɪs-e/	[ˈko͡ɪks-e]	'the bread'	/σ́σσ/ → [σ́σ]
ii.	/ʔa-mepo-t-in/	[ʔa-ˈme͡op-t-in]	'workers'	/σσ́σσ/ → [σσ́σ]

b. *Compounds: metathesis reduces left-edge lapses*

i.	/manu-ˈfuɟ͡j/	[ˌma͡ʊn-ˈfuɟ͡j]	'wild chicken'	/σσσ́/ → [σσ́]
ii.	/fafi-ˈʔanaʔ/	[ˌfa͡ɪf-ˈʔanaʔ]	'piglet'	/σσσ́σ/ → [σσ́σ]
iii.	/ʔatoni-ˈkaseʔ/	[ʔaˌto͡ɪn-ˈkase]	'city man'	/σσσσ́σ/ → [σσσ́σ]

c. *Complex phonological phrases: metathesis reduces left-edge lapses*

i.	/manu-ˈmoloʔ/	[ˌma͡ʊn-ˈmoloʔ]	'yel. chicken'	/σσσ́σ/ → [σσ́σ]
ii.	/fafi-ʔaˈhinet/	[ˌfa͡ɪf-ʔaˈhinet]	'smart pig'	/σσσσ́σ/ → [σσσ́σ]

In addition to these metathesis patterns, roots of other templatic shapes undergo other coalescence alternations, namely diphthongisation and deletion. These are shown in (12) and (13). These alternations occur in identical prosodic environments to metathesis and also reduce stress lapses.

(12) *Non-metathesising coalescence: diphthongisation*

a. *Suffixation: diphthongisation reduces right-edge lapses*

i.	/meo-nu/	[ˈme͡o-nu]	'cats'	/σ́σσ/ → [σ́σ]
ii.	/tai-s-e/	[ˈta͡ɪ-s-e]	'the sarong'	/σ́σσ/ → [σ́σ]

b. *Compounds and complex φPs: diphthongisation reduces left-edge lapses*

i.	/meo-ˈʔanaʔ/	[ˌme͡o-ˈʔanaʔ]	'kitten'	/σσσ́/ → [σσ́]
ii.	/noe-ˈnoni/	[ˌno͡e-ˈnoni]	'Silver River'	/σσσ́σ/ → [σσ́σ]
iii.	/kuan-ˈleko/	[ˌku͡a-ˈleko]	'nice village'	/σσσ́σ/ → [σσ́σ]
iv.	/biɟ͡jae-ˈmoloʔ/	[biˌɟ͡ja͡e-ˈmoloʔ]	'brown buffalo'	/σσσσ́σ/→[σσσ́σ]

(13) *Non-metathesising coalescence: deletion*

a. *Suffixation: deletion reduces right-edge lapses*

i.	/kibaʔ-e/	[ˈkibʔ-e]	'the ant'	/σ́σσ/ → [σ́σ]
ii.	/ʔulan-e/	[ˈʔuln-e]	'the rain'	/σ́σσ/ → [σ́σ]

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b. *Compounds & complex φPs: deletion reduces left-edge lapses*

i.	/ʔulan-ʔanaʔ/	[ˌʔul-ˈʔanaʔ]	‘small rain’	/σσσ́σ/ → [σσ́σ]
ii.	/kibaʔ-metan/	[ˌkib-ˈmetan]	‘black ant’	/σσσ́σ/ → [σσ́σ]
iii.	/nine-moloʔ/	[ˌnin-ˈmoloʔ]	‘yellow winged’	/σσσ́σ/ → [σσ́σ]

I now go through each of these cases in turn, starting with metathesis in compounds and phrases (§§2.1 and 2.2), then going on to diphthongisation and deletion subpatterns (§§2.3 and 2.4). Each of these alternations is parasitic on prosodic truncation: a V-slot deletes, and then features spread or remain unassociated to create metathesis, diphthongisation and deletion alternations.

2.1 Coalescing metathesis in compounds

In this section, I focus on morphologically complex words that contain multiple roots. Similar to how suffixation creates right-edge lapses, compounding creates lapses at the left edge of a word. Left edge lapses are dispreferred, but due to positional restrictions on truncation, they can only be improved by deleting a root-final vowel.

In (14), I show examples of compounds. The first root undergoes apparent metathesis, reducing the left-edge lapse by one. Faithful candidates (shown at right) contain more violations of ALIGN(X,L).[11]

(14) *Compounding: left-edge lapses reduced by apparent metathesis*

a.	[ˌma͡ʊn-ˈfu͡ɟj]	σσ́	‘wild chicken’
	*[ˌmanu-ˈfu͡ɟj]	*σσσ́	
b.	[ˌkol-ˈkaʔ]	σσ́	‘crow’
	*[ˌkolo-ˈkaʔ]	*σσσ́	
c.	[ˌfa͡ɪf-ˈʔanaʔ]	σσ́σ	‘piglet’
	*[ˌfafi-ˈʔanaʔ]	*σσσ́σ	
d.	[ˌne͡ɔn-ˈmeseʔ]	σσ́σ	‘Monday’
	*[ˌneno-ˈmeseʔ]	*σσσ́σ	
e.	[ʔaˌto͡ɪn-ˈkase]	σσσ́σ	‘city man’
	*[ʔaˌtoniʔ-ˈkase]	*σσσσ́σ	
f.	[ʔaˌto͡ɪn-ˌka͡es-ˈmutiʔ]	σσσσ́σ	‘foreign man’
	*[ʔaˌtoniʔ-ˌkase-ˈmutiʔ]	*σσσσσσ́σ	

I derive this pattern by ranking ALIGN(X,L) below ALIGN(X,R). This left alignment does not affect stress assignment, but can still feed prosodic truncation.

(15) ALIGN(X,L): Assign one violation for each syllable that separates the primary stress from the left edge of a prosodic word/phrase (cf. McCarthy & Prince 1993; Gordon 2002, among others)

In the derivation of /fafi-ʔanaʔ/ → [ˌfa͡ɪf-ˈʔanaʔ] ‘piglet’ (14c), the first stage of the derivation is cyclic stress assignment. In the first cycle, roots receive penultimate

[11] For consonant deletion in /ʔatoniʔ/ →[ʔato͡ɪn] ‘man’, see §4.1.

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stress, and then in the second cycle, the word promotes the stress of the rightmost root (cf. ENDRULE-L; Prince 1983, McCarthy 2003).[12] These cycles of stress assignment produce the output shown in Step 0 of (16), /ˌfafi-ˈʔanaʔ/.

(16) a. *Step 0: Stress assignment*

C V̀ C V - C V́ C V C
f a f i ʔ a n a ʔ [ˌfafi-ˈʔanaʔ]

b. *Step 1: Prosodic truncation*

C V̀ C - C V́ C V C
f a f i ʔ a n a ʔ [ˌfafi̯-ˈʔanaʔ]

c. *Step 2: Spreading*

C V̀ C - C V́ C V C
f a f i ʔ a n a ʔ [ˌfa͡ɪf-ˈʔanaʔ]

At the input for Step 1, there are two violations of ALIGN(X,L) for the word-level stress. Since ALIGN(X,L) ≫ MAX_{V}, the derivation truncates the final V-slot in /ˌfafi/ 'pig' to [ˌfafi̯]. This is shown in (17):

(17) *Step 1: Prosodic truncation*

/ˌfafi-ˈʔanaʔ/	MAX_{F}	ALIGN(X,R)	ALIGN(X,L)	*FLOAT	*XSPR	MAX_{V}
a. ˌfafi-ˈʔanaʔ		*	**!			
☞ b. ˌfafɪ̯-ˈʔanaʔ		*	*	*		*
c. ˌfafV-ˈʔanaʔ	*!	*	**	*		
d. ˌfa͡ɪfi-ˈʔanaʔ		*	**!		*	

Structure of candidate (b): C V̀ C C V́ C V C
f a f i ʔ a n a ʔ

In Step 2, the floating vowel spreads leftwards, giving the appearance of metathesis even though the features remain *in situ.*

(18) *Step 2: Spreading*

/ˌfafɪ̯-ˈʔanaʔ/	MAX_{F}	ALIGN(X,R)	ALIGN(X,L)	*FLOAT	*XSPR	MAX_{V}
a. ˌfafɪ̯-ˈʔanaʔ		*	*	*!		
b. ˌfaf-ˈʔanaʔ	*!	*	*			
☞ c. ˌfa͡ɪf-ˈʔanaʔ		*	*		*	

[12]In compounds, the derivation must choose which root's X_1 mark to promote to X_2. I assume that an undominated constraint ENDRULE-L governs this, which means that the rightmost X_1 mark will be promoted regardless of violations to NONFIN. Only the highest-available stress marks are evaluated for alignment.

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Structure of candidate (c): C V̀ C C V́ C V C
f a f i ʔ a n a ʔ

After this, the faithful candidate (18c) [ˌfa͡if-ˈʔanaʔ] wins, and the derivation converges. No further truncation is possible, because only unstressed, root-final V-slots may delete (see discussion in §1.2).

In the next section, I turn to metathesis in phonological phrases. Like compounds, metathesis in phrases reduces left-edge lapses. I use the phrasal metathesis data to argue against syntactic accounts of Meto metathesis (e.g. Edwards 2018, 2020).

2.2 Coalescing metathesis in phonological phrases

In phonological phrases (φPs), we see an identical pattern to compounds: all roots to the left of primary stress metathesise. From an alignment perspective, the pattern here is the same as in compounds. The rightmost root receives primary stress, and any roots to the left truncate to reduce ALIGN(X,L) violations.

In (19), I show some examples of metathesis in phonological phrases. When there are two roots in one φP, non-final roots metathesise. In contrast, when the root is final in a phonological phrase, it surfaces in its faithful form.[13]

(19) *Coalescing metathesis in φPs*

a. *Nominal domain: Noun Adjective*

i. [ma͡ʊn ˈmutiʔ]$_{\varphi P}$ ˈnua
chicken white two
'two white chickens'

ii. [ˈmanu]$_{\varphi P}$ ˈnua
chicken two
'two chickens'

b. *Nominal domain: nominal compounds*

i. [fa͡if ˈʔanaʔ]$_{\varphi P}$ ʔii
pig baby DEM
'this piglet'

ii. [ˈfafi]$_{\varphi P}$ ʔii
pig DEM
'this pig'

c. *Verbal domain: Verb Direct Object*

i. aʊ [ʔ-a͡im baˈkaseʔ]$_{\varphi P}$ ʔii
1SG 1SG.AGR-look.for horse DEM
'I look for the horse.'

ii. baˈkase ʔii aʊ [ˈʔ-ami]$_{\varphi P}$
horse DEM 1SG 1SG.AGR-look.for
'The horse, I look for it.'

[13]These cases are not exhaustive. Metathesis also occurs when modifiers are added to adjectives or adverbs, in serial verb constructions, or whenever a phonological phrase contains more than one stress-bearing word. See the Supplemental Material for further examples of metathesis in verbs.

d. *Other: adjuncts in fast, connected speech*

i. jermy na-tonan jefri [he-n meop ne ˈlalan]$_{\varphi P}$
Jermy 3-told Jefri IRR-3.AGR work LOC road

'Jermy told Jefri to work in the road.'

ii. jermy na-tonan jefri [he-n ˈmepo]$_{\varphi P}$ ne ˈlalan
Jermy 3-told Jefri IRR-3.AGR work LOC road

'Jermy told Jefri to work in the road.'

In previous work, some of these cases have been analysed as 'syntactic' metathesis, conditioned directly by phrasal constituency (Steinhauer 1993; Edwards 2016, 2018, 2020; see §2.2). In contrast, I view this metathesis as an indirect consequence of the syntax–prosody mapping: small syntactic phrases (NPs and VPs) must align with a φP edge, and so metathesis will correlate with some syntactic phrase edges, but not with syntactic constituency. Under this analysis, metathesis occurs in every medial root of a φP, since only the final root bears primary stress.

The prosodic analysis offers clear coverage of how metathesis interacts with focus intonation in the language. As in many languages (Büring 2009; Féry 2013), Meto focus intonation inserts a prosodic boundary to the right of a focused constituent. This has the effect of overriding normal syntax–prosody mappings so that focus intonation bleeds metathesis.

To illustrate, take the focus-sensitive operator *ha* 'only' in (20), which inserts a prosodic boundary after the focused prosodic word /kiso/ 'see'. This prevents wrapping of the verb and direct object into a single phonological phrase, and so metathesis is blocked in (20b) by NonFin.[14]

(20) a. ˈaʊ [ˌkius ˈko]$_{\varphi P}$
1.SG see you

'I see you.'

b. ˈaʊ [ˈkiso]$_{\varphi P}$ ha ˈko
1.SG see only you

'I only see you.' Amarasi dialect, Oekabiti speaker

This effect is not morphological, as similar results can be found with contrastive focus intonation. If we drop *ha* but contrastively focus [ˈkiso] 'see' with a focus high tone, we obtain the same result.[15]

Focus intonation is valuable in a prosodic account because it also acts as a diagnostic between compound metathesis and phrasal metathesis. Unlike phrases, compounds cannot alternate depending on focus intonation. Only the primary stress of

[14] I show data from the Amarasi dialect here, because in Molo *ha* 'only' is a clitic. It promotes the word-level stress of any word it attaches to, but it induces consonant epenthesis in CV# words (e.g. [ˈkisb=aha] 'only see'), similar to suffixes in §3.2.

[15] Contrastive focus intonation behaves the same way in nominal phrases: if we contrastively focus the word /asu/ 'dog' in [ʔau ʔit ˌʔaus ˈmutiʔ] 'I look at a white dog', we obtain [ʔau ʔit ˈʔasu ˈmutiʔ] 'I look at a white DOG (not some other animal)'. Alternatively, this example could also be analysed as a cleft, i.e. 'I see a dog that is white', in which case the noun and adjective would be expected to fall in separate φPs for syntactic reasons.

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the compound is visible to focus, and earlier stresses may not be promoted. In (21), we see that the first root in the compound [ˌfa͡ɪf-ˈʔanaʔ] 'piglet' may not receive any focus intonation, either from contrastive focus or a focus-sensitive operator like *ha* 'only':

(21) a. [ˌfa͡ɪf-ˈʔanaʔ] 'piglet'
b. *[ˈfafi-ˈʔanaʔ] intended: 'PIGLET (not something else)'
c. *[ˈfafi-ˈʔanaʔ ha], *[ˈfafi-ha-ˈʔanaʔ] intended: 'only piglets'

Under this analysis, focus intonation can only target word- or phrase-level stresses. In compounds, the first root is invisible to focus intonation because it only has root-level stress.

To sum up, here I have argued in favour of a prosodic account to Meto phrasal metathesis. Phonological phrases undergo stress promotion much like compounds, and so pre-tonic roots metathesise to reduce left-edge lapses. Before continuing on, I briefly discuss an alternative account of these alternations, where metathesis is directly conditioned by the syntax. I ultimately dismiss this alternative, because it does not predict syntax–phonology mismatches.

2.2.1 Alternative: syntactic metathesis

The most salient alternative to the prosody-based analysis is a syntactic account, proposed in detail in Edwards (2016). In Edwards's account, metathesis can be syntactically conditioned by a head–specifier relation. Nouns metathesise when they have an adjectival specifier, and verbs metathesise when they have serial verb in their specifier. There are two faulty predictions this analysis makes: (i) that NPs can induce only one instance of metathesis and (ii) that metathesis should be able to diagnose syntactic constituency.

In response to (i), we see in (22) that multiple adjectives can be wrapped into a single φP, where each root undergoes metathesis:

(22) a. [ˌfa͡ʊt ˌmu͡it ˈkoʔu $]_{\varphi P}$
stone white big
'big white stone'
b. [ˌfa͡ʊt ˌko͡ʊʔ ˈmutiʔ $]_{\varphi P}$
stone big white
'white big stone' Kotos Amarasi dialect, Oekabiti speaker

In a prosodic account, this behaviour is predicted: no matter how many phrase-medial roots you add, only the final root bears stress. In a syntactic account, we would need to stipulate that all but the final root in any NP or VP metathesises, since they cannot all be the specifier of N. This stipulation is remarkably similar to my prosodic analysis – only the final roots of NPs and VPs are special – but in the prosodic account this follows from how phrasal stress is assigned.

The core problem with a syntactic analysis is that it predicts that metathesis should be able to diagnose adjunct height. For instance, metathesis should occur on a verb followed by a PP adjunct only when the PP is interpreted in the same

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domain as that verb. Yet adjunct attachment height is ambiguous in both (19d-i) and (19d-ii). The high-attachment reading persists regardless of metathesis, and the only difference between these two sentences is their intonational contour.[16] This is not easily compatible with a syntax/allomorphy-based account, and is better analysed as a type of prosodic wrapping (cf. WRAP; Truckenbrodt 1999, 2006).

An anonymous reviewer suggests that an Edwards-style account would treat the adjunct metathesis in (19d-i) as 'discourse metathesis', not syntactic metathesis. Despite listing several examples of where discourse metathesis is expected to occur, Edwards (2016, 2020) does not provide independent diagnostics for discourse metathesis *versus* syntactic metathesis. In the absence of diagnostics of this type, I treat syntactic and discourse metathesis as a single phenomenon that is the result of syntax–prosody mappings.

Before continuing on, I discuss a remaining issue for the prosodic account: metathesis in ellipsis environments (cf. Edwards 2016: 287). When answering a yes–no question, it is possible to answer with just the subject and verb, eliding the remainder of the sentence. In these cases, the verb maintains its metathesised form, even though it is phrase-final:

(23) a. ho=m ˌlo͡im ˌsis ˈmanu?
2SG=2SG.AGR like meat chicken
'Do you like chicken?'

b. aʊ <u>lo͡im</u> / *ˈlomi
1SG like
'I like (it).'

There are several options on how to capture this pattern within a prosodic analysis. For one, the intonation found in these ellipsis environments is not identical to the intonation of most phrase-final words. Phrase-final words (especially those in nominal phrases) generally bear H* or L*+H tones, but verbs preceding ellipsis sites tend to bear L* tones. It is possible that L* tones cannot induce violations of NONFIN, and so metathesis will not be blocked in these contexts. A second option is that the ellipsis site is not empty at the time of metathesis – either prosodification occurs before ellipsis takes place, or the ellipsis site contains null prosodic elements. An adequate answer to this question requires more detailed work into intonation and ellipsis in Meto, and so I leave these possibilities for future work.

In the next section, I turn to diphthongisation, another coalescence alternation found in the language. The same contexts that condition metathesis force CVV(C) words to diphthongise. This evidence strengthens the case that Meto metathesis is prosodically driven.

[16]Under the present analysis, we may have expected the φP boundary after the VP [ˈmepo] to be obligatory in (19d-ii). This can be corrected by making the alignment constraint on φPs/VPs dominated. In fast speech, even NPs and VPs may be wrapped into larger phonological phrases to minimise the overall number of φPs. This type of dependency between speech rate and metathesis is expected under a prosodic account, but not under a syntactic one.

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2.3 Diphthongisation: coalescence without metathesis

Outside of metathesis, diphthongisation provides further support for alignment-driven coalescence in Meto. Underlying vowel hiatus shortens into a diphthong to align the primary stress closer to an edge.

In compounds and phonological phrases, diphthongisation reduces a left-edge lapse, as in (24). The coalescence of vowel hiatus into a diphthong reduces violations of ALIGN(X,L).

(24) *Diphthongisation in compounds and phonological phrases*

a.	[ˌme͡o-ˈʔanaʔ]	σσ́σ	‘kitten’	*[ˌme.o-ˈʔanaʔ]	*σσσ́σ
b.	[ˌno͡e-ˈnoniʔ]	σσ́σ	‘Silver River’	*[ˌno.e-ˈnoniʔ]	*σσσ́σ
c.	[biˌɟ͡ja͡e-ˈmoloʔ]	σσσ́σ	‘yellow buffalo’	*[bi.ˌɟ͡ja.e-ˈmoloʔ]	*σσσσ́σ

In contexts with suffixes, diphthongisation reduces a right-edge lapse, as in (25). Diphthongisation is blocked by NONFIN in isolation, since then stress would be phrase-final.

(25) *Diphthongisation under suffixation*

a.	[ˈme.o]	σ́σ	‘cat’	*[ˈme͡o]	*σ́
	[ˈme͡o-nu]	σ́σ	‘cats’	*[ˈme.o-nu]	*σ́σσ
b.	[ˈfa.i]	σ́σ	‘night’	*[ˈfa͡ɪ]	*σ́
	[ˈfa͡ɪ-nu]	σ́σ	‘nights’	*[ˈfa.i-nu]	*σ́σσ
c.	[ˈta.i-s]	σ́σ	‘sarong’	*[ˈta͡ɪ-s]	*σ́
	[ˈta͡ɪ-s-in]	σ́σ	‘sarongs’	*[ˈta.i-s-in]	*σ́σσ
d.	[ˈku.an]	σ́σ	‘village’	*[ˈku͡an]	*σ́
	[ˈku͡an-e]	σ́σ	‘the village’	*[ˈku.a.n-e]	*σ́σσ
e.	[ˈlo.i-t]	σ́σ	‘money’	*[ˈlo͡ɪ-t]	*σ́
	[ˈlo͡ɪ-t-e]	σ́σ	‘the money’	*[ˈlo.i-t-e]	*σ́σσ

In this analysis, the treatment of diphthongisation is almost identical to metathesis: the V-slot deletes, and so the floating vowel features spread leftwards to form a diphthong. Diphthongisation does not apply rightwards, as this often would constitute spreading past a morpheme boundary (see §3.2).

(26) a. *Step 0: Stress assignment*

```
C  V́  V  -  C  V
|  |  |     |  |
m  e  o     n  u          /ˈmeo-nu/
```

b. *Step 1: Prosodic truncation*

```
C  V́    -  C  V
|  |       |  |
m  e  o    n  u           [ˈmeo̯-nu]
```

c. *Step 2: Spreading*

```
C  V́    -  C  V
|  |\      |  |
m  e  o    n  u           [ˈme͡o-nu]
```

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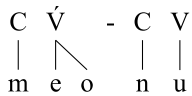
d. *Step 3: Convergence*



[ˈme͡o-nu]

I introduce the constraint *MULTIPLE, which militates against multiple linkage of features and slots:

(27) *MULTIPLE: Assign a violation for any feature bundle associated with more than one slot, and vice versa. (Uffmann 2006: 1096)

I show the derivation of /meo-nu/ → [ˈme͡o-nu] 'cats' in (28). In Step 1, the final V-slot of the root truncates due to ALIGN(X,R), leaving a vowel feature floating. In Step 2, the floating vowel spreads leftwards to the preceding V-slot, violating *MULTIPLE. After Step 2, /me͡o.-nu/ becomes the new input, but no further changes harmonically improve the output and the faithful candidate wins. The derivation converges, yielding [me͡o.-nu] as the output.

(28) a. *Step 1: Prosodic truncation*

/ˈme.o-nu/	MAX$_F$	(X,R)	*FLOAT	*MULT	MAX$_V$
a. ˈme.o.-nu		**!			
b. ˈme.V.-nu	*!	**	*		
☞ c. ˈmeo̯.-nu		*	*		*
d. ˈmeo̯.V.-nu		**!	**		

b. *Step 2: Spreading*

/ˈmeo̯.-nu/	MAX$_F$	(X,R)	*FLOAT	*MULT	MAX$_V$
a. ˈmeo̯.-nu		*	*!		
☞ b. ˈme͡o.-nu		*		*	
c. ˈme.-nu	*!	*			
d. ˈme.o.-nu		**!			

The status of diphthongisation in Meto is contested, and previous research claimed there to be no diphthongisation in cases like (24) and (25) (e.g. Edwards 2018: 26). However, there are serious methodological issues with Edwards's phonetic study (see §1.5.2). When the prosodic context is more controlled (e.g. [ˈku.an] 'village' *vs.* ˈ[ku͡an-e] 'the village'), there is a difference between vowel hiatus and diphthongs (see §1.5.1).

In the next section, I turn to cases where metathesis is blocked. In these cases, the vowel remains floating instead of spreading leftwards, yielding surface vowel deletion. This pattern provides further evidence in favour of line-crossing, because it shows that metathesis involves spreading that is less local than spreading in diphthongisation.

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2.4 Deletion occurs when metathesis is blocked

Meto has a preference against rising-sonority diphthongs, and so non-local spreading is blocked when it would create one. In these cases, the vowel features remain floating instead of reassociating leftwards, giving the appearance of deletion. This holds for words expected to metathesise with suffixes (29a) or in compounds and complex phonological phrases (29b).[17]

(29) *Deletion instead of metathesis for rising-sonority roots*

a. *Suffixation: deletion reduces right-edge lapses*

i.	[ˈpe.naʔ]	σ́σ	‘corn’	
	[ˈpenʔ-e]	σ́σ	‘corn-DEF’	*[ˈpe͡an.ʔ-e]
ii.	[ˈkibaʔ]	σ́σ	‘ant’	
	[ˈkibʔ-e]	σ́σ	‘ant-DEF’	*[ˈki͡ab.ʔ-e]
iii.	[ˈʔu.lan]	σ́σ	‘rain’	
	[ˈʔuln-e]	σ́σ	‘rain-DEF’	*[ˈʔu͡al.n-e]

b. *Compounds and complex* φP*s: deletion reduces left-edge lapses*

i.	[ˌʔut-ˈmutiʔ]	σσ́σ	‘mustard greens’	*[ˌʔu͡at-ˈmutiʔ]
	/ʔutan-ˈmutiʔ/			
ii.	[ˌkib metan]	σσ́σ	‘black ant’	*[ˌki͡ab ˈmetan]
	/kibaʔ ˈmetan/			
iii.	[ˌnin ˈmoloʔ]	σσ́σ	‘yellow winged’	*[ˌni͡en ˈmoloʔ]
	/nine moloʔ/[18]			

However, rising-sonority diphthongs are possible when they do not cross consonantal association lines. They are rare, but some examples derived from vowel hiatus can be found, as in (30):

(30) *Rising sonority diphthongs derived from vowel hiatus*

a.	[ˈbi.an]	‘other’	
	[ˈbi͡an-e]	‘the other’	*[bi.n-e]
b.	[ˈno.ah]	‘coconut’	
	[ˈno͡a.h-e]	‘the coconut’	*[no.h-e]
c.	[ˈpu.ah]	‘areca nut’	
	[ˈpu͡a.h-e]	‘the areca nut’	*[pu.h-e]

These data suggest that rising-sonority diphthongs are only illicit when created by metathesis.

I capture this in my analysis using constraint conjunction (Smolensky 1995). I introduce a HeavyDiph constraint in (31), which penalises rising-sonority diphthongs. I conjoin HeavyDiph with *XSpread to create Heavy∧*XSpr in (32), which is violated when V-slot bearing a rising-sonority diphthong has a crossed association line. I assume a standard sonority hierarchy for vowels (a ≫ ɛ, ɔ ≫ e, o ≫ i, u; de Lacy 2006: 286).

[17] For details on the consonant deletion pattern in (29b), see §4.1.
[18] This example is from Middelkoop (1972: 151).

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(31) HeavyDiph (dominated): Assign a violation for each diphthong $\widehat{V_\alpha V_\beta}$ where the sonority of V_β is greater than the sonority of V_α.

(32) Heavy∧*XSpr (undominated): For a rising-sonority diphthong $\widehat{V_\alpha V_\beta}$ where the sonority of V_β is greater than the sonority of V_α, assign a violation when an association line of the diphthong's V-slot crosses another association line.

The constraint Heavy∧*XSpr is undominated, and so it will rule out any rising-sonority diphthong that crosses an association line. Meanwhile, HeavyDiph is dominated, and so rising-sonority diphthongs are licit as long as they are local.

In my analysis, the deletion patterns from (29) are composed of a subset of the operations used in metathesis: assign stress, delete a V-slot and then converge. Since the vowel features are not linked to a timing slot, they are not pronounced (cf. Hyman 1986; Kenstowicz & Rubach 1987; Rubach 1993).[19]

(33) a. *Step 0: Stress assignment*

```
C  V́  C  V  C  -  V
|  |  |  |  |     |
k  i  b  a  ʔ     e        [ˈkibaʔ-e]
```

b. *Step 1: Prosodic truncation*

```
C  V́  C     C  -  V
|  |  |     |     |
k  i  b  a  ʔ     e        [ˈkiba̯ʔ-e]
```

c. *Step 2: Convergence*

```
C  V́  C     C  -  V
|  |  |     |     |
k  i  b  a  ʔ     e        [ˈkiba̯ʔ-e]
```

The crucial step from (33) is Step 2, where we would ordinarily see spreading. In this case, spreading is blocked by Heavy∧*XSpr, since this would create a rising-sonority diphthong [i͡a] that is non-local. The features are forced to remain floating, yielding [kiba̯ʔ-e] 'the ant', as in (34). I assume that [kiba̯ʔ-e] is acoustically identical to [kibʔ-e].

(34) *Step 2: Convergence* (33c)

/ˈkiba̯ʔ-e/	Heavy ∧*XSpr	Max$_F$	(X,R)	*Float	*XSpr	Heavy
☞ a. ˈkiba̯.ʔ-e			*	*		
b. ˈki͡ab.ʔ-e	*!		*		*	*
c. ˈkib.ʔ-e		*!	*			
d. ˈki.ba.ʔ-e			**!			

[19] I discuss why these features must be floating, rather than fully deleted, in §4.1.

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Structure of candidate (a): C V́ C C - V (violates *Float)

k i b a ʔ e

Structure of candidate (b): C V́ C C - V (violates Heavy∧*XSpr)

k i b a ʔ e

In contrast, hiatus-derived diphthongs will not violate Heavy∧*XSpr, and so spreading is preferred over leaving vowel features floating. This is seen in (35) for the derivation of /bian-e/ → [bi͡an-e] ‘the other’:

(35) *Step 2: Deletion*

/ˈbia̯n-e/	Heavy ∧*XSpr	Max$_F$	(X,R)	*Float	*Mult	Heavy
a. ˈbia̯.n-e			*	*!		
☞ b. ˈbi͡a.n-e			*		*	*
c. ˈbin-e		*!	*			

Structure of candidate (b): C V́ C - V (violates *Multiple)

b i a n e

In this pattern, it is crucial that metathesis is non-local spreading rather than spreading that is relatively local along a tier. In a tier-based model, the diphthong generated in (35) [bi͡ane] would ostensibly have an identical representation to the illicit diphthong in (34) *[ki͡abʔe]. Both are V-slots associated with vowel features that rise in sonority. For a tier-based model, it is puzzling why diphthongisation should be ruled out in one case but not another, since spreading is still perfectly local along the tier.

This is a well-known problem in related Austronesian languages such as Rotuman (McCarthy 2000). In Rotuman, falling-sonority diphthongs cannot be generated by metathesis. Besnier (1987) analyses this pattern using tiers: any spreading that generates a falling-sonority diphthong is blocked, and the vowel must delete instead (e.g. /rako/ → [rak] ‘to imitate’ (phrase-medial)). However, this makes the faulty prediction that falling-sonority diphthongs are uniformly illicit. This is not the case – like Meto, Rotuman *does* allow falling-sonority diphthongs when they are generated locally (e.g. /vao/ → [va͡o] ‘net’, McCarthy 2000: 6).

McCarthy (2000) analyses this alternation as resulting from a maximal weight restriction LightDiph, which permits falling-sonority diphthongs only in open syllables. This happens to work in Rotuman because CVCV roots metathesise into closed syllables, whereas CVV roots diphthongise but remain as open syllables. In Meto, a weight-based analysis will not work, because rising-sonority diphthongs can occur in closed syllables, e.g. /buabaʔ-e/ → [bu͡ab.ʔ-e] ‘gather it’. This leaves only locality as a possible explanation for the [bi͡ane] *vs.* *[ki͡abʔe] distinction. Local spreading can create rising-sonority diphthongs, but non-local spreading cannot. This pattern therefore provides evidence against a tier-based model by showing that spreading in metathesis is truly less local than spreading in diphthongisation.

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In models that use coindexation rather than spreading, such as Takahashi (2019), we encounter similar problems. The output representations of [b͡iane] 'the other' and *[k͡iabʔe] 'the ant' have identical surface representations, but are not equally well-formed. In Harmonic Serialism, the way around this problem is to claim that INTEGRITY cannot be violated for high-sonority segments, and so /ki_1ba_2ʔ-e/ cannot split into [$\text{ki}_1\text{a}_2\text{ba}_2$ʔ-e] to begin with. The vowel would therefore delete fully, yielding [kibʔ-e] 'the ant'. A crucial difference between an account using coindexation and one using spreading is that there is no floating feature bundle in the coindexation model. The final vowel is fully deleted, leaving a consonant-final word. In §4.1, I show how this is problematic in Meto, since true word-final consonants undergo deletion in phrases, whereas consonants followed by floating vowel features do not.

As an alternative to the present account, Edwards (2016) analyses these cases as metathesis, wherein the [a] vowel assimilates to the preceding vowel and lengthens it (e.g. /penaʔ/ → [peen] 'corn'). However, in contrast to Amarasi, the Molo dialect does not have evidence of vowel lengthening in these contexts (see §1.5.1). This raises an interesting set of questions on what the differences really are between these dialects: vowel length could be parametrically set by the phonetics, or Amarasi metathesis could have a weight-sensitive component, with the SWP inducing lengthening if spreading is ruled out (see §4.1). These issues merit independent phonetic study, and so I set them aside for future work.

To sum up, the Molo dialect of Meto does not allow rising-sonority diphthongs to be derived through metathesis, even though rising-sonority diphthongs may occur elsewhere. I analyse this as a restriction on line-crossing for rising-sonority diphthongs. This offers an improvement over tier-based accounts, which cannot distinguish between diphthongs derived from VV(C)# *versus* VCV# sequences.

2.5 Interim summary

In this section, I provided an analysis of coalescence alternations in Meto, where prosodic factors condition diphthongisation, coalescing metathesis or deletion. Under this analysis, each of these alternations is parasitic on prosodic truncation – a root-final V-slot deletes to improve prosodic well-formedness, leaving floating vowel features that must either spread or remain unassociated. In diphthongisation and coalescing metathesis, the floating features spread leftwards to reassociate with another V-slot. In the deletion cases, non-local spreading is blocked due to the high sonority of the delinked vowel, and so the delinked features remain floating.

In the next section, I turn to epenthetic metathesis, another type of metathesis in the language. Unlike the CV → VC coalescing metathesis, epenthetic metathesis is VC → CV and does not form a diphthong. However, like coalescing metathesis, epenthetic metathesis is parasitic on prosodic truncation, and so it can only surface in roots that are able to truncate.

3. Interactions with epenthesis

In this section, I explore connections between metathesis and epenthesis in Meto, and present some additional data providing evidence for several locality restrictions on Meto spreading. In particular, I predict that Meto metathesis arises through mechanisms similar to copy-epenthesis, and so in §3.1 I rule out synchronic copy-epenthesis in the language. In §3.2, I also present diphthongisation data that support treating metathesis as line-crossing instead of strictly local spreading.

I first introduce data on epenthetic metathesis, a VC → CV alternation that eliminates word-final consonant clusters. I argue that epenthetic metathesis is composed of deletion and spreading mechanisms, just as with coalescing metathesis (§2). The difference is that in epenthetic metathesis, the floating features spread rightwards to an epenthetic V-slot. The main contribution of this section is to establish the locality requirements on spreading active in Meto grammar.

In (36), I show some initial examples of epenthetic metathesis. Epenthetic metathesis eliminates *CC# sequences in non-monosyllabic roots.

(36) *Epenthetic metathesis* (VC → CV) *to resolve* *CC#

a.	[maˈnikin]	σσ́σ	‘to be cold’		
	[maˈnikni-t]	σσ́σ	‘(the) cold’	*[maˈnikin<u>a</u>-t]	*σσ́σσ
				*[maˈnikin<u>i</u>-t]	*σσ́σσ
b.	[ˈkapan]	σ́σ	‘Kapan (town)’		
	[ˈkapna=t]	σ́σ	‘While (at) Kapan…’	*[ˈkapan<u>a</u>=t]	*σ́σσ
c.	[ˈsonaf]	σ́σ	‘palace’		
	[ˈsonfa=m]	σ́σ	‘and the palace…’	*[ˈsonaf<u>a</u>=m]	*σ́σσ
d.	[ˈtenab]	σ́σ	‘think’		
	[ta-ˈtenba=t]	σσ́	‘when we think…’	*[ta-ˈtenab<u>a</u>=t]	*σσ́σ

It should be noted that (36a) is the only example I have with a non-CVCaC root from my fieldwork. If (36a) is later found to be spurious, we can eliminate predictions of epenthetic metathesis by imposing a ban on rightwards spreading. Under this alternative, we would expect roots to undergo leftwards coalescing metathesis or deletion, while the epenthetic vowel remains featureless (e.g. *[manikn<u>a</u>-t] ‘the cold’).

In this analysis, epenthetic metathesis has four steps: stress assignment, epenthesis, truncation and spreading. The derivation of /manikin-t/ → [manikni-t] ‘(the) cold’ is shown in (37):

(37) a. *Step 0: Stress assignment*

```
… C V C – C
  | | |   |
  k i n   t        [maˈnikin-t]
```

b. *Step 1: Epenthesis*

```
… C V C V – C
  | | |     |
  k i n     t      [maˈnikinV-t]
```

c. *Step 2: Truncation*

```
… C   C V – C
  |   |     |
  k i n     t      [maˈniki̯nV-t]
```

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d. *Step 3: Spreading*

```
… C     C  V  –  C
  |   - -|- -    |
  k  i  n        t      [maˈnikni-t]
```

I introduce two constraints: *CC# and DEP$_V$. These militate against word-final consonant clusters and V-slot epenthesis. While slot epenthesis is dominated, I treat the constraint against featural epenthesis (DEP$_F$) as undominated in the language. I discuss this in further depth in §3.1.

(38) *CC#: Assign a violation for a sequence of two adjacent C-slots at the end of a word.

(39) DEP$_V$ (dominated): ‘Don’t epenthesise V-slots’

(40) DEP$_F$ (undominated): ‘Don’t epenthesise features’

In tableau form, the derivation of /manikin-t/ → [maˈnikni-t] begins by assigning stress, and then epenthesising a V-slot. This is shown in (41). Vowel epenthesis prefers to occur word-internally in Uab Meto (cf. R/L-ANCHOR; McCarthy 1995: 123), and so I only consider candidates with epenthesis in those positions.

(41) *Step 1: Epenthesis*

/maˈnikin-t/	*CC#	MAX$_C$	DEP$_V$	(X,R)	*FLOAT	*XSPR	MAX$_V$
a. ma.ˈni.ki.n-t	*!			*			
b. ma.ˈni.kin-t̯		*!		*			
☞ c. ma.ˈniki.nV-t			*	**	*		

Structure of candidate (c):

```
… C  V  C  V  –  C
  |  |  |        |
  k  i  n        t
```

In Step 2 (42), the post-tonic V-slot truncates to reduce ALIGN(X,R) violations. All other candidates are less well-formed with respect to ALIGN(X,R) or *CC#.

(42) *Step 2: Prosodic truncation*

/maˈnikinV-t/	*CC#	MAX$_C$	DEP$_V$	(X,R)	*FLOAT	*XSPR	MAX$_V$
a. ma.ˈni.ki.nV-t				**!	*		
☞ b. ma.ˈniki̯.nV-t				*	**		*
c. ma.ˈni.kin-t	*!			*			*
d. ma.ˈni.ki.ni-t				**!		*	

Structure of candidate (b):

```
… C     C  V  –  C
  |     |        |
  k  i  n        t
```

In Step 3 (43), the floating vowel spreads to the epenthetic V-slot. This eliminates both *FLOAT violations in one step. Spreading leftwards (candidate (43c)) is dispreferred because the epenthetic V-slot remains floating and featureless.

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(43) *Step 3: Spreading*

/maˈniki̯nV-t/	*CC#	MAX$_C$	DEP$_V$	(X,R)	*FLOAT	*XSPR	MAX$_V$
a. ma.ˈni.ki̯.nV-t				*	*!*		
☞ b. ma.ˈnik.ni-t				*		*	
c. ma.ˈnik.nV-t				*	*!	*	

Structure of candidate (b): … C C V – C
k i n t

In comparison to coalescing metathesis (§2), epenthetic metathesis is rare in Meto. This is largely because epenthetic metathesis only occurs when a CVCVC root combines with a consonantal suffix. Meto has a bias in favour of CVCV roots (Edwards 2020: 135), and so the lexicon is skewed in a way that restricts the environments for epenthetic metathesis. Of the remaining roots that are CV_1CV_2C, most have [a] as V_2 and so epenthetic metathesis could also be analysed as epenthesis (e.g. /CVCC/ → [CVCa̲C]; see §3.1). Under this view, the only unambiguous case of epenthetic metathesis is (36a), /maˈnikin-t/ → [manikni-t] 'the cold'.

Despite appearances, this ambiguity between epenthetic metathesis and true epenthesis is desirable from a learning perspective. A learner's choice between metathesis and epenthesis will not yield diverging results for most CVCVC roots due to biases in the lexicon, since most CVCVC roots are CVCaC. This strengthens the stability of the Meto metathesis system, since learners can take either analytic route and still produce the correct output for almost all roots.

As an aside, there is also some evidence that Meto spreading cannot cross morpheme boundaries. In words with multiple suffixes, default epenthesis breaks up illicit consonant clusters (e.g. /ʔolɪ-f-m/ → [ˈʔo͡ɪl-fa̲=m]). In these cases, we might have expected epenthetic metathesis, where the truncated vowel spreads across a morpheme boundary (e.g. /ʔolɪ-f=m/ → *[ˈʔol-fɪ=m] 'and the younger sibling'). However, spreading here seems to be blocked by the morpheme boundary, and so the delinked vowel can only spread leftwards, leaving the epenthetic vowel default.[20] To rule this out, I assume that spreading across morpheme boundaries is prohibited in Meto by an undominated MORPH*XSPR constraint.

To sum up, word-final consonant clusters can induce epenthetic metathesis (VC → CV). I analyse epenthetic metathesis as the combination of epenthesis, deletion and spreading. In the next section, I show how Meto epenthetic metathesis is dependent on prosodic truncation – where truncation cannot occur, epenthetic metathesis cannot occur. This reveals an important locality restriction on Meto spreading: non-local spreading is only possible for floating features.

[20] Note that in Meto, we cannot analyse metathesis as being independent of morphological structure, since then we would expect metathesis in monomorphemic words like /ˌkabuˈpaten/ 'regency' (a loanword from Indonesian) → *[ˌka͡ubˈpaten], instead of [ˌkabuˈpaten]. Since this does not occur, I restrict truncation to root-final vowels. See MAX-INITIAL in §1.2.

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3.1 Monosyllabic roots do not metathesise

Monosyllabic roots cannot undergo epenthetic metathesis, and instead have default vowel epenthesis in these contexts. The main reason for this is that monosyllabic roots cannot truncate. Uab Meto has a positional restriction on truncation: only unstressed, post-tonic vowels in roots may delete (see §1.2). Since monosyllabic V-slots are stressed, truncation in these contexts is not possible.

In (44), we see that words with monosyllabic roots have default vowel epenthesis to prevent word-final consonant clusters. The epenthetic vowel [a] is underlined in the examples below.

(44) *Monosyllabic roots undergo default epenthesis*

a.	[ˈplena-t]	σ́σ	'command'	*[ˈplen-t]
	[ˈplen-t-e]	σ́σ	'the command'	*[ˈplenat-e]
b.	[ˈkena-t]	σ́σ	'gun'	*[ˈplen-t]
	[ˈken-t-e]	σ́σ	'the gun'	*[ˈkenat-e]
c.	[ʔa-ˈbsoʔa-t]	σσ́σ	'dancer'	*[ʔa-bsoʔ-t]
	[ʔa-ˈbsoʔ-t-e]	σσ́σ	'the dancer'	*[ʔa-ˈbsoʔ-at-e]
d.	[ˈtoʔ]	σ́	'angry'	
	[ʔa-ˈtoʔa-s]	σσ́σ	'angry person'	*[ʔa-ˈtoʔ-s]
e.	[ˈna͡en]	σ́	'run'	
	[ʔa-m-ˈna͡ena-t]	σσ́σ	'runner'	*[ʔa-m-nane-t]
f.	[fa͡i-ˈnek]	σσ́	'to advise' (lit. 'open-heart')	*[fai-ˈneka]
	[ʔa-fa͡i-ˈneka-t]	σσσ́σ	'advisor'	*[ʔa-fai-ˈnek-t]

In this analysis, I treat default epenthesis as a floating, featureless V-slot (cf. Archangeli 1984, 1988; Pulleyblank 1988). The phonetics interprets featureless slots as a language-specific default epenthetic segment, in this case [a]. These default epenthetic segments violate *FLOAT, but not DEP$_{F}$. This gives us the constraint ranking DEP$_{F}$ ≫ *FLOAT ≫ *XSPREAD, which means that epenthetic slots will be default unless they inherit features via spreading.

Historically, this type of constraint ranking has been associated with copy-epenthesis patterns (Kawahara 2007). If a language allows spreading and disprefers feature epenthesis, then epenthetic consonants should 'copy' the features of a nearby segment through spreading. The fact that this cannot happen in Meto monosyllabic roots reveals another restriction on spreading in the language: vowel features cannot spread non-locally if they are already associated. Intuitively, this means that Meto spreading has a contiguity restriction, which permits multiple association only when slots are adjacent. This is conceptually similar to constraints on multiple linkage across syllable boundaries, as proposed for Esimbi 'flop' (see Walker 1997).

I formalise this spreading restriction as constraint conjunction of *MULTIPLE from (27) and *XSPREAD. Vowel features can only spread across association lines when they are floating.

(45) *MULT∧*XSPR (undominated): 'Only floating features may cross association lines.'
Assign one violation when a multiply associated vowel feature has an association line that crosses some other association line.

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In copy-epenthesis languages, *MULT∧*XSPR is dominated because features spread across an intervening consonant while maintaining their original associations. In contrast, the Molo dialect of Uab Meto has undominated *MULT∧*XSPR. This is schematised in (46):

(46) a. *Copy-epenthesis violates* *MULT∧*XSPR

```
C  C  V́₁  C  V₂  –  C
|  |  └--┼---        |
p  l  e   n          t        *[plenet]
```

b. *Meto epenthesis never violates* *MULT∧*XSPR

i. *Default epenthesis*

```
C  C  V́₁  C  V₂  –  C
|  |  |   |          |
p  l  e   n          t        [ˈplenVt]
```

ii. *Epenthetic metathesis*

```
… C    C  V  –  C
  |  --┼--      |
  k  i n        t        [maniknit]
```

To illustrate, take the derivation of /ˈplen-t/ → [ˈplena̲-t] ‘the command’. In Step 1 (47), a V-slot is epenthesised to eliminate the *CC# violation.

(47) *Step 1: V-Slot Epenthesis*

/ˈplen-t/	*MULT ∧*XSPR	*CC#	DEP_V	(X,R)	*FLOAT	*XSPR	MAX_V
a. ˈplen-t		*!					
☞ b. ˈple.nV-t			*	*	*		

Structure of candidate (b):

```
C  C  V́  C  V  –  C
|  |  |  |        |
p  l  e  n        t
```

In Step 2 (48), no further changes harmonically improve the output, and so the faithful candidate (48a) wins and the derivation converges. Copy-epenthesis spreading (candidate (48a)) is ruled out by *MULT∧*XSPR. Deletion of the root’s V-slot is also ruled out (not shown in (48)), because stressed V-slots cannot delete.

(48) *Step 2: Convergence*

/ˈplenV-t/	*MULT ∧*XSPR	*CC#	DEP_V	(X,R)	*FLOAT	*XSPR	MAX_V
☞ a. ˈple.nV-t				*	*		
b. ˈple.ne-t	*!			*		*	
c. ˈplen-t		*!					*

At this point, my analysis has independently presented epenthesis and vowel deletion patterns for Meto (see §2.4). It is therefore reasonable to ask if these ∅ ~ [a]

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alternations could be analysed as a single phenomenon, instead of positing separate deletion and epenthesis mechanisms. I claim we do need both vowel epenthesis and vowel deletion for Meto, and review some arguments in favour of this here.

I begin with the vowel epenthesis pattern from (44). This pattern must be analysed as epenthesis (and not deletion), due to pairs like [bsoʔ] 'dance' and [ʔa-bsoʔ-at] 'dancer' in (44c). If the [a] vowel were underlying (i.e. if the UR of 'dance' were */bsoʔa/), we would expect for the verb to surface as *[bsoʔa] in phrase-final positions to avoid a NonFin violation. However, the verb surfaces as [ˈbsoʔ], and so we are forced to treat the vowel as epenthetic.

Similarly, the vowel deletion cases from §2.4 cannot be reanalysed as epenthesis. For instance, take an alternation like [nine] 'edge/wing' and [nin moloʔ] 'yellow wing'. This must be analysed as deletion, because the missing vowel in [nin moloʔ] 'yellow wing' does not have a predictable quality. Furthermore, if this were epenthesis we would expect that NonFin ≫ Dep, so that /nin/ → [nin<u>e</u>] 'wing' in isolation. This would imply that no stress-final words exist in the language, but again this is not the case (e.g. [ˌma͡ʊn-ˈfu͡ɟj] 'wild chicken', *[ma͡ʊn-fu͡ɟj<u>a</u>]; see §2.1).

That said, the alternations in many Meto words can be analysed as either deletion or epenthesis. For instance, in [ʔutan] 'vegetable', the UR could be either /ʔutn/ or /ʔutan/: the derivation will predict identical alternations regardless of UR. By Richness of the Base, any [CVCaC] word can have either /CVCaC/ or /CVCC/ as its UR.[21] I take this as an advantage of the present analysis: where there is unclear evidence in favour of deletion or epenthesis, the grammar will tolerate either option.

I now return to discuss the locality constraint proposed in this section, *Mult∧*XSpr. This constraint prohibits crossing association lines connected to multiply linked features, and is the only thing that prevents Molo from having copy-epenthesis. I therefore predict that languages with synchronic metathesis and copy-epenthesis should be quite similar, since they only differ in their ranking of *Mult∧*XSpr. This prediction seems to be borne out. In Ro'is Amarasi, another dialect of Uab Meto, there is preliminary evidence of a copy-epenthesis system. This is shown in (49):[22]

(49) *Ro'is Amarasi copy-epenthesis* (Edwards 2020: 170)

a.	[prenet]	'government'	cf. Molo [plen<u>a</u>-t]
b.	[surut]	'letter'	cf. Molo [sul<u>a</u>t]
c.	[meten]	'black'	cf. Molo [met<u>a</u>n]
d.	[ʔoros]	'time'	cf. Kotos Amarasi [ʔor<u>a</u>s]

This pattern suggests that *Mult∧*XSpr is dominated in Ro'is Amarasi.

In the present analysis, *Mult∧*XSpr also rules out metathesis for linked features, and so we might predict that metathesis will also behave differently in Ro'is Amarasi. Specifically, if *Mult∧*XSpr is dominated, we predict that line-crossing should be

[21] For longer words, like [CVCVCaC], we will need *CC# to be resolved before stress assignment. This will ensure that /CVCVCC/ words surface with penultimate stress (e.g. [CVCV́CaC]), not antepenultimate stress (e.g. *[CV́CVCaC]). That said, trisyllabic roots are rare, so this situation would rarely come up, if at all.

[22] Thank you to an anonymous reviewer for bringing this to my attention.

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possible even when vowels do not delete. This prediction is correct: Ro'is Amarasi diphthongises even in isolation (e.g. /manus/ → [ma͡unus] 'betel vine'; Edwards 2020: 195). We can capture this pattern by saying that Ro'is Amarasi differs from Molo in two respects: (i) *Mult∧*XSpr is dominated, and (ii) metathesis is driven by a need to make stressed syllables heavy. By contrast, Molo metathesis is driven by gradient alignment constraints and has stricter locality requirements on spreading, which rule out both copy-epenthesis and diphthongisation in isolation. The fact that Ro'is Amarasi has both copy-epenthesis and diphthongisation in isolation is encouraging, since the present analysis uses *Mult∧*XSpr to militate against both.

In the next section, I turn to consonant epenthesis in Meto. While not strictly related to metathesis, consonant epenthesis provides evidence in favour of treating metathesis as line-crossing rather than coindexation or strictly local spreading.

3.2 Consonant epenthesis and diphthongisation

In this section, I focus on the relationship between consonant epenthesis, metathesis and diphthongisation. I argue that epenthetic consonants receive their features from adjacent vowels by spreading (Staroverov 2014), building on existing accounts of Meto consonant epenthesis (Edwards 2016, 2020; Culhane 2018). The contiguity restriction on Meto spreading, enforced by *Mult∧*XSpr, means that consonant epenthesis bleeds metathesis. This pattern provides indirect evidence in favour of viewing metathesis as spreading, rather than some other type of coindexation.

In (50), I show examples of consonant epenthesis in the Molo dialect. Consonant epenthesis prevents vowel hiatus across a morpheme boundary, but bleeds metathesis of the truncated vowel:[23]

(50) Consonant epenthesis bleeds metathesis

a.	/fatu-e/	[fatb̲-e]	'the stone'	*[fa͡ʊtb-e]
b.	/belo-e/	[belb̲-e]	'the monkey'	*[be͡ɔlb-e]
c.	/mepo-e/	[mepb̲-e]	'work it'	*[me͡ɔpb-e]
d.	/aʔnoʔe-e/	[aʔnoʔl̲-e]	'the lontar palm'	%[ʔano͡eʔl-e]
e.	/nafnafɪ-e/	[nafnaf͡ɟ̲j̲-e]	'the spider'	*[nafna͡ɪf͡ɟj-e]
f.	/tasi-e/	[tas͡ɟ̲j̲-e]	'the sea'	*[ta͡ɪs͡ɟj-e]
g.	/toti-e/	[tot͡ɟ̲j̲-e]	'tell it'	*[to͡ɪt͡ɟj-e]

The quality of the epenthetic consonants in (50) is predictable from the underlying final vowel of the root. Round vowels condition [b], front mid vowels condition [l] and high front vowels condition [ɟ͡j]. These relationships are unusual, but not unheard-of in consonant–vowel spreading paradigms. In Samoan, for instance, vowel epenthesis in loanwords shows similar tendencies: labial consonants condition epenthetic /u/ and coronal consonants condition epenthetic /i/ (Uffmann 2006).

[23] In my Molo data, there are two counterexamples to this generalisation: (i) [aʔnoʔl̲-e] 'the lontar palm' can also be pronounced as [aʔno͡eʔl-e] by some speakers, and (ii) [ʔumɟ͡j-e] 'the house' can also appear as [ʔu͡iml-e]. I treat these counterexamples as variation in the UR, where the /l/ consonant has been reanalysed as underlying, not epenthetic.

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There are several reasons why these consonants must be epenthetic, rather than underlying, and I briefly summarise them here. First, if the consonants in (50) were underlying, then most of these words would have a /CVCVC/ templatic shape (e.g. /fatub/ for (50a)). Words of this templatic shape are expected to metathesise (e.g. /kokɪs-e/ → [ko͡ɪks-e] 'the bread'), but the words in (50) cannot (e.g. *[fa͡ʊtb-e], cf. (50a)). Second, plural allomorphy suggests that these words are vowel-final. The plural morpheme has three allomorphs: /-nu/ after VV sequences, /-n/ after CV and /-in/ after consonants (see data in the Supplemental Material). Words that are clearly CVCVC take /-in/ (e.g. /kokɪs-in/ → [ko͡ɪks-in] 'breads'), but the words in (50) all take /-n/ (e.g. [fatu-n] 'stones', *[fatub-in], *[fa͡ʊtb-in]). This, again, is evidence that these words are vowel-final, since there is no clear phonotactic reason why one CVCVC word should take /-in/ and the other /-n/. I therefore analyse these consonants as epenthetic, following Edwards (2016: 165) and Culhane (2018).

In this analysis, the consonant epenthesis pattern has four main steps: stress assignment, C-slot epenthesis, vowel truncation and spreading. C-slot epenthesis is driven by *V-V, which penalises vowel–vowel transitions at morpheme boundaries.[24] After spreading to C, metathesis is blocked by *Mult∧*XSpr, even though this leaves the vowel features associated only with a C-slot.

(51) *Consonant epenthesis bleeds metathesis*

a. *Step 1: C-slot epenthesis*

C V́ C V C – V
f a t u e   [ˈfatuC-e]

b. *Step 2: Truncation*

C V́ C C – V
f a t u e   [ˈfatu̯C-e]

c. *Step 3: Spreading to C*

C V́ C C – V
f a t u e   [ˈfatb-e]

d. *No spreading to V*

* C V́ C C – V
f a t u e   *[ˈfa͡ʊtb-e]

I assume that vowel features prefer to be associated with at least one V-slot (LetVbeV, cf. *Link(C,V); Uffmann 2006: 1096). This constraint is dominated by *Float in the Molo dialect, and so spreading will target the C-slot instead of the

[24] *V-V: For a sequence of two vowel features F_1 and F_2 that are separated by a morpheme boundary, assign a violation if there is no C-slot that immediately precedes the morpheme boundary.

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preceding V-slot. In tableau form, the crucial step of the derivation for /fatu-e/ → [ˈfatb-e] is shown in (52):[25]

(52) *Step 3: Spreading to C*

/ˈfatu̯C-e/	*MULT ∧*XSPR	*V-V	DEP$_C$	(X,R)	*FLOAT	LETVBEV	*XSPR
a. ˈfatu̯C-e				*	**!		
☞ b. ˈfatb-e				*		*	
c. ˈfa͡ʊtC-e				*	*!		*

After this step, spreading of the vowel to the preceding V-slot is ruled out by *MULT∧*XSPR, since features can associate with multiple slots only if the slots are adjacent.

Under this account, we expect there to be no restrictions on multiple association for adjacent segments. This means that in CVV words, consonant epenthesis does not interfere with diphthongisation:

(53) *Consonant epenthesis does not bleed diphthongisation (round and non-high vowels)*

a. /ʔau-e/ [ʔa͡ʊb̲-e] 'the lime'
b. /hau-e/ [ha͡ʊb̲-e] 'the tree'
c. /meo-e/ [me͡ɔb̲-e] 'the cat'
d. /biɟ͡jae-e/ [biɟ͡ja͡el̲-e] 'the water buffalo / cow'
e. /noe-e/ [no͡el̲-e] 'the river'

Molo has one exception to this pattern: high front vowels cannot multiply associate. In these cases, consonant epenthesis bleeds diphthongisation:

(54) *Consonant epenthesis bleeds diphthongisation for high front vowels*

a. /ʔai-e/ [ʔaɟ͡j-e] 'the fire' *[ʔa͡ɪɟ͡j-e]
b. /fai-e/ [faɟ͡j-e] 'the night' *[fa͡ɪɟ͡j-e]
c. /klei-e/ [kleɟ͡j̲-e] 'the church' *[kle͡ɪɟ͡j̲-e]

These patterns are simple to derive: LETVBEV outranks *MULTIPLE, and so we get one more instance of spreading after Step 3 in (55). For high front vowels, Meto has an undominated *MULTIPLE[+HI,+FR] constraint that prevents [i, ɪ] from associating with more than one slot.

(55) a. *Step 1: C-slot epenthesis*

```
C  V́  V  C  –  V
|  |  |        |
m  e  o        e        [meoC-e]
```

[25]Step 3 is probably two steps: first spreading of the vowel to the C-slot /fatu̯C-e/ → [ˈfatw-e], and then changing the vowel feature to [+CONS] to get /ˈfatw-e/ → [ˈfatb-e] to avoid a glide. In dialects with glides, such as Amanuban, the derivation yields [ˈfatw-e].

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b. *Step 2: Truncation*

```
C  V́    C  –  V
|  |          |
m  e  o       e        [meo̯C-e]
```

c. *Step 3: Spreading to C*

```
C  V́    C  –  V
|  |          |
m  e  o       e        [meb-e]
```

d. *Step 4: Spreading to V*

```
C  V́    C  –  V
|  |          |
m  e  o       e        [me͡ob-e]
```

In an alternative to the present account, Edwards (2016: 198) analyses consonant epenthesis as being driven by ONSET rather than *V-V. If we stipulate that metathesis cannot form valid onsets, this is a viable alternative within the present account.[26]

Returning to the data from (54), I argue that this pattern with high front vowels provides indirect evidence in favour of treating metathesis as line-crossing rather than strictly local spreading. In a strictly local spreading model, metathesised vowels would spread first to the intervening C-slot and then to the preceding V-slot. Every instance of metathesis would have a vowel that is linked to two slots. The problem with this account is that we need to rule out multiple linkage for high front vowels; otherwise, we would expect diphthongisation under consonant epenthesis (e.g. /fai-e/ → [faɟ͡ʝ-e], *[fa͡ɪɟ͡ʝ-e] 'the fire'). However, this incorrectly predicts that metathesis should not be possible for high vowels in Molo. There is no such restriction – high vowels can metathesise (e.g. /fani/ → [fa͡ɪn] 'return' (phrase-medial)). This supports the conclusion that metathesis is different from the multiple linkage seen with diphthongisation and epenthetic consonants.

To summarise, Uab Meto consonant epenthesis involves spreading of a truncated vowel to an epenthetic C-slot. This pattern reveals an unusual restriction on spreading: non-local spreading is only possible for floating features. Given this restriction, it follows that Meto metathesis is parasitic on prosodic truncation because only prosodic truncation will generate floating features. I summarise the final constraint ranking in Figure 3.

[26] In an OT implementation of Edwards's analysis, this use of ONSET leads to some problems. For instance, consider CVCV words that undergo metathesis and epenthesis in Kotos Amarasi, e.g. /fatu-e/ → [faatgʷ-e] 'the stone' (Edwards 2016: 129). Under Edwards's account, ONSET ≫ DEP, driving consonant epenthesis, and metathesis is triggered by CRISPEDGE ≫LIN. The problem is that this incorrectly predicts that *[faut-e] should harmonically bound [faatgʷ-e]. Both candidates violate ONSET once (recall that Edwards treats all V_1V_2 sequences as hiatus), but *[faut-e] only violates LIN instead of both DEP and LIN. This problem is difficult to escape if we treat metathesised VC sequences as fully transposed, onsetless syllables, but poses no significant issues within the present coalescence-based account.

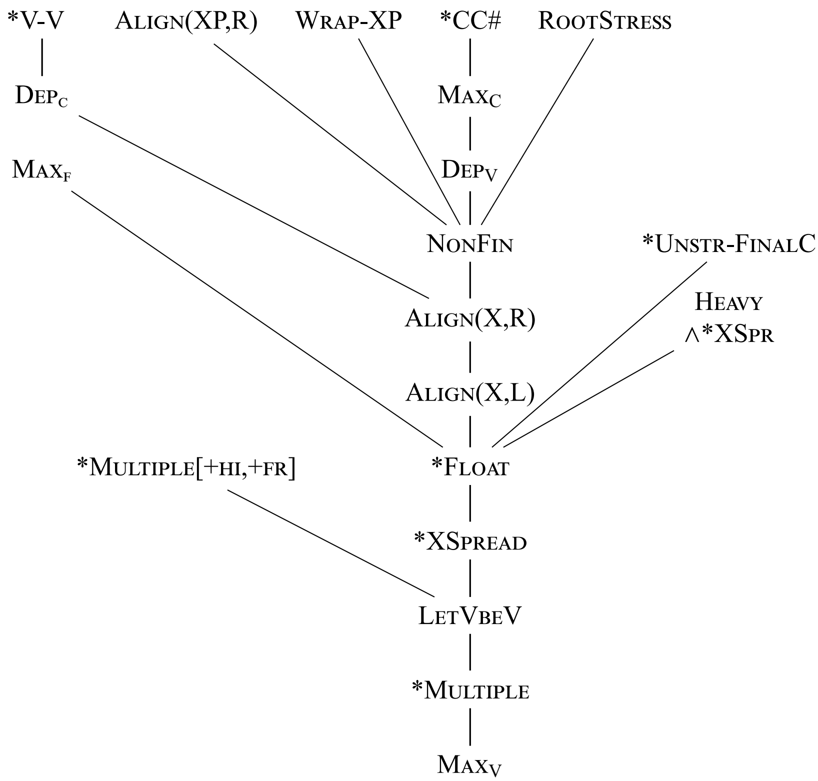

Figure 3. *Hasse diagram summarising the proposed constraint rankings.*

4. Discussion

In this section, I review alternatives to the analysis proposed here, and then turn to implications this proposal has for the typology of metathesis. Among the alternatives, I consider transposition-based accounts, SPE-style rewrite rules using spreading, indexation-based copying (Takahashi 2019) and allomorphy-based approaches (Edwards 2018, 2020). Of these, Takahashi (2019) comes closest to deriving the typology, but still falls short on deriving the correct phonetic and phonological behaviour for metathesised consonant–vowel sequences. I then discuss what the present proposal means for the typology of metathesis, and lay out some discrete predictions for the distribution of spreading-based *versus* infixation-based metathesis.

4.1 Alternatives

Previous work in OT has struggled with two incorrect predictions about the typology of metathesis: (i) long-distance metathesis patterns (e.g. ABCD → DABC) and (ii) multiple metatheses (e.g. ABCD → BADC). Both of these patterns have been argued to be unattested (see McCarthy 2006), and yet Parallel OT generates each one without problems. In the analysis presented here, both of these predictions are eliminated. The

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long-distance metathesis pattern is eliminated by assuming the NCC is universal for like over like – consonants cannot spread over like consonants, nor vowels over like vowels (cf. Archangeli & Pulleyblank 1994). When combined with the restriction on spreading across morpheme boundaries (§3), this effectively limits Meto metathesis to root-final syllables without further stipulations. In the typology at large, like-over-like spreading restrictions will also limit metathesis to adjacent syllables in most cases.

On the other hand, the multiple-metathesis pattern is largely eliminated by gradualness requirements in Harmonic Serialism. For instance, multiple metathesis in /apetka/ → [pateka] is ruled out via the assumption of harmonic improvement, since each intermediate stage between /apetka/ and /pateka/ must be more well-formed than the last (see discussion in McCarthy 2006). In contrast, Parallel OT will predict these patterns to be possible, since all that matters are the net final violations incurred by epenthesis, deletion and spreading. The only time we see something that appears like a multiple-metathesis pattern in Meto is when multiple roots metathesise in compounds and phrases, in which case each root only undergoes a single instance of local CV metathesis. Under this approach, this restriction is expected: metathesis can only occur in syllables that truncate.

Harmonic Serialism has been criticised in recent years on the grounds that it exceeds computational limits expected of phonology. For example, Lamont (2018) observes that Harmonic Serialism with local transposition in GEN requires use of a Turing machine, since it can model alphabetical sorting. Phonology has been hypothesised to require only finite-state transducers, and so the fact that Harmonic Serialism exceeds this level of expressive power is seen as a serious formal overgeneration issue. This issue is significant, but perhaps not fatal to Harmonic Serialism. Instead, I treat it as strong evidence that we should build new restrictions into the formalism. Eliminating transposition from GEN, as argued for in this article, may be one such example of how Harmonic Serialism could be restricted to help alleviate these formal overgeneration issues.

In SPE-style rewrite rules, it is possible to implement a near-identical analysis to the one proposed here, but with each step implemented via rule rather than tableau. The problem with this is that it decouples the properties of the stress system from the phonological alternations. In principle, a rule-based account should be able to derive Meto metathesis for languages with any type of stress system, since rules of stress assignment and prosodic truncation may be independently manipulated. In contrast, the spreading-based account predicts that Meto metathesis is tightly linked to its stress system: truncation is driven by ALIGN(X,R), which also contributes to penultimate stress assignment. If the Harmonic Serialism account is right, we should only see metathesis systems like this in languages that favour gradient alignment of stress towards edges.

In addition to arguing in favour of Harmonic Serialism, I also employ an enriched CV structure, which allows us to distinguish phonological feature order from surface-level gestural timing relationships. The core argument in favour of this bidimensional CV representation is that metathesised segments often do not have phonetic or phonological behaviour consistent with their surface form (see §1.3). This is predicted under the present analysis because feature order does not change.

For concreteness, I introduce one more argument along these lines, this time using a consonant deletion pattern in the language. While consonant deletion does not directly figure into metathesis, its positional restrictions reinforce the claim that metathesis does not change feature order. In (56), underlying word-final consonants delete when a word does not bear primary stress.

(56) *Underlying word-final consonants delete when the word does not bear primary stress*

a.	/tai-s metan/	[ˌta͡ɪ ˈmetan]	‘black sarong’
b.	/loi-t mate/	[ˌlo͡ɪ ˈmate]	‘green money’
c.	/fof leko/	[ˌfo ˈleko]	‘good smell’
d.	/hun mate/	[ˌhu ˈmate]	‘green grass’
e.	/snaen mutiʔ/	[ˌsna͡e ˈmutiʔ]	‘white sand’
f.	/napan moloʔ/	[ˌnap ˈmoloʔ]	‘yellow butterfly’
g.	/kibaʔ metan/	[ˌkib ˈmetan]	‘black ant’

By contrast, the metathesis-derived word-final consonants in (57) are immune to this restriction and do not delete.

(57) *Derived word-final consonants do not delete*

a.	/tasi metan/	[ˌta͡ɪs ˈmetan]	‘black sea’	*[ˌta͡ɪ ˈmetan]
b.	/manu mutiʔ/	[ˌma͡ʊn ˈmutiʔ]	‘white chicken’	*[ˌma͡ʊ ˈmutiʔ]
c.	/kolo-ʔane/	[ˌkol-ˈʔane]	‘finch’	*[ˌko-ˈʔane]
d.	/kokɪs moloʔ/	[ˌko͡ɪk ˈmoloʔ]	‘yellow bread’	*[ˌko͡ɪ ˈmoloʔ]
e.	/ʔa-mepo-t lele/	[ʔa-ˌme͡op ˈlele]	‘field worker’	*[ˌʔa-me͡o ˈlele]

I analyse this as a restriction on consonant-final words, *Unstr-FinalC: a word can have a final C-slot only if it bears primary phrasal stress (cf. Final-C, McCarthy & Prince 1994: 22).[27] In (56), this forces word-final C-slots to delete when they are phrase-medial. On the other hand, metathesised words from (57) do not have a word-final consonant – there is a floating vowel feature at the end of the word – and so they do not incur a violation of this constraint. In this way, metathesised words behave as though no transposition has occurred: their surface phonological behaviour is consistent with their underlying precedence structure.

For other models of metathesis, whether they use transposition, index-based coalescence or rules, this pattern is troubling. If metathesis fully transposes a CV sequence to VC, why does the consonant not delete in (57)? A tempting possibility is to appeal to some type of output–output faith here, where consonants occupying medial positions in one output form must be preserved in other outputs as well. However, this leads to a ranking paradox. First, we know that *Unstr-FinalC must be outranked by Align(X,L), because otherwise metathesis would be blocked in (57) to avoid the word-final consonant.

[27] Some speakers of the Molo dialect have an additional variant of this constraint: phrase-final syllables must contain a C-slot. This creates a consonant epenthesis pattern for CVV words in phrase-final contexts, e.g. /meo/ → [me.ob] ‘cat’ (phrase-final). These word-final consonants are entirely predictable; see §3.2.

(58) /tasi metan/ [ˌt͡aɪs ˈmetan] 'black sea' #[tasi ˈmetan]
Align(X,L) ≫ *Unstr-FinalC ≫ Max_C

In addition to this, vowel epenthesis shows us that Max_C ≫ Dep; otherwise, we would see consonant deletion instead of epenthesis in (59).

(59) /ken-t/ [ˈkena̲-t] 'gun' #[ken]
Max_C ≫ Dep

Lastly, we know that Dep ≫ NonFin ≫ Align(X,L); otherwise, we would see epenthesis instead of stress-final words like [kol-ˈkaʔ] 'crow' in (60).

(60) /kolo-kaʔ/ [ˌkol-ˈkaʔ] 'crow' *[kolo-ˈkaʔa̲] (see §2.1)
Dep ≫ NonFin ≫ Align(X,L)

This creates a paradox, because (58) and (59) imply that Align(X,L) ≫ Dep, but (60) implies that Dep ≫ Align(X,L). This paradox suggests that metathesised consonants are not truly word-final, because they must be entirely exempt from the *Unstr-FinalC restriction.

This problem is a deep one, as it applies to any Parallel OT or Harmonic Serialism analysis where the output is fully transposed. For example, in indexation-based models of metathesis such as Takahashi (2019), word-final consonants derived by metathesis are predicted to be indistinguishable from underlying ones, both phonetically and phonologically. In §1.3, I introduced data from Meto showing that phonetically, metathesised VC sequences have greater-than-normal overlap (e.g. [taɪs] 'sarong' *vs.* [t͡aɪsʲ] 'sea'). The consonant deletion pattern further reinforces this distinction, since the phonology does not seem to recognise metathesised consonants as true codas.

As a final alternative, I now turn to morphological approaches to Meto metathesis. Edwards (2018, 2020) proposes that metathesis is a type of allomorphy in which a morphological rule induces transposition in a CV skeleton. Under this approach, the rules for deletion, epenthesis, vowel lengthening and transposition must be independently asserted, instead of being derived directly from the language's stress system. This is necessary because Edwards treats Amarasi metathesised CVVC sequences as disyllables (Edwards 2018: 44). In the Molo dialect, experimental data suggest that these metathesised VV sequences may be monosyllabic (see §1.3). Provided that this is the case, it is preferable to treat Meto metathesis as prosodically driven coalescence, because it allows unified treatment of a variety of phenomena in the language.

That said, the syllabic status of metathesised CVVC sequences needs further verification for both the Amarasi and Molo dialects, since there are discrepancies between the Amarasi data reported in Edwards (2018, 2020) and the Molo data reported here. Both phonetic studies are small, and are based on field recordings from just one speaker. At this point, Edwards's reported facts for Amarasi are consistent with metathesis being partially driven by the SWP, following the lines of Takahashi (2019). Under a stress-to-weight analysis, vowels would lengthen, and then deletion and spreading would occur. Vowel lengthening would therefore be predicted in isolation (e.g. /manu/ → [ˈmaːnu] 'chicken') or when metathesis fails (e.g. /penaʔ/ → [ˈpeːnʔ-e] 'corn'). Vowel lengthening in isolated forms would distinguish a

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stress-to-weight account from the morphological account proposed in Edwards (2018, 2020) and the alignment-based account proposed here. These predictions are left for future work.

4.2 Predictions for the typology of metathesis

In my account, metathesis is a type of covert non-local spreading, resulting from the serial application of deletion and spreading operations. While this type of approach is not new (e.g. Arabic, McCarthy 1979; Maltese, Hume 1991; Rotuman, Besnier 1987), the Meto case provides unique evidence showing that deletion, epenthesis and spreading are all active in the synchronic grammar. For this reason, I predict that synchronic, productive metathesis should be common in language families with active spreading and deletion patterns, since these are the precursors to apparent metathesis. This prediction shares its core reasoning with earlier diachronic work on metathesis – Blevins and Garrett (1998), for instance, also argue in favour of 'pseudo-metathesis' arising diachronically from spreading and deletion precursors. In my account, however, the precursors must also be active in the synchronic grammar.

In Austronesian, I predict that metathesis is common precisely because its precursors – deletion and spreading – are widespread in the family. For instance, prosodic truncation is known to be prevalent throughout the Pacific (Zuraw 2018). Similarly, vowel spreading has been observed in Samoan loanword epenthesis (Uffmann 2006), where an epenthetic vowel inherits its place features from a preceding consonant. This pattern is an inverted version of the spreading seen in consonant epenthesis in Molo, where underlying vowels spread to epenthetic C-slots. Copy-epenthesis in Austronesian languages is also fairly common (Blust 1990; Kitto & de Lacy 1999; Lin 2014), and can also be analysed as autosegmental spreading. It is therefore no accident that metathesis is well represented in Austronesian languages: where the precursors of metathesis are common, it is possible for non-transpositional metathesis to arise. I predict that further work in specific languages with metathesis will show phonological evidence of active spreading and deletion sub-patterns, which will be phonetically implemented as gestural overlap. I tentatively put forward the following languages as potentially having metathesis patterns of this type: Sevillian Spanish (Gilbert 2022), Nivaĉle (Gutiérrez 2015, 2020), Balantak (Pater 2003), Zoque (Hall 2000), Maltese (Hume 1991), Kwara'ae (Heinz 2005a), Leti (internal metathesis; Mills & Grima 1980; Hume 1997; van Engelenhoven 2004) and Cherokee (Flemming 1996).

While this hypothesis accounts for many cases in the typology of metathesis, it does not capture all of them. Many metathesis patterns show restricted productivity, occurring only with specific morphemes or in certain derived environments. As an example, take Leti 'external metathesis', in which the nominaliser *n* metathesises into a root, as in /n-kili/ → [k-n-ili] 'act of looking' (Blevins 1999; van Engelenhoven 2004). This type of metathesis creates marked consonant clusters, does not bear any signs of overlap and is morphologically specific. This alternation does not appear to be phonologically optimising, since initial [nk] clusters are licit (Blevins 1999). For Leti, this pattern has been analysed as infixation (Blevins 1999; Kalin 2020), since it seems to be morpheme-driven.

I therefore hypothesise that there are at least two types of metatheses: phonological metathesis and infixational metathesis. Transposition is not possible in GEN, but can be generated by morphophonological processes like infixation. Phonological metathesis is non-transpositional and productive and involves some combination of deletion, spreading and epenthesis. Infixational metathesis is true transposition, bears morphological restrictions and is implemented through morpheme-specific rules such as those used for true infixation.

Exactly how to implement infixational metathesis is beyond the scope of this article, but some possibilities include co-phonologies (Orgun 1996; Anttila 1997; Inkelas 1998; Inkelas & Zoll 2005, among others), generalised reduplication (Harris & Halle 2005; Arregi & Nevins 2012) or prosodic alignment (McCarthy & Prince 1993; Yu 2002). In any of these approaches, it should be possible for infixational metathesis to be non-optimising for the global phonology. If the mechanism for infixational metathesis turns out to be the same as for ordinary infixes, then I predict that infixes and infixational metathesis should have similar distributions. For example, infixational metathesis would be expected have a strong left-edge bias, and so it should occur more frequently at the left edges of morphemes rather than right edges.[28]

In Table 5, I offer some potential cases of each type of metathesis, along with their predicted characteristics. These predictions are left to be tested in future phonetic and phonological studies.

Table 5. *Properties and examples of two types of metatheses.*

Phonological metathesis	**Infixational metathesis**
Mechanism	
Serial delete-and-spread or spread-and-delete	Placement determined by morpheme-specific rules similar to infixation
Examples	
• Sevillian Spanish (Gilbert 2022) • Nivaĉle (Gutiérrez 2020) • Zoque (Hall 2000) • Leti internal metathesis (Hume 1997)	• Georgian (Butskhrikidze & van de Weijer 2003) • Mutsun (Okrand 1979) • Fur (Jakobi 1989) • Leti external metathesis (Blevins 1999)
Characteristics	
• increased consonant–vowel overlap • productive • phonologically optimising • precursors of metathesis present	• ordinary consonant–vowel overlap • bears morphological restrictions • may not be phonologically optimising • no requirement of precursors

[28] In Yu (2002), 67% of infixes had a left-edge pivot, whereas only 18% targeted a right-edge and 15% targeted a prosodic prominence. This is a notable quality of infixes, since affixation has a strong right-edge bias (Greenberg 1966; Cutler *et al.* 1997).

To sum up, I hypothesise that phonology cannot transpose. Phonological metathesis can be decomposed into serial spreading, deletion and epenthesis operations, which when combined give the surface appearance of transposition. On the other hand, I hypothesise that morphophonological operations are responsible for metathesis patterns that do seem to involve true transposition, since these cases are less productive and have morphological restrictions. This would support a model of grammar where transposition is only a syntactic or morphophonological operation, never a purely phonological one.

5. Conclusion

In Uab Meto, metathesis occurs in complementary distribution with a variety of other phonological processes, including epenthesis, deletion and coalescence. Instead of analysing the intricate phonology of the language as happenstance, I derive metathesis from the combination of these synchronic sub-patterns, so that metathesis is essentially a serial delete-and-copy mechanism in the phonology. While this approach is not new (see Mills & Grima 1980; Besnier 1987; Hume 1991), this places Uab Meto in a previously undescribed position in the typology of spreading phenomena, where non-local spreading is possible only as long as features are not yet associated with a timing slot.

The typological rarity of metathesis thus follows from the complexity of metathesis as a phonological pattern. Phonological metathesis is always based on spreading and deletion operations, and may only arise in languages where the precursors are present and occur in overlapping environments. In the Austronesian family, it so happens that prosodic truncation, spreading and epenthesis are all robust (cf. Blust 1990; Kitto & de Lacy 1999; Uffmann 2006; Zuraw 2018), and so it is unsurprising that metathesis is relatively widespread in the family. Outside of this pathway, I predict that metathesis should be subject to morphological restrictions, and therefore should be derived using morpheme-specific operations such as those used for infixation.

Supplementary material. The supplementary material provides data for the phonetic study on vowel length (§1.5) and an accompanying R script. These materials also contain additional transcribed data for metathesis in nouns and verbs, along with their elicitation contexts. The supplementary material for this article can be found at https://doi.org/10.1017/S0952675723000088.

Acknowledgements. Thanks to Maria Gouskova, Gillian Gallagher, Juliet Stanton and Lisa Davidson for comments on the article, as well as audiences at LSA 2019, Rutgers PhonX, Yale Ling Lunch and PhoNE 2019. Special thanks to the people of Bijaepunu, West Timor, for participating in this research. All data were collected in collaboration with Nona Seko (Sekolah Tinggi Bahasa Asing Cakrawala Nusantara Kupang) in August 2019, under the research title ‘Documenting Traditional Uab Meto’. Special thanks also to Yanti, Peter Cole and Gabriella Hermon for the NSF-sponsored language documentation training program in 2018 (BCS – 1747801), which set the groundwork for this fieldwork. Thanks also to the three anonymous reviewers and the associate editor for their detailed feedback on the manuscript.

Competing interests. The author declares no competing interests.

Funding statement. This research was partially supported by an NSF Graduate Research Fellowship (#DGE2234660).

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