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Juliette Blevins, Andrew Garrett

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THE ORIGINS OF CONSONANT-VOWEL METATHESIS

JULIETTE BLEVINS
University of Western Australia

ANDREW GARRETT
University of California, Berkeley

We argue against the prevailing view that metathesis is somehow less natural phonetically than other processes and distinguished by a relatively greater phonological motivation. We survey cases of consonant-vowel metathesis—both synchronic processes and diachronic changes—with the goal of understanding how metathesis sound changes arise. We identify two types of CV metathesis, with distinct synchronic properties and distinct historical origins, and we argue that the two types do have natural, phonetic bases and fundamental commonalities.*

1. METATHESIS. Metathesis has long posed a problem for linguistic theories in which phonetic naturalness plays a role. The problem partly reflects the articulatory orientation of many such theories: a process is phonetically natural if it corresponds to an attested articulatory pattern such as coarticulation or lenition. In diachronic models, surface similarity is often posited as a pivotal mechanism of sound change, but the input and output of metatheses have seemed fundamentally dissimilar—with no phonetic process bridging the gap. Similarly, metathesis has resisted characterization in synchronic process-oriented phonological models that try to integrate phonetic naturalness.[1]

The usual solution to the problem has been to say that metathesis is indeed less natural phonetically than other processes, and has a relatively greater phonological motivation. First suggested in a footnote in the manifesto of the neogrammarian movement (Osthoff & Brugman 1878:xvi), this view was later clearly stated by Brugmann (1902:246): metathesis arises when 'the order of sounds and the syllable boundary make for inconvenience'; it causes 'a group of sounds [to be] placed where it is easier for the speaker'.

This phonotactic optimization approach has prevailed in descriptive and typological studies. According to Grammont (1950:239), for instance, metathesis yields 'a better syllable structure', 'safeguards the unity and the harmony of a language's sound system

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Throughout this paper, abstract underlying phonological forms are enclosed in slash brackets. These underlying forms follow analyses in published sources except as indicated. We use IPA notation everywhere except as stated to the contrary, and the following abbreviations and cover symbols: V = vowel; I = high vowel; C = consonant; R = sonorant consonant; L = liquid (i.e. rhotic or lateral); T = unaspirated stop; G = guttural (i.e. uvular, pharyngeal, or laryngeal) continuant; PAN = Proto-Austronesian; PCMP = Proto-Central-Malayo-Polynesian; and PMP = Proto-Malayo-Polynesian.

[1] In other theories it has seemed less problematic. According to Chomsky and Halle (1968:361), metathesis is 'readily available to the child as he attempts to construct the grammar of his speech community. We could, of course, have decided otherwise and established conventions that would have made the formulation of metathesis extremely "costly", but this would not harmonize with the fact that metathesis is a perfectly common phonological process'.

in replacing unusual groups by common groups', 'separates [cluster] types which are or have become unpronounceable in substituting simple types for them', and 'avoids useless articulatory efforts'. Ultan's (1978) survey also concludes that 'the superficial cause of most metatheses is conversion of a phonologically inadmissible or disfavored sequence into an acceptable one' (p. 395). Finally, Hock (1985:532–33) contends that metathesis 'can become regular only when it serves a specific structural purpose', usually that of 'converting phonologically or perceptually "marked" structures into more acceptable ones'.

Precisely the causes of its traditional marginalization—its alleged 'structural purpose' and unnaturalness as a phonetic process—give metathesis a central role in the current phonological theater. With the development of optimality theory, a major research program has been dedicated to the view that interacting constraints on surface forms may be responsible for a variety of sound patterns. Analyses from this point of view continue the traditional phonotactic optimization approach: metathesis occurs because output forms are phonotactically 'better' than input forms (McCarthy 1995, Flemming 1996, Hume 1997, 1998). Such output forms may have improved perceptual cues or the greater articulatory 'convenience' assumed by Brugmann, but in either case they are attributed to speakers' grammatical knowledge of phonotactic optimality. This framework, in short, might seem to account for a phonological phenomenon which has long been a special case at best and an embarrassment at worst.

In this article we will argue against the view of metathesis that has reigned in linguistic theory for the last twelve decades. Metathesis is as phonetically natural as other processes, we will show, and no special assumptions are needed to account for its evolution. Its phonological motivation is no greater (or less) than that of other processes which lead to regular sound patterns, and it offers no special justification for a new or different approach to sound change. On the contrary, metathesis has a distinctive typological profile which follows quite naturally from the traditional view that sound change arises from the reinterpretation of phonetically ambiguous surface forms. This typological profile is unexplained by the phonotactic optimization approach.

We will limit our discussion here to one major set of regular metathesis processes: synchronic and diachronic CV metatheses, in which CV → VC or VC → CV. Our general conclusions about the naturalness of metathesis are only partly justified, therefore, inasmuch as we will not discuss VV metathesis, CC metathesis, or irregular CV metathesis (though we believe our approach could fruitfully be applied to them). While also practical, the limitation of our discussion reflects our view that all CV metathesis processes, despite significant differences, have basic commonalities in their diachronic phonetic basis. Two general types of CV metathesis will be distinguished. They have distinct synchronic properties, and we will argue that the diachronic paths along which they evolve differ in significant ways. The reasons for the terms we use to describe these two CV metathesis types will become clear as our arguments develop.

One CV metathesis type, which we will call PERCEPTUAL METATHESIS, is illustrated by an apparent laryngeal metathesis process in the Northern Iroquoian language Cayuga. According to Foster (1982), Cayuga /V?/ → [?V] and /Vh/ → [hV] in odd-numbered nonfinal syllables (with some additional restrictions to be discussed in §2). Examples appear in 1a–c; the /ks/ → /s/ change in 1a is due to an independent phonological rule.

(1) Cayuga
   a. /kahwista?eks/ → [k^{h}a̤wísd?aes] 'it strikes, chimes (a clock)'
   b. /akekaha?/ → [agékhaa?] 'my eye'
   c. /ko?nikõha?/ → [g?oníkhwa?] 'her mind'
   d. No change:
      /akahwistá?ek/ → [agahwisdá?ek] 'it struck, chimed'

The salient property of perceptual metathesis is that it is limited to certain segment types, for example laryngeals as in Cayuga, and in some cases certain CV combinations.

We will use the term COMPENSATORY METATHESIS for the second CV metathesis type. Its most famous example occurs in the Oceanic language Rotuman (Churchward 1940), where forms like those in 2 alternate according to context.

(2)

	$-V_1CV_2$	$-V_1V_2C$	
a.	fúti	fýt	'to pull'
b.	móse	møs	'to sleep'
c.	seséva	seséav	'erroneous'
d.	tíko	tíok	'flesh'
e.	?úlu	?úl	'breadfruit'

Two of the $-V_1V_2C$ forms here actually show V_1V_2 diphthongs or apparent metathesis (2c–d); in others, V_1 and V_2 have in some sense merged (2a–b) or only V_1 surfaces (2e). Salient properties of this metathesis type are given in 3.

(3) Compensatory CV metathesis:
   a. reduces the number of syllables;
   b. is not structure-preserving;
   c. is conditioned by stress; and
   d. affects all or most (rather than a restricted class of) segment types.

The property in 3d crucially distinguishes compensatory metathesis from perceptual metathesis.

Perceptual and compensatory metathesis will be discussed in §§2–3 respectively. In §4 we will discuss what we will call PSEUDOMETATHESES, focusing on a set of synchronic alternations in Leti, a Central Malayo-Polynesian language described by van Engelenhoven (1995a). Certain Leti words show the distinct phrase-medial and phrase-final forms in 4.

(4)

MEDIAL	FINAL	
mɛtam	mɛtma	'black'
kukis	kuksi	'kind of sandwich'
βuar (< *βu?ar)	βu:ra (< *βu?ra)	'mountain'
lout (< *lo?ut)	lo:tu (< *lo?tu)	'servant'

The apparent metathesis in 4 is structure-preserving, preserves syllable count, and affects all segment types. Therefore, despite the superficial similarity of the alternations in 2c–d and 4, the two metatheses are quite different. A summary of our results and a brief discussion of some general issues appear in §5.

2. PERCEPTUAL METATHESIS. In cases of perceptual metathesis, segments with certain features in effect jump over adjacent segments. Our diachronic analysis of this type of metathesis has two basic phonetic ingredients: an acoustic or perceptual feature with a relatively long duration; and some ambiguity as to the (linear or segmental) cause or origin of the feature in question.

We propose that perceptual metatheses originate when features extending across a CV or VC domain, or perceived as extending across such a domain, are reinterpreted

as originating in nonhistorical positions. This analysis is partly based on Ohala's (1981, 1993) account of dissimilation. On his account, dissimilation arises in C_1VC_2 contexts, say, when an intrinsic feature of C_1 is reinterpreted as a phonetic effect of the same feature associated with C_2. Breathy voice dissimilation whereby /C[fi]VC[fi]/ > /CVC[fi]/, for instance, might originate when the CV breathy voice transition in /C[fi]VC[fi]/ = [C[fi]V̤C[fi]] is reinterpreted as caused by the postvocalic consonant. Similarly, /CVfiC/ > /CfiVC/ metathesis might originate when the breathy vowel in /CVfiC/ = [CV̤C] is reinterpreted as caused by a prevocalic /fi/ and not a postvocalic /fi/.

If our proposal is right, then the segment types that undergo perceptual metathesis should be those whose acoustic or perceptual cues have relatively long durations. Essentially the same cues are, according to Ohala, involved in dissimilation:

> [D]issimilation . . . should only involve features which manifest themselves over fairly long temporal intervals, that is, which can encroach on adjacent segments and thus create an ambiguity as to where the feature is distinctive and where fortuitous. Examples of such 'stretched out' features are labialization, aspiration, retroflexion, pharyngealization, the voice quality called 'glottalization', and place of articulation. It would not involve features such as 'stop', 'affricate' which do not stretch over long temporal intervals. In general, this prediction is borne out (Ohala 1993:251).

For the representative Cayuga case in 1 above, we propose that the nuclei of metrically weak syllables were shortened phonetically. In syllables with nuclei followed by /h/, this resulted in vowels which were fully or mostly devoiced: schematically and somewhat abstractly, /CVh/ = [CVV̥] > [CV̥]. The sound change responsible for /h/ metathesis would then consist of the reinterpretation of phonetic [CV̥] sequences as standing phonologically for /ChV/ rather than /CVh/. Likewise, we suggest, /ʔ/ metathesis would originate as a reinterpretation of vowels in shortened weak syllables where an originally postvocalic /ʔ/ was realized as creaky voice: /CVʔ/ = /CVV̰] > [CV̰].

This scenario is partly hypothetical, because Cayuga laryngeal metathesis—VC > CV transposition—is not in fact complete. This was originally suggested as a possibility by Floyd Lounsbury (cited by Foster 1982:70) and has been confirmed by Dougherty's (1993) acoustic analysis. Concerning laryngeal 'metathesis' Dougherty reports that:

> A vowel followed by /ʔ/ is [ordinarily] realized as a sequence of plain voice followed by creaky voice . . . In laryngeal metathesis the creaky voice spreads to the entire vowel. A vowel followed by /h/ is [ordinarily] realized as a sequence of plain voice followed by voicelessness. In laryngeal metathesis the voicelessness spreads to the entire vowel (276).

This feature spread or merger is precisely the sort of phonetically ambiguous elongated cue which we posit as a necessary intermediate stage in perceptual CV metathesis. In the Cayuga case itself, there is little evidence that originally postvocalic laryngeals have been phonologically reinterpreted as prevocalic.[2]

[2] In fact there is conflicting evidence. Evidence against the view that laryngeal spreading is now interpreted phonologically as metathesis comes from an experiment conducted by Dougherty. Speakers asked to pronounce one syllable at a time (with intervening pauses) did not produce forms with laryngeal spreading or metathesis: in such cases 'the "slow" version does not reflect a change in speaking rate but rather the omission of the laryngeal spreading rule which is optional or absent in the speech of some speakers in some styles' (Dougherty 1993:277–78).

The orthographic practices of native speakers offer interesting additional evidence. (The orthography in use was originally developed by Reg Henry, and for information about it we thank Carrie Dyck.) With /Vh/ sequences in 'metathesis' environments, the vowel is consistently underlined, presumably indicating devoicing. Normally the ⟨h⟩ continues to be written in postvocalic position, but sometimes it is dropped and the obstruent onsets /d g/ which precede underlined vowels are also often written as ⟨t⟩ and ⟨k⟩ respectively. The use of a vocalic diacritic in all cases suggests that /h/ has not fully metathesized: even in metathesis contexts where ⟨t⟩ and ⟨k⟩ are written preceding underlined vowels, there is evidence for the phonological association of [spread glottis] to a CV domain rather than segmentation into ChV. As for /ʔ/, in metathesis environments with underlying /VʔC/ sequences, speakers sometimes write the glottal stop in prevocalic position, most commonly when the preceding consonant is a sonorant. (When this is an obstruent, glottal

Cayuga laryngeal 'metathesis' has two major exceptions: it only occurs in odd-numbered nonfinal syllables and it does not occur if it would result in a laryngeal cluster [hʔ] or [ʔh]. We have already suggested an explanation for the prosodic conditioning: odd-numbered nonfinal syllables are the class of weak or unaccented syllables in Cayuga. These syllables were shorter than unstressed syllables, allowing laryngeal features to encompass the entire temporal domain of the preceding short vowel.[3] The failure of 'metathesis' to apply in contexts where a laryngeal cluster would be created follows from the physiological impossibility of shifting between constricted and spread glottis without an intermediate phase of glottal aperture. In /hVʔ/ and /ʔVh/ sequences, the normal anticipation of the second laryngeal gesture is inhibited by the activity of the first. As a result, laryngeal spreading is limited, and no subsequent phonological reinterpretation occurs.[4]

Perceptual metathesis as we understand it has at least three discrete diachronic stages. In the first stage, a string is phonologically analyzed into a discrete VC or CV sequence; an example is a hypothetical earlier stage of Cayuga, with C in this case a laryngeal. In the second stage, the features of the consonant shift or spread across an adjacent vowel, and the phonological analysis calls for multiple association of a feature to the segment string; this analysis seems appropriate for present-day Cayuga. In the third and final stage, the metathesizing consonant is reanalyzed as originating on the other (nonhistorical) side of the vowel in question. Cayuga has not reached this third stage—and so has not actually undergone metathesis—but another Iroquian language has: some postvocalic laryngeals have been reanalyzed as prevocalic in Cherokee. We will discuss this further in §2.4.

2.1. FEATURAL DISTRIBUTION. At least the segment types shown in Table 1 are attested in perceptual CV metathesis (or the feature-spreading stage found in Cayuga). These are essentially the segment types cued by one or more drawn-out perceptual features. Glides are included, and we discuss several CV metatheses in which a high vowel surfaces metathesized as a glide. But we do not discuss glide/consonant metathesis as such, though this is found in many languages (e.g., Ancient Greek and Zoque) and a parallel analysis is probably warranted.

Laterality is not among the 'stretched out' features cited above, but laterals are listed in Table 1. Ohala (1993:252–53) comments that 'laterals would seem to be segments that should not dissimilate since laterality cannot easily spread to adjacent segments . . . But laterals do not have very long transitions of Formants 2 and 3'. Therefore, he concludes, since they 'have cues that require a long time-window for their perception

stop is often not written at all.) This appears to be the orthographic equivalent of writing ⟨t⟩ and ⟨k⟩ for phonological /dh/ and /kh/. Some speakers have also extended the use of the underline diacritic to glottal stop environments: in $V_1ʔV_2$, in an odd-numbered syllable V_1 is sometimes underlined. In this context, V_1 is often 'so glottalized no voicing occurs at all, just one "creak"', with the underline diacritic on vowels likely indicating lack of periodic voicing in speakers' perceptual representation (Carrie Dyck, p.c. 1996). In short, while there is some evidence that speakers associate postvocalic laryngeals with prevocalic position in 'metathesis' environments, the common use of underlined vowels in the orthography suggests continued association of laryngeal features with vowel positions as well.

[3] According to Foster (1982:61), even-numbered syllables have secondary stress in Cayuga, but Dougherty (1993:162–63) reports that a 'search for acoustic correlates of secondary stress . . . found nothing' despite the 'overwhelming impression of iambic rhythm expressed by various investigators'.

[4] A third restriction is that there is no evidence of /h/ 'metathesis' in the first syllable of vowel-initial words. Since such words begin with a phonetic [ʔ] in Cayuga (Michelson 1988:10), the absence of laryngeal 'metathesis' is perhaps a special case of its absence where it would result in a laryngeal cluster.

SEGMENT	FEATURE	EXAMPLES DISCUSSED HERE
liquids		Slavic (Tables 2–3), Bagnères-de-Luchon French (26–27)
laterals	laterality	Latin (12)
rhotics	rhoticity	Le Havre French (13–14)
laryngeals		Cayuga (1), Nłeʔkepmxcín (5–6)
h	aspiration	Cherokee (18)
ʔ	glottalization	Zoque (16–17), Mohawk (21)
pharyngeals	pharyngealization	Proto-Indo-European (n. 6); cf. Nxa'amxcin (§2.2), Arabic dialects (20, Tables 4–5)
glides/vowels		Koshin (9), Birom (10–11), Leti (§4)
j/i	palatalization	Greek (15)
w/u	labialization	Aghem (7), Noni (8)

TABLE 1. Consonant types attested in perceptual CV metathesis.

. . . their involvement in dissimilation is not puzzling'. For the same reason, we believe, their involvement in perceptual metathesis is predicted. A well-known example involving laterals and rhotics is the Slavic liquid metathesis, shown in Table 2 with initial-position data from representative Slavic languages (not in IPA. The first three reconstructed forms have word-initial rising-pitch VL diphthongs, and the last two have falling-pitch diphthongs, *intonation rude* and *douce*, respectively; for discussion see e.g. Jakobson 1962, Arumaa 1964, Shevelov 1964, and Schenker 1993).

PROTO-SLAVIC		BULGARIAN	POLISH	UKRAINIAN
*olkŭtĭ	'elbow'	lákot	łokieć	lókit' (dialectal)
*orbota	'work'	rábota	robota	robóta
*orkyta	'willow'	rakíta	rokita	rokýta
*ordlo	'plough'	rálo	radło	rálo
*ortajĭ	'farmer'	rátaj	rataj	ratáj

TABLE 2. Slavic liquid metathesis: initial-position data (Torbiörnsson 1901–1903).

An apparent example of laryngeal metathesis from Cayuga was given in 1 above. Another is found in the Interior Salish language Nłeʔkepmxcín (Thompson River Salish). In immediately pretonic Nłeʔkepmxcín syllables, surface context determines whether the laryngeals /h ʔ/ are interpreted in prevocalic or postvocalic position. Thompson et al. (1996:615) describe the precise conditioning as follows:

> If there is a single consonant or a cluster beginning in an obstruent intervening between the stressed vowel and the laryngeal, then the laryngeal precedes that consonant or cluster directly. In other words, the laryngeal ends the preceding syllable, and the single consonant or cluster begins the stressed syllable . . . If there is no intervening consonant before the stressed vowel, or if there intervenes a cluster beginning in a resonant [i.e. any of /m n l z j ɣ w ʕ ʕʷ/ or their glottalized counterparts], then the laryngeal precedes the vowel of the first pretonic syllable. In other words, the laryngeal follows directly after the consonant (or cluster) that begins the syllable preceding the stressed one.

Some examples are given in 5–6.

(5) Postvocalic laryngeal: . . .CVH.CÝ . . . or . . .CVH.TC(CC)Ý . . .

a. /məkʷʔu-t-éʃ/ → mkʷuʔtéʃ 'she wraps it'
b. /ʃ-naʔz-ítʃ̓eʔ/ → ʃnaʔzítʃ̓eʔ 'mountain-goat-hair blanket'
c. /tʃeh-t-éʃ/ → tʃetéʃ 'he fixes it'
d. /mʔaʕ-újəmʔxʷ/ → maʔʕújmʔxʷ 'it grows light'
e. /tʃ̓ʔo-tʃ̓ʔóz/ → tʃ̓oʔtʃ̓ʔóz 'it is rather dark'

(6) Prevocalic laryngeal: . . .CHV.Ý . . . or . . . CHVR.C(CC)Ý . . .

a. /məkʷʔu-énʔih-n-t-éʃ/ → məkʷʔénʔinʃ 'she wraps, covers it up'
b. /tʃ̓eʔ-ə́me/ → tʃ̓ʔém 'she lays out (s.t. to sit on)'
c. /tʃeh-ə́me/ → tʃhém 'she puts (things) away'
d. /mʔaʕ-mín-t-ʃej-me/ → mʔaʕmíntʃime 'it grows light on me'

The deleted /h/ in 5c must be postvocalic because /h/ 'is retained before a vowel', as in 6c; and, as seen in 6a–c, '[a]ny pretonic vowel ... is dropped directly before the main-stressed vowel when no consonant intervenes' (Thompson & Thompson 1992:31, 39). On the vowel changes and other details of the derivations in 5–6, see Thompson & Thompson 1992 and Thompson et al. 1996.

As suggested by Thompson et al. (quoted above), the syllable appears to be the relevant domain of laryngeal coarticulation and spread in Nłeʔkepmxcín. We propose that the following phonetic patterns are reflected in 5–6. Syllable-internally, a postvocalic laryngeal is coarticulated with the preceding vowel. For Vʔ sequences, this gives rise to surface laryngealized vowels. In tautosyllabic VR sequences, a single extended sonorant voicing gesture gives rise to vowels which are only partially laryngealized. As a result of these phonetic patterns, all and only fully laryngealized vowels are analyzed as deriving from tautosyllabic /Vʔ/ sequences, while partially laryngealized vowels with transitional voicing into voiced sonorant codas are analyzed as deriving from /ʔV/ sequences. The one exception to these generalizations occurs in heterosyllabic VV contexts: despite full-vowel laryngealization here, the source of laryngealization cannot be a postvocalic glottal stop, since this would not be tautosyllabic with the preceding vowel.[5]

We have yet to find a regular, unambiguous example of pharyngeal metathesis in a living or attested language.[6] However, as we will argue in §2.5, the diachronic phonetic basis for perceptual CV metathesis is closely related to that of certain copy-vowel epenthesis processes. Such epentheses are attested across pharyngeals, as in the history of Cypriot Arabic, where syllable-final $V_1\text{ʕ} > V_1\text{ʕ}V_1$ (Borg 1985:36–38). Moreover, the relevant general phonetic ambiguity has been noted by Bessell (1992:160 n. 12) with reference to Interior Salish languages: 'Low vowel-pharyngeal sequences are notoriously difficult to transcribe in proper order without the aid of phonological information. The Nxa'amxcin word for "crow" is transcribed χa¿χa¿, but one speaker (AB) wrote it variably as χa¿χa¿, χ¿aχ¿a'; cf. Flemming et al. (1994:19–25) on Montana Salish pharyngeals.

High-vowel metathesis with adjacent consonants can also be explained in perceptual terms. We view this as the resegmentation of elongated palatalization and labialization phases, an extreme version of the common type of change where high-vowel loss results in distinctive secondary articulations on adjacent consonants. Some examples brought to our attention by Larry Hyman are found in Birom, a Benue-Congo Plateau language of Nigeria, and in some Beboid and Grassfields Bantu languages of western Cameroon. In these languages, noun-class prefixes reconstructed as *i- and *u- are the historical source of palatalization and labialization respectively. Intermediate stages in the development of these processes are still attested in some of the Beboid and neighboring Grassfields Bantu languages. Compare the reflexes of the reconstructed class 3 noun

[5] A referee rightly notes that we do not give 'evidence ... to support the claim that the vowels in question are fully or partially laryngealized'. Our hypothesis is justified by its general plausibility and by the sense it makes of laryngeal patterning, since published data are limited: the Nłeʔkepmxcín spectrograms given by Bessell (1992:411–13) show /ʔ/ only in stressed and posttonic syllables (and not in the vicinity of resonants).

[6] A synchronic pharyngeal metathesis process can be identified in a reconstructed language if the so-called Proto-Indo-European laryngeals were pharyngeals, as is likely (Beekes 1989). Proto-Indo-European sequences of laryngeal plus high vowel metathesized between consonants: /ph_3i-tó-s/ 'drunk' surfaced as [pih_3tós] (> Sanskrit *pi:tás* with loss of *h_3 and compensatory lengthening), for instance, though the root 'drink' unquestionably had the form **peh*$_3$-*i*-. (For data and further references see Mayrhofer 1986:174–75). The 'laryngeal' *h_3 was probably [ʕʷ].

prefix **ú-* in Aghem, Noni, and Koshin. In Aghem, as shown in 7, class 3 nouns are marked with a prefix *ó-* as well as an infixed glide *w*.

(7) Aghem class 3 (singular) nouns (Hyman 1979:21)

SINGULAR (cl. 3)	PLURAL	
ó-kwɨ́ŋ	é-kíŋ (cl. 4)	'mortar'
ó-kwâʔ	é-káʔà (cl. 4)	'hill, mountain'
ó-twíi	ń-tíi (cl. 12)	'medicine'

The same noun class is marked by an infixed glide in Noni, as shown in 8.

(8) Noni class 3/4 nouns (Hyman 1981)

	SINGULAR (cl. 3)	PLURAL (cl. 4)	
a.	kwen	ken	'firewood'
b.	gwéŋ	géŋ	'root, vein'
c.	mbwesɛm	mbesɛm	'green grasshopper'
d.	twéŋ	téŋ	'vine branch'
e.	fwɛ́w	fɛ́w	'thorn'

In Koshin, as shown in 9, the class 3 **w* infix has merged with a preceding velar to produce labiovelar stops. (We do not know the reflexes of other **Cw* sequences.) In the class 4 plurals of these class 3 nouns, the original prefix **í-* evidently passed through a comparable glide-infix stage and has now merged with a preceding velar, resulting in coronal affricates.

(9) Koshin class 3/4 nouns (Hombert 1980:89)

	SINGULAR (cl. 3)	PLURAL (cl. 4)	
a.	k͡pən	t͡sən	'firewood'
b.	g͡bɨ́ŋ	d͡zíŋ	'root'
c.	g͡bēà	d͡zāà	'house'
d.	wí	jí	'eye'

Compare the cognates in 8a–b and 9a–b: Noni *kw* and *gw* correspond to Koshin *k͡p* and *g͡b* (and are in fact optionally also pronounced [k͡p] and [g͡b]). The initial high vowels in the noun-class prefixes **ú-* and **í-* have undergone spreading over a following consonant. Palatalization and labialization were subsequently reanalyzed as originating postconsonantally.

Comparable historical processes occur in Birom as described by Bouquiaux (1970, analyzed by him synchronically as glide infixation). Labialization, illustrated in 10, occurs in noun classes 1, 3, and 7. (Mid tone is unmarked.)

(10) Birom class 3/4 nouns (Bouquiaux 1970)

SINGULAR (cl. 3)	PLURAL (cl. 4)	
pwɛl	pɛ̀l	'moon'
rwí	rìí	'door'
gwat	gàt	'bed'
fwom (< **twom*)	tòm	'work'

Palatalization occurs in noun classes 9 and 10 and is quite regular, occurring before all vowels and affecting all consonants except the palatals /t͡ʃ d͡ʒ j/ and the labiovelar stops /k͡p g͡b/. Examples appear in 11.

(11) Birom class 9/10 nouns

SINGULAR (cl. 9)	PLURAL (cl. 10)	
a. njàma	njama	'animal'
b. sjòk	sjok	'bee'
c. vjɔ̀l	vjɔl	'goat'
d. tʃòj	tʃoj	'leopard'
e. jùmúŋ	júmúŋ	'cobra'
f. sjìlà		'chickpea'
g. sjùú		'mushroom'
h. wjɔ̀m		'habit (clothing)'

Our coarticulatory account explains the absence of palatalization after palatals: in this context palatalization was interpreted as originating from the palatal consonant. For the labiovelar stops, an articulatory account based on the complexity of a palatalized labiovelar seems appropriate. The vocalic origin of these noun-class markers is reflected in the fact that they still contribute a tone to the phonological representation. The class 9 /j/ has a low tone and the class 10 /j/ has a mid tone; compare *njàma* 'animal' and *njama* 'animals' in 11a.

2.2. SYMMETRY AND UNIVERSAL MARKEDNESS ACCOUNTS. As noted in §1, most accounts of metathesis take the view that the output of metathesis is somehow less 'marked' phonotactically than the input. Here we argue for three basic reasons that universal markedness constraints alone cannot easily account for crosslinguistic patterns of perceptual CV metathesis.

First, perceptual CV metathesis processes appear to be symmetrical: for any natural class of consonants where CV > VC metathesis is attested, there is also a case of VC > CV metathesis. The Slavic liquid metathesis shown in Table 2 involves a VL > LV change, for instance, but LV > VL metatheses also occur, as in the reconstructed Latin lateral metathesis in 12.

(12) Latin: *lu > ul / C____ [-cor]
  a. *dlukis > dulkis 'sweet'
    *plumo: > pulmo: 'lung'
  b. No change
    pluteus 'shed'

The Latin change is debated (cf. Juret 1938 and Leumann 1977:101), but liquid metatheses are also well documented in Romance dialects. An example from the French dialect of Le Havre (Grammont 1909) affects rhotics in unstressed syllables. Rhotics remain intact in stressed syllables, but other preconsonantal *rə* sequences have metathesized except when immediately followed by labial fricatives *(f, v)* or the labial nasal *m*.[7] This is shown in 13, where the original syllable position of the *r* is seen from the standard French forms in the glosses.

(13) Le Havre French: in unstressed syllables, *rə > ər / ____ consonants other than {f, v, m}

[7] The attested data point to the narrower natural class consisting of *m* and *v*, but 'it would certainly be necessary to add *f* here if there were examples of *ər, rə* before this phoneme' (Grammont 1909:181). The forms in 13b actually include no example before *m*, but we assume, based on the word *frɔmāʒi* 'sort of cheese which is only eaten in soup' (Maze 1903:160), that the cognate of standard French *fromage* 'cheese' would be of the type in 13b were it attested in Maze's glossary. Grammont's original analysis states explicitly that metathesis is restricted to unstressed syllables, but we take this to be redundant if (as we assume) *ə* is found only in unstressed syllables.

a. bərdɛl 'suspenders, bretelle'
bərbi 'ewe, brebis'
fərʃɔ̃ne 'to shiver, frissonner'
fərlyk 'tuft, freluche'
fərtije 'to wag (a tail), to wriggle, frétiller'
gərzi 'sleet, grésil'
gərnje 'granary, grenier'
b. No change
ekrəviʃ 'crayfish, écrevisse'
krəvaʃ 'crack, crevasse'

As shown in 14, the mirror-image metathesis has occurred before labial fricatives and nasals.

(14) Le Havre French: in unstressed syllables, *ər > rə / ____ {f, v, m}
a. eprəvie 'sparrow-hawk, épervier'
frəme 'closed, fermé'
frəmi 'ant, fourmi'
b. No change
gərduje 'gurgle, gargouiller'

In short, for unstressed syllables in Le Havre French (and ignoring standard-language interference effects), the metatheses in 13–14 have had the effect that only *rə* (not *ər*) occurs before labial fricatives and nasals, while only *ər* (not *rə*) occurs before other consonants.

A phonotactic markedness account of LV > VL metathesis might appeal to the crosslinguistic preference for liquids (as opposed to other sonorant and obstruent consonants) in coda position. But such an analysis cannot be extended to the Slavic liquid metathesis, which has in fact been interpreted phonotactically as one of several strategies to eliminate closed syllables. Yet on this account it is hard to explain why only liquids underwent metathesis in Slavic, with other strategies resulting in the elimination of other coda consonant types. The Le Havre French data pose an even more serious problem for phonotactic accounts: there is no absolute sense in which *r* is preferred as a coda in pretonic syllables. Rather, its well-formedness as a coda is dependent on the following consonant. But it is not enough to posit a general constraint *r{f,v,m}, since such clusters do occur after stressed vowels. In short, no unified account of liquid metathesis seems possible.

The directional symmetry seen with liquids is also found with other 'stretched out' segment types. For instance, **iC* > *Cj* and **uC* > *Cw* metatheses appear in 7–11 above. A reverse example has been proposed for the prehistory of Greek by Kiparsky (1967; cf. Rix 1992:251): word-final **VCi* > *VjC* just in case the consonant was coronal. Two examples are shown in 15.

(15) Greek *i*-metathesis
*pʰéresi > pʰérejs 'you (sg.) carry'
*pʰéreti > *pʰérejt > pʰérej 's/he carries'

This is a natural sound change: apocope befell word-final **i* where its acoustic signal was most masked—after coronals—and the palatalization gesture was reinterpreted as a precoronal off-glide. (Word-final stops were lost via a subsequent regular change.)

In the incipient laryngeal metathesis shown in 1 above, Cayuga /Vʔ/ → [ʔV] in certain weak syllables. But as shown in 16, a /ʔV/ → [Vʔ] shift is found in Zoque (Wonderly 1951).

(16) Zoque: $V_1 + {}^{?}V_2 \rightarrow V_1V_2{}^{?}$

/ʔʌʔwʌ-ʔaŋi/		→ ʔʌʔwaʔŋi	'to that one'
/minʌ-ʔaʔ/	→ minaʔʔ	→ minaʔ	'come now'
/kenu-ʔaʔa/	→ kenwaʔʔa	→ kenwaʔa	'he already looked'
/homi-ʔaŋge/		→ homjaʔŋge	'until tomorrow'

Here V_1 surfaces as a glide if high and is deleted if nonhigh. A possible phonotactic account of the Cayuga shift is that laryngeals are preferred in onset (as opposed to postvocalic coda/rime) position. But this account cannot be extended to Zoque, where glottal stop surfaces in both rime and onset position, as shown in 17, yet (in 16) shifts via metathesis to postvocalic position within the syllable rime.

(17) nʌʔ 'water' ʔoma 'taste' (cf. ʔjoma 'its taste', jomo 'woman')
waʔna 'sand' kuʔis 'of a tree' (← /kuj-ʔis/)
kuʔtpa 'he eats' ʔʌʔaŋi 'near me' (← /ʔʌh/ 'me' + /ʔaŋi/ 'near')

Even more strikingly, in contrast to the incipient VH > HV metathesis seen in Cayuga, a mirror-image change occurs in two closely related Northern Iroquoian languages, Mohawk and Oneida; we discuss these cases in §2.5.

A second basic problem is that sound changes like those in 12–14 have phonetic conditioning factors which are expected on the perceptual account but unexpected on any purely phonotactic approach. For the Latin change in 12, assuming velarization of postconsonantal /l/ before /u/, the phonetic string being reinterpreted is /lu/ = [lʷu]. As pointed out by von Essen (1964), Jonasson (1971), and Ohala (1974), the formant structure of a velarized lateral is quite similar to that of [w]. This explains the common sound change /lʷ/ > /w/ as the result of a perceptual reinterpretation on the part of the listener. For the Latin case, we propose that the time window involved in the perception of laterality combined with the similar formant structure of [lʷ] and [u] allowed the listener to reinterpret laterality as originating postvocalically, with the velarization component of the lateral associated with [u]. The absence of metathesis preceding coronals is probably due to the phonetic fronting effect of coronals on adjacent back rounded vowels (Lindblom 1963; Ohala 1981, 1992). This in turn would block perceptual metathesis, since the fronted /u/ would not have a formant structure similar to that of the velarized lateral. For this case the phonotactic approach cannot account for vocalic and consonantal conditioning factors: there is no sense in which /ul/ is better formed than other /Vl/ sequences in Latin, nor are lateral-peripheral clusters better formed than lateral-coronal clusters.

For the changes in Le Havre French we propose a similar phonetic explanation. The restriction to unstressed syllables is a result of these syllables' short duration. In short syllables, long phonetic cues such as lowered F3 for rhotics are more likely to spread into a preceding or following vowel. The general pattern seen in 13–14 is that rhoticity of a syllable is associated with prevocalic position before labial fricatives and nasals and with postvocalic position elsewhere. The critical observation here is that F3 is lowered in the environment of labial consonants—an especially salient effect for fricatives, with their relatively long VC transitions. The general perceptual pattern is for listeners to attribute lowered F3 to a postvocalic segment. Therefore, where there is a rhotic adjacent to the vowel historically, it will be analyzed as postvocalic. The one exception is when a labial fricative or nasal occupies postvocalic position historically: in just this case, there is an alternative potential source for lowered F3 in the vowel offset, and any additional F3 lowering in the vowel onset can be attributed to a prevocalic rhotic. In stressed positions, where vowel durations are longer, the acoustic cues

for rhotics do not overlap with the entire vowel duration, and the historical position of the rhotic is straightforwardly recovered.

A third and final problem is that purely phonotactic accounts do not properly limit the sets of segments or features involved in perceptual CV metathesis. There are many languages (e.g. many of the Pama-Nyungan languages of Australia) in which the set of coda consonants is limited to sonorants. If metathesis were a purely phonotactically driven process, then we might expect languages in which tautosyllabic VC > CV just in case C is an obstruent. Since features like obstruent do not stretch over long temporal intervals, the model of perceptual metathesis we propose correctly predicts that such metatheses are unattested. A more complex case is that of languages (like Japanese) where intervocalic CC clusters are geminates or homorganic nasal-stop sequences. For such languages, the phonotactic account of metathesis predicts the possibility of a change whereby $C_1VC_2 > VC_1C_2$ provided that C_1 is homorganic with C_2. Again, as far as we know, such metatheses are unattested. For cases like Latin, note also that phonotactic constraints like the obligatory contour principle (barring adjacent identical segments or features) cannot be invoked, since metathesis does not eliminate the adjacency of the two segments in question.

In sum, contrary to the apparent prediction of phonotactic markedness approaches, perceptual CV metatheses are symmetrical and can involve fine phonetic features (e.g., lowered F3 or precoronal fronting of [u]) which are not normally represented phonologically. The phonotactic account also predicts common metathesis types which in fact are unattested, and is unable to properly limit CV metathesis to the consonant types in Table 1.

2.3. STRUCTURE PRESERVATION. An interesting question raised by the analysis of perceptual metathesis is whether a language's preexisting sound patterns play a role in guiding the listener's (mis)perception or (re)interpretation of CV or VC sequences. The question is of interest because several authors have proposed, for empirical and theoretical reasons, that structure preservation is a universal property of certain types of sound change. Proposed examples include compensatory lengthening (de Chene & Anderson 1979, de Chene 1985), dissimilation (Ohala 1993, Kiparsky 1995), and metathesis (Kiparsky 1995).

One theoretical explanation for structure preservation in sound change (if it exists) has been offered by John Ohala and Paul Kiparsky. According to Kiparsky (1995:658), for example, sound changes 'driven by the possibility of alternative parsing of the speech output . . . like all reinterpretation processes . . . should be subject to inherent top-down constraints defined by the linguistic system. The wrong parses that generate them should spring from a plausible phonological analysis'. This view has its basis in language acquisition: 'the learner . . . selectively intervenes in the data, favoring those variants which best conform to the language's system. Variants which contravene language-specific structural principles will be hard to learn, and so will have less of a chance of being incorporated into the system' (Kiparsky 1995:655). Since Kiparsky treats metathesis as one of the relevant perceptually motivated types of sound change, his analysis predicts that all metathesis is structure-preserving.

This view of metathesis has two problems. The first is a general problem relevant also for Ohala's view of dissimilation. If linguistic change arises in first language acquisition, as Kiparsky suggests, then it is hard to see why structure preservation should have any effect. The sound patterns of a target language are not known in advance to learners, and the same is true of any 'inherent top-down constraints defined

by the linguistic system'. For a hypothetical /CVfiC/ > /CfiVC/ metathesis, language learners cannot know in advance whether other /Cfi/ sequences exist. It is therefore not clear why the preexistence of such sequences should constrain the language learner's interpretation of phonetically ambiguous [CV̤C] sequences. In short, without a more detailed model of phonological acquisition, it seems circular to insist that any class of sound changes—whether grounded in articulation or perception—is expected to be structure-preserving.[8]

A second problem is empirical: Cayuga laryngeal 'metathesis' provides clear evidence against the view that perceptual CV metathesis is always structure preserving. The only surface stop + ʔ clusters in Cayuga are those derived through laryngeal metathesis (Michelson 1988:21). Indeed, there are no surface stop + ʔ clusters at all in three of the four other living Lake Iroquoian languages—Mohawk, Oneida, and Onondaga—and /tʔ/ is the only such cluster in Seneca, the fourth Lake Iroquoian language (Michelson 1988:chap. 2). Moreover, a constraint against stop + ʔ clusters is phonologically active in Mohawk and Oneida, where vowel epenthesis serves to break up some such clusters (Michelson 1988:136, 145–46; cf. also §2.5 below). For this reason too, therefore, we are not persuaded that perceptual CV metatheses as a class are likely to be structure-preserving.

2.4. PHONETIC OPTIMALITY. As described by Feeling (1975), Cook (1979), Scancarelli (1987), and Flemming (1996), Cherokee has the synchronic metatheses shown in 18a–b.[9]

(18) Cherokee (Flemming 1996:30, 40)

a. TVhR → T^hVR
/aaki-hwaska/ → [àak^{h}ìwàska] 'I'm buying it'

b. TV_1hV_2 → ($T^hV_1V_2$ →) T^hV_2:
/aaki-hawoostiiʔa/ → [àak^{h}àwóóstììʔa] 'I'm choking'

c. No metathesis
RVhV: nìhi 'you'
RVhR: wàhya 'wolf'
T^hVhR: àat^{h}ìhni 'he's taking him somewhere'
TVVhR: ààkòòhwàhtiiʔa 'he sees him'

[8] A referee wonders whether it is 'necessary to assume that the language learner has not acquired ANY aspects of the language system', but the question is whether it is necessary to assume that learners ALWAYS acquire certain relevant aspects of the language after certain others. No evidence or explicit model of acquisition has been adduced in favor of this assumption.

In connection with dissimilation, Ohala (1993) states that sound change caused by 'hypercorrection' does not create new segments. He attributes this to 'dissimilation being the result of the listener applying normalization processes to the speech signal: normalization requires recovering a (presumed) standard sound from a signal that differs in some way from the standard'. Again, it is unclear to us how language learners know which sounds are standard, or what model of change restricts innovations to those who already have a standard. An alternative explanation for the fact that most dissimilation is structure-preserving may be that dissimilating consonant features are typically laryngeal features or secondary features such as palatalization, labialization, and pharyngealization. Segment inventories with such consonant types generally also include their plain (e.g., unaspirated or nonpalatalized) counterparts.

[9] Cherokee /hR/ is usually analyzed as a sequence. Flemming analyzes it as a single [+sonorant, spread glottis] segment, in which case Cherokee would fall outside the limits of our study of segmental CV metathesis. We accept the cluster analysis because /h/ occurs independently in Cherokee and /h/ + obstruent clusters do exist; the absence of underlying /hR/ clusters must be stipulated on the single-segment analysis. But because we argue here against the motivation of Flemming's analysis, not its specific implementation for Cherokee, the proper analysis of /hR/ is somewhat orthogonal to our discussion.

Flemming (1996) presents an optimality theory analysis of Cherokee metathesis based on the idea that phonological alternations can directly instantiate phonetic markedness constraints independent of perceptual ambiguity or articulatory overlap:

> Metathesis . . . can be understood as resulting from the attempt to associate [s.g.] to the optimal position. The best docking site for [s.g.] is on the release of a stop, where the high rate of air-flow allows the realization of salient cues to the state of the glottis . . . The alternative positions in which [s.g.] can appear are in isolation as [h], or associated to a sonorant. The feature [s.g.] is undesirable on a sonorant because it conflicts with the realization of sonorancy and voicing . . . The segment [h] is also problematic . . . Intervocalic [h] also does not produce any major transitions in spectral shape or amplitude, especially if voiced (as in Cherokee) (1996:31).

The essential constraint giving rise to metathesis in Flemming's account is *[sonorant, spread glottis], which prohibits the realization of /h/ (the feature [spread glottis]) from appearing on a sonorant if there is a better docking site in the vicinity. In particular, /h/ is realized on the preceding unaspirated obstruent since its occurrence there will be more perceptually salient and will give rise to a less marked segment type.

This analysis is essentially a phonetic version of the phonotactic accounts discussed above: Cherokee metathesis occurs because there is a phonetic output for /TVhR/ strings which is better than the input. However, as argued above, metathesis can hardly originate via global constraints of this sort: language learners hearing [TVhR] must have some reason for reinterpreting this as [T^hVR]—some reason which is not a consequence of the phonological constraint system itself, since this is precisely what learners are aiming to acquire. Even if we attribute the constraints and constraint-ranking of Cherokee to Universal Grammar, attempting to account for the origins of metathesis through phonetic functionalism of the sort suggested by Flemming commits one to the view that speakers have knowledge of universal phonetics which allows them to manipulate articulations in order to give rise to utterances that optimize feature realization. This view is undermined by the fact that some languages do have breathy-voiced or voiceless sonorants in the context /TV_/. Examples from Klamath include *paḷpaḷw̥ʔam* 'wokas leaf', *ska:w̥a* is cold', and *kuw̥jʔasqs* 'venereal disease' (Blevins 1993). Optimality theory analyses can describe the distinct patterns in Cherokee and Klamath by ranking input-output faithfulness constraints in Klamath above the relevant universal phonetic constraint(s)—in this case *[son, spread glottis]—but these language-specific constraint rankings are not claimed to correspond to any particular phonetic properties of the features or segments in question. By contrast, our general account of metathesis suggests distinct phonetic realizations of aspiration in Cherokee and Klamath: it is likely that Cherokee aspiration is of longer duration, covering entire CV or VC domains, and is partially inhibited by sonorant voicing, whereas Klamath aspiration is of shorter duration, and voiceless (or breathy-voiced) sonorants occur.

Moreover, phonetic optimality accounts cannot be easily extended to other cases of CV laryngeal metathesis. Consider the Zoque glottal stop metathesis in 16 above. An intervocalic glottal stop is metathesized, often resulting in a surface word-final or preconsonantal glottal stop. Intervocalic position is arguably the most perceptually salient position for any non-syllabic segment, including glottal stop. It is therefore hard to understand the Zoque metathesis as giving rise to strings where the phonetics of glottal stop are improved upon in any way.

On our account, Cherokee exhibits a simple case of perceptual metathesis. A /Vh/ sequence was realized as a voiceless (or breathy) vowel, and following a voiceless unaspirated stop this was reinterpreted as the aspirated release of the stop. After aspirated stops, there is no metathesis because the duration of aspiration in /T^hVhR/ strings

was too great to be attributed (by listeners) solely to the stop, not because of an ''"OCP"-type constraint'(Flemming 1996:41). After long vowels, metathesis is absent because voicelessness did not spread over an entire /VVh/ sequence.[10]

2.5. METATHESIS VS. VOWEL EPENTHESIS. For many cases of CV perceptual metathesis, there is an alternative analysis according to which the effect of metathesis is due to two successive changes: vowel epenthesis (or, perhaps more properly, consonant interpolation within a vowel) followed by deletion. This is shown schematically in 19a, with a schematic metathesis in 19b.

(19) a. Step I Epenthesis/C-Interpolation: $C_1C_2V_1C_3 \rightarrow C_1V_1C_2V_1C_3$
Step II Vowel Deletion: $C_1V_1C_2V_1C_3 \rightarrow C_1V_1C_2C_3$
b. Metathesis: $C_1C_2V_1C_3 \rightarrow C_1V_1C_2C_3$

One reason why such epenthesis-and-deletion accounts have sometimes seemed preferable to metathesis accounts is that vowel epenthesis and deletion are types of change that can be shown to exist independently and which seem likely to be phonetically natural. Yet as we have shown, perceptual metathesis is also phonetically natural.

A second reason why some scholars have preferred epenthesis-and-deletion accounts of apparent cases of metathesis is that many such cases are (as it were) dialectally related to cases of vowel-copying epenthesis WITHOUT deletion. The Slavic liquid metathesis in Table 2 provides a good example. Word initially, as in Table 2, this metathesis is found throughout the Slavic family. In medial position, however, metathesis occurs in only two of the three branches of Slavic. Medial tautosyllabic VL → LV in South and West Slavic (e.g., Bulgarian and Polish respectively), as seen in Table 3, but East Slavic (e.g. Ukrainian) instead shows the effects of VL → VLV vowel copying. This epenthesis (*POLNOGLASIE*) is restricted to VL sequences with nonhigh vowels. It has been proposed that *polnoglasie* was in fact the first step in liquid metathesis (or vice versa), but we accept the arguments of Jakobson (1962), Shevelov (1964), and others that the two types of change were independent. At the same time, we suggest below that liquid metathesis and *polnoglasie* are two logical interpretations of the same phonetically ambiguous substring.

PROTO-SLAVIC		BULGARIAN	POLISH	UKRAINIAN
*dervo	'tree'	—	drzewo	dérevo
*soldŭ	'malt'	—	słód	sólod
*gordŭ	'city'	grad	gród	hórod
*melko	'milk'	mléko	mleko	molokó

TABLE 3. Slavic liquid metathesis: medial-position data.

Still, some apparent synchronic metathesis processes can be shown to have originated with epenthesis and deletion. One such case involves the set of guttural continuents—uvular /χ ʁ/, pharyngeal /ħ ʕ/, and laryngeal /h/—in some Arabic dialects. For

[10] Flemming also analyzes vowel deletion adjacent to /h/ in Cherokee. The basic analysis of deletion parallels that of metathesis: voiceless (or breathy) vowels violate the constraint *[+sonorant, spread glottis]. We believe that deletion in this context also has a perceptual basis. In sequences with adjacent voiceless or breathy-voiced V and /h/, there is, as Flemming (1996:31) notes, ambiguity as to whether one is simply hearing /h/ or /Vh/. (Deletion does not occur before sonorant consonants because their specified voicing gesture blocks the spread of voicelessness.) Note that the proposed behavior of /Vh/ sequences is partly parallelled by that of coda glottal stops, which are lost with 'lengthening of preceding short vowels' and 'laryngealization of the second half of the preceding long vowel' (Wright 1996:15).

TEMPLATE	NO METATHESIS		METATHESIS	
CaCCat	tsabdat	'liver'	nʕaɻat	'ewe'
CaCCa	ħamra	'red'	dhama	'brown'
ma + CCuuC	maftuuħ	'open'	mħabuus	'imprisoned'
ja + CCVC	janhab	'he pillages'	jχadim	'he serves'
	jakrah	'he hates'	jʁarag	'he drowns'
	jalʕan	'he curses'	jhaɻm	'he attacks'

TABLE 4. Najdi Arabic aGC/GaC alternations (Abboud 1979:470–71).

instance, Najdi Arabic has alternations like those in Table 4. These are analyzed as synchronic metathesis by al-Mozainy (1981) and al-Mozainy et al. (1985), but they originated via processes of vowel epenthesis and deletion whose dialectal distributions are quite distinct. As shown by the partial Perfective paradigms in 20, the deletion process (CaCaC → CCaC) is still productive in dialects like Najdi Arabic (Abboud 1979:468).

(20)

NO DELETION		DELETION	
ʃirib	'he drank'	sikan	'he dwelled'
ʃarbat	'she drank'	skanat	'she dwelled'
ʃarbaw	'they drank' (masc.)	skanaw	'they dwelled' (masc.)
ʃarban	'they drank' (fem.)	skanan	'they dwelled' (fem.)

In 20, the process called 'Low Vowel Deletion' by Abboud (and al-Mozainy 1981 and al-Mozainy et al. 1985) affects the last three forms of /sakan-/ 'dwell', but /ʃarib-/ 'drink' is unaffected. (An *i*-deletion process is seen in 'drink', and an open-syllable *a*-to-*i* change is also seen in the data.)

Some other dialects without low vowel deletion nonetheless do have aGC > aGaC epenthesis. This is shown in Table 5 for the Negev Bedouin dialect described by Blanc (1970). In Tables 4-5, note the distinct treatments of historical *aC_1C_2 sequences where C_1 is a guttural continuant. The Najdi dialect shows apparent CV metathesis, whereas the Negev Bedouin dialect preserves a hypothetical earlier stage of vowel epenthesis without deletion.[11]

TEMPLATE	NO EPENTHESIS		EPENTHESIS	
ma + CCuuC	maktuub	'written'	maħaʤuub	'veiled'
			maʕaguuɻ	'reasonable'
ja + CCVC	jaʃraḅ	'he drinks'	jaħalam	'he dreams'
			jaħáfir	'he digs'
			jaʕagil	'he tethers'

TABLE 5. Negev Bedouin Arabic aGC > aGaC epenthesis (Blanc 1970).

A significant difference between the Arabic and Slavic situations is that there is independent evidence for vowel deletion in Arabic; the same kind of evidence does not exist in Slavic. We therefore maintain that the apparent metatheses have different histories in Arabic and Slavic: the Slavic liquid metatheses were independent of *polnoglasie,* but the Arabic metathesis did indeed arise from epenthesis followed by deletion.

But what are important here are points of contact between perceptual CV metathesis and the kinds of epenthesis seen in Slavic and Arabic. These epentheses, we propose, have the same sort of diachronic phonetic explanation as perceptual CV metathesis:

[11] The finite verbs in Tables 4-5 are Imperfective; underdots in Table 5 mark the phonological feature of emphasis. On the Arabic dialectal distribution of the epenthesis process see Blanc 1970:127 n. 29 and Jastrow 1980a:109, 1980b:145, and for additional examples like those in Table 4 see Ingham 1994:24.

they arise because the precise linear or segmental origin of certain 'stretched out' features can be ambiguous. They differ only in the nature of the resulting reinterpretation. In perceptual CV metathesis, a segment is perceived (and reinterpreted) as having its origin ON THE OTHER SIDE of an adjacent segment. In Slavic *polnoglasie* and Arabic guttural epenthesis, a consonant was perceived (and reinterpreted) as having its origin IN THE MIDDLE of an adjacent vowel. The same kind of phonetic ambiguity gives rise to both kinds of change.[12] Support for this proposal is the fact that *polnoglasie*-like sound changes involve copy vowels rather than epenthetic vowels of a particular quality, and affect the set of segments and features of long duration in Table 1.

Given our proposal that perceptual CV metathesis reflects the same sort of phonetic ambiguity as vowel epenthesis or consonant interpolation, we would expect to find cases where some CV or VC sequence has undergone a conditioned split yielding vowel epenthesis in some contexts and metathesis (unmediated by vowel epenthesis) in other contexts. One such case may appear in the Northern Iroquoian languages Mohawk and Oneida. As Postal (1969) and Michelson (1988:56–58) show in detail for Mohawk, some [CVʔ] sequences are derived from underlying /CʔV/ via apparent metathesis. Examples appear in 21.

(21) Apparent ʔ metathesis in Mohawk (Michelson 1988:56)

a.	/k-ojʔak-s/	→ [kójaʔks]	'I throw'
b.	/ã-k-ojʔak-ʔ/	→ [ãkójaʔkeʔ]	'I'll throw'
c.	/hs-rihw-isʔa-s/	→ [serihwísaʔs]	'you always promise'
d.	/wak-rihw-isʔ(a)-u/	→ [wakerihwísuʔ]	'I already promised'

In each example an underlyingly prevocalic glottal stop surfaces in postvocalic position, but 'the correct derivation cannot involve metathesis because [e.g. in 21d] the underlying *C ʔu* sequence is represented on the surface by the sequence *Cu ʔu* when the sequence is not word-final' (Michelson 1988:57).[13] An example of the latter is /wak-nuhs-isʔ(a)-u-hatye-Ø/→ [wakenuhsisuʔuhátye] 'I finish the house a little bit at a time'. In such examples, as analyzed by Postal and Michelson, the output of consonant interpolation or vowel epenthesis ($CʔV_1 \rightarrow CV_1ʔV_1$) is affected by a deletion process whereby $CV_1ʔV_1 \rightarrow CV_1ʔ$ in nonfinal syllables.[14] But unlike Arabic, say, where dialectological arguments show that epenthesis and deletion originated separately, Mohawk and Oneida seem to offer no evidence that deletion was a later innovation than epenthesis. There is in fact no evidence for epenthesis apart from the surface [VʔV] sequences in question, so there is no unambiguous evidence for a diachronically intermediate stage with surface word-final [VʔV] sequences which have since been deleted. It is equally likely that the common ancestor of Mohawk and Oneida underwent a sound change whereby /$CʔV_1$/ sequences were more or less simultaneously reinterpreted—in final (i.e. posttonic) syllables as metathesized /$CV_1ʔ$/, and elsewhere as interpolated /$CV_1ʔV_1$/.

[12] The phonetic link between gutturals and low vowels is an obvious additional factor relevant in Arabic guttural epenthesis. Here the precise linear origin of the guttural was disguised not only by its stretched out acoustic signal but also by the similarity of the formant structure of the adjacent low vowel.

[13] Stress, vowel epenthesis, and comparative Iroquoian evidence provide the motivation for assuming that these glottal stops are underlyingly prevocalic rather than postvocalic. Note that epenthetic [e] appears in examples 21b–d, and that underlying /au/ is converted to /u/ in 21d by a regular rule deleting the first vowel in a sequence of two vowels.

[14] According to Michelson (1988:57) the deleted vowel must be word final, but Postal's formulation whereby it must be 'the last vowel in the word' (1969:295) seems better in light of data such as 21a–c. The *e* in 21b is epenthetic.

Either analysis is consistent with our view that perceptual CV metathesis has the same sort of diachronic phonetic basis as $CV_1 \rightarrow V_1CV_1$ vowel epenthesis.

2.6. LONG-DISTANCE MOVEMENT. Only relatively recently has it become standard to use the term METATHESIS for processes in which adjacent elements are transposed, such as CV perceptual metathesis. For adjacent-element transposition, Grammont (1950) and other earlier writers use the term INTERVERSION. The term METATHESIS itself was used for longer-distance changes, including those in which a segment moves from one syllable to a corresponding position in an adjacent syllable. In this section we review a few long-distance movement changes of this type and compare them with metatheses in the current sense.

A representative case of long-distance consonant movement is found in Colville, an Interior Salish language. As described by Mattina (1979:17), 'some words in Colville . . . appear to have shifted a pharyngeal resonant from the root to the stressed suffix'. Examples are given in 22.

(22)

	BASE		SUFFIXED FORM	
a.	c$^{\text{ʔ}}$ʕan	'tight'	c-ən-c$^{\text{ʔ}}$ən-c$^{\text{ʔ}}$ən-m-ʕás-əm	'he keeps his eyes tightly shut'
b.	pʕas	'scared'	c-ps-ʕáya$^{\text{ʔ}}$	'senseless'
c.	pʕat	'boil'	s-ən-pə-pt-ʕála$^{\text{ʔ}}$q$^{\text{w}}$	'dumplings'
d.	pʕáw	'he ran down'	pw-ən-cʕát-əlx	'they make noise running down'
e.	q$^{\text{ʔw}}$ʕáy	'black'	q$^{\text{ʔ}}$əy-lscʕát	'his clothes are dirty'

The two forms in 23, each based on the root /q$^{\text{ʔw}}$ʕáy/ 'black' in 22e and each with an unstressed suffix and root stress, show that Colville pharyngeal movement is sensitive to stress.

(23) s-t-q$^{\text{ʔw}}$ʕáy-xən-x 'Blackfeet'
q$^{\text{ʔw}}$ʕáy-ḷqs 'black robe, priest'

Pharyngeal movement is an old process whose synchronic reflex in many Interior Salish languages is vowel-retracting harmony rather than overt pharyngeal movement. For a survey of the cognate processes see Bessell (1992, 1998), who writes that Colville pharyngeal movement may have 'the foot [as] the relevant domain' (1992:254).

Comparable processes are attested in other languages for essentially the same range of features as those found in perceptual CV (contact) metathesis. Stress-triggered glottalization transfer, for instance, is said by Thompson (1979) to be a property of Shuswap, Twana, and other Salishan languages. But in still others, including Nłeʔkepmxcín and Squamish, 'certain roots have the property of glottalizing any sonorant in the immediately following suffix . . . The roots themselves often contain no synchronically recognizable glottalic element, while others actually containing glottalized sonorants fail to have this effect; some glottalizing element is indicated for the proto-language as part of those roots' (Thompson 1979:718–19).

Another laryngeal feature—aspiration—moves between adjacent syllables in Ancient Greek. In describing this process Lejeune (1972) and others cite diachronic examples such as those in 24.

(24) *orhmá: > *hormá: (>hormé:) 'impulse, onset'
*éherpon > he:rpon 'I moved'
*éuho: > heuo: 'I singe'

The aspirate /h/ surfaces as such only word initially. In forms where a morpheme-initial /h/ is not word-initial, the process shown in 25 operates. This process is productive only in compounds because Greek is mainly a suffixing language and no suffixes have initial /h/.

(25) a. /pro-hódos/ → [p^{h}roódos] 'gone'
b. /tétr-hippos/ → [tét^{h}rippos] 'with four horses'

In forms like 25a above, Steriade (1982:158) points out, '*h* has skipped over two skeleton positions before reaching the syllable initial *p*'.

Long-distance consonant movements involving liquids are found in a variety of Romance languages. One interesting example appears in the French dialect of Bagnères-de-Luchon as analyzed by Grammont (1905–06). Like the dialect of Le Havre illustrated in 13–14 above, Bagnères-de-Luchon French has local metathesis of liquids in historically pretonic syllables.[15] Noninitial syllables have been affected by a long-distance movement process, and stop-/r/ onset clusters do not remain intact. Posttonic *r* has moved one syllable to the left, as seen in 26, into the historically stressed syllable (which is often also the initial syllable).

(26)

Bagnères-de-Luchon		Latin
crambo	'room, chambre'	kámera > *kámbra
crabo	'goat, chèvre'	kápra
prawbe	'poor, pauvre'	páwperum > *páwpru
trende	'tender, tendre'	ténerum > *téndro
brespes	'vespers, vêpres'	wéspera:s > *wéspras

The cited Latin forms are the ancestors of the French forms to their left. As shown in 27, long-distance movement has also affected *r* in historically stressed syllables.

(27)

Bagnères-de-Luchon		Latin
crumpa	'to buy'	kompará:re > *kompráre
escrumba	'to sweep'	*ekskombrá:re
brespalh	'evening snack'	*wesperá:kulum > *wespráklu
trempa	'to mix, tremper'	temperá:re > *tempráre
brembas	'to remember'	memorá:re se: > *membrás

Here *r* has moved one syllable to the left, into the historically pretonic syllable.[16]

[15] Here we describe the behavior of *r* only, though *l* and *r* are said by Grammont to show the same metathesis and long-distance movement behavior in Bagnères-de-Luchon French, because there are few examples involving the lateral (which has in coda position become a glide *w*, as in other French dialects). To avoid misrepresentation and because vowel quality is largely irrelevant, Bagnères-de-Luchon forms are cited in Grammont's orthography, which is modelled on standard French orthography. (Neither Grammont nor his source shows the synchronic position of stress in the Bagnères-de-Luchon dialect, but stress position in Romance generally and French in particular is with well-defined exceptions notoriously faithful to Latin.)

One difference between the metathesis processes in Le Havre and Bagnères-de-Luchon French is that *s* behaves like the labials in the latter dialect. A possible explanation is that this *s* is (or was at the time of the relevant changes) somewhat retroflex, hence also producing a lowered third formant. A second difference is that there is no metathesis in the Bagnères-de-Luchon dialect if the metathesizing sequence is preceded by *h*, as in *hurmadže* 'cheese, fromage' and other examples. Grammont (1905–06:87) offers a phonotactic explanation: 'the group *hr* is impossible'. We suggest that the devoicing of the initial portion of the vowel after *h* prevented reinterpretation of VR as RV, since the vowel in RV should be fully voiced.

[16] The output of long-distance movement precedes and feeds the local liquid metathesis process already described; further restrictions are discussed by Grammont (1905–06). A partial alternative analysis suggested to us by Brian Joseph is that long-distance movement may evolve in two discrete stages: spreading followed by dissimilatory loss. This analysis may well be correct for some cases, but the crucial points of contact between long-distance movement and local metathesis remain.

Long-distance movement seems to involve the same set of segments and features as perceptual CV metathesis. Indeed, in some cases it cooccurs with a metathesis involving the same segment types: within a single language in the case of Bagnères-de-Luchon French, and in two related and typologically similar languages in the case of Colville and Nłeʔkepmxcín. In addition, long-distance movement processes evidently move segments or features into syllables which are in some sense more prominent: stressed syllables, as in Colville; or initial syllables, as with Bagnères-de-Luchon French *r* and Ancient Greek *h*. We cannot fully explain these patterns, but they are consistent with the view that the segments and features in Table 1 occupy long durational windows which allow for their reinterpretation in nonhistorical positions. This perceptual reinterpretation involves segments and features which are drawn to positions of prosodic prominence.

3. COMPENSATORY METATHESIS. Compensatory metathesis, as the name suggests, is prosodically conditioned. In this type of metathesis, a vowel at the edge of the phonological domain undergoes phonetic weakening in quality and duration, with compensation for this weakening by anticipatory or perseverative coarticulation of the original vowel quality in stressed position. In other words, the articulation of the original peripheral vowel is superimposed over an adjacent consonant, aligning itself more closely with the stressed syllable. Perhaps the simplest view of this sound change is as a gradual shift of the peripheral vowel articulation towards the tonic vowel.

Our diachronic analysis of compensatory metathesis has three essential phonetic ingredients: what we will refer to as EXTREME vowel-to-vowel coarticulation in VCV sequences, where one vowel perseveres or anticipates itself in full; unstressed vowel reduction and loss of the peripheral vowel; and the longer duration of tonic vowels which facilitates the perception of the resulting phonetic diphthong. The sequence of sound changes we propose occurring at each end of the relevant phonological domain is shown schematically in 28.

(28) a. RIGHT EDGE
$\cdots \acute{V}_1 C V_2] > \cdots \acute{V}_1 \check{V}_2 C \check{V}_2] > \cdots \acute{V}_1 \check{V}_2 C]$

b. LEFT EDGE
$[V_1 C \acute{V}_2 \cdots > [\check{V}_1 C \check{V}_1 \acute{V}_2 \cdots > [C \check{V}_1 \acute{V}_2 \cdots$

Rotuman instantiates the right edge sequence in 28a, which occurs within a final trochee. Ngkoṭ, a Northern Paman language of Australia, exemplifies the sound change in 28b, occurring within a word-initial iamb.

(29) Rotuman

fúti	→ fýt	'to pull'
móse	→ møs	'to sleep'
seséva	→ seséav	'erroneous'
tíko	→ tíok	'flesh'

(30) Ngkoṭ

*alí-	> láj-	'to go'
*amí-	> máj-	'up'
*iˈná-	> njá-	'to sit'
*ulán	> lwán	'possum'

In Rotuman, the original V-to-V coarticulation has been obscured by further changes whereby, for example, **ui* > *y* and **oe* > ∅.

The common independent existence of the relevant phonetic events and properties indirectly supports our view that metathesis like that in Rotuman and Ngkoṭ results

from compensation for weak peripheral vowel articulations. Consider first the longer duration of tonic vowels, which plays a role in facilitating the perception of the V_1V_2 sequence as a diphthong. Within Oceanic and Pama-Nyungan, stressed vowels are typically longer than unstressed vowels in languages with unreduced peripheral vowels. This has been phonologized in languages like Hixkaryana, where all stressed vowels in open syllables are long (Derbyshire 1985). Conversely, for instance within Oceanic, a number of Micronesian languages show final vowel reduction and loss without regular adjacent tonic lengthening. Partial vowel-to-vowel coarticulation with or without peripheral vowel reduction is commonly phonologized as umlaut. Examples of extreme coarticulation parallel to the cases we consider here were seen in Aghem (in 7 above); a similar phonetic effect is reported for Eggon, a language of Nigeria, where /egoN/ is phonetically [eogõ] (Ian Maddieson, p.c.). Tonic lengthening and vowel reduction together occur without documented coarticulatory effects in Middle English open syllable lengthening (Minkova 1991).

The apparent typological rarity of compensatory metathesis deserves comment if it is indeed caused by three fairly common phonetic events: coarticulation or gradual temporal realignment in VCV sequences; tonic length; and peripheral vowel reduction and loss. To be sure, at least diachronically, compensatory metathesis may not be as rare as it seems. In the Austronesian language family, the sound changes in 28a seem to have occurred independently in Rotuman, Kwara'ae, Meto, and elsewhere. In Pama-Nyungan, three independent subgroups show the sound changes in 28a–b: Northern Paman, Arandic, and Nganyaywana. In languages where peripheral vowel reduction results in neutralization to schwa or some other nondistinctive vowel quality, compensatory metathesis also evidently occurs, despite the fact that the full range of CV inversions is not found. Details of these cases are discussed further below.

Nonetheless, there are several factors that may interact to inhibit compensatory metathesis in some languages. In particular, the occurrence of perceptually salient phonetic copy vowels as a result of coarticulation is probably dependent on numerous interacting phonetic parameters. One is the size and distribution of the vowel inventory (Keating & Huffman 1984). If the vowel inventory is large and vowels are close together in acoustic or perceptual vowel space, extreme coarticulation is more likely to result in mergers with existing vowel categories. Compensatory metathesis is thus more probable in languages with small and widely spaced vowel inventories like the Oceanic (5-vowel) and Australian (3-vowel) languages mentioned above.

Another relevant phonetic parameter is the degree of vowel variation (Manuel & Krakow 1984, McAdams 1987). If a particular vowel phoneme varies greatly in its phonetic realization, then there is less likelihood that variation due to coarticulation will alter category membership. We therefore expect compensatory metathesis to be more common in languages where acoustic vowel targets occupy relatively small areas within the possible vowel space. Related to this effect is that of pure vs. diphthongal vowels: in languages where diphthongs exist, extreme coarticulation is more likely to yield merger with existing diphthong categories. Compensatory metathesis should thus be more common in languages with pure relatively steady-state vowels.

An additional relevant parameter is the presence of secondary consonant articulations, which have been shown to inhibit vowel-to-vowel coarticulation in VCV sequences (Keating 1985, 1988; Hussein 1987). Extreme coarticulation and compensatory metathesis are thus more likely in languages with no secondary consonant articulations.[17]

[17] Kwara'ae (discussed in §3.1 below) does have surface labiovelars, but we have seen no examples in posttonic positions where they could conceivably exhibit a blocking effect on coarticulation. This gap is systematic if, as per Sohn 1980, labiovelars are derived from sequences of velar plus prevocalic round vowel.

Consonant length has also been shown to inhibit or reduce V-to-V coarticulation (Smith 1987), so that compensatory metathesis is not expected in languages with long consonants or consonant clusters. Finally, an important role in coarticulation may be played by prosodic structure: foot and syllable structure, for instance, and timing relationships between them. Our findings suggest that the stress foot may in some cases be the locus of extreme coarticulation, with migration of vocalic articulation from the unstressed syllable into the stressed syllable.[18]

In short, while tonic length, peripheral vowel loss, and V-to-V coarticulation are crosslinguistically common, extreme coarticulation as posited in compensatory metathesis may be inhibited by consonant length, consonant clusters, large vowel inventories, vowel variation and diphthongization, stress patterns, and secondary consonant articulations. This is why compensatory metathesis is perhaps not as common as might otherwise be expected.

We now summarize our general analysis. Compensatory metatheses originate when VCV sequences are pronounced with extreme coarticulation of one vowel, resulting in a seepage or shift of that vowel to the other side of the medial consonant. This extreme form of coarticulation occurs in syllables which are already long due to stress. The peripheral unstressed vowel, whose cues are now primarily on the opposite side of the consonant, withers into a reduced form, and is ultimately lost. The migration of the peripheral vowel across the intervening consonant into tonic position is complete.[19]

3.1. KWARA'AE. Kwara'ae is an Oceanic language spoken in the Solomon Islands. We have used published data (Deck 1933–34, Sohn 1980) as well as data in unpublished work by Andrew Pawley and David Gegeo; for correcting several errors we are extremely grateful to Gegeo, a native speaker of Kwara'ae. Table 6 compares citation and normal speech forms for a variety of V_1CV_2 sequences. Citation forms consist of sequences of open syllables, and lack the vowel sequences and range of vowel qualities found in normal forms. Citation forms can be viewed as careful speech, and are also found in 'calling-out' routines (Watson-Gegeo & Gegeo 1986), caretaker speech (Karen Watson-Gegeo, p.c. 1996), and song (Laycock 1982:279).

The citation forms are clearly the conservative forms, with final vowels intact, stress on the penultimate syllable (but see below) and alternating syllables to the left, and pure vowels [i u e o a] in all positions. Comparative data from Kwaio and Lau support this view. In normal forms, the final vowel has either undergone devoicing (e.g. a-b in Table 6) or been lost altogether (e.g. c–e in Table 6). In forms with final voiceless vowels, extreme coarticulation is evident in the transcriptions of preceding vowels as diphthongs, with second halves identical to final vowels (a in Table 6), or in the form of vowel length in case the penultimate and final vowels are identical in quality (b in Table 6).[20]

[18] Fowler (1981) has shown that English stressed syllables resist coarticulation, but Germanic umlaut effects support the view of stressed vowels as potential targets of coarticulation. Vowel position is another factor reported to affect V-to-V coarticulation. An electropalatographic study of English by Butcher and Weiher (1976) revealed the strongest coarticulatory effect with the most extreme vowel /i/, a less substantial effect with /u/, and the weakest effect with /a/. Note that umlaut is typically triggered only by the extreme vowels.

[19] Among comparable earlier accounts we should mention especially that of Ultan 1978, despite its imprecision: 'The tendency toward apocope of unaccented final vowels frequently leads to metathesis with the preceding consonant' (384). Autosegmental analyses of metathesis as vowel spreading with subsequent delinking of peripheral vowel features (e.g. Dench 1990) also have points of contact with our account, but with no reference to phonetic motivation.

[20] Variation between what we here call CITATION and NORMAL forms is not categorical. According to Karen Watson-Gegeo and David Gegeo (p.c. 1997), final citation-form *a* is often preserved in ordinary speech: 'it is really in very rapid speech that it is reduced to schwa. In fact there is a range of realizations in all speakers'

RELATIVE SONORITY	CITATION FORM	NORMAL FORM		COMPARANDA KWAIO	COMPARANDA LAU
a. $V_1 \geq V_2$,	ábufáŋa	əubu̥fa'ŋ	'avoid food'	abufaŋa	
$V_2 \neq e$	ási	ʌisi̥	'sea'	asi	asi
	fúsi	huisi̥	'cat'		
	kádo	kaodo̥	'thin'		
	kʷálu	kʷəulu̥	'eight'	kʷaro	kʷalu
b. $V_1 = V_2$	óso	o'so̥	'lie'		
	sáta	sa'tḁ	'name'		hatana
	satáda	sa'ta'dḁ	'their names'		
c. C = N	lúma	luəm	'house'	luma	luma
	óno	o'n	'six'	ono	ono
	alíŋa	aliʲəŋ	'ear'	ariŋa-	ʔaliŋa
	sína	siən	'sun'	sina	
	óne	wə'n	'sand'	one	one
d. V_1 = [+hi],	lífa	liəh	'teeth'	lifo	nifo
V_2 = [−hi]	úta	wət	'rain'		uta
	asíla	asiəl	'salty, sweet'	asila	
	núta	nuət	'squid'		
	íʔa	yəʔ	'fish'	iʔa	iʔa
	ʔasúfe	ʔasuəh	'rat'		
	bíta	biət	'Peter'		
	lísa	liəs	'Lisa'		
e. V_1 = a,	láde	læɛ'd	'coral gravel'		
V_2 = e	ʔáfe	ʔaɛh	'old woman'		
	ʔábeʔáni	ʔæ'bʔɛin	'help'		

TABLE 6. Kwara'ae metathesis.

Loss of final voiceless vowels has occurred in some contexts, and unsurprisingly is itself determined by phonetic factors. Following nasal consonants, loss of voiceless vowels is complete (c in Table 6). We attribute this to the muting properties of the preceding nasal consonant. Ohala (1983:205–6) suggests that nasalization will block or substantially reduce the audible flow of air produced by turbulence:

> [I]f air pressure is to be released through one of the vocal tract's valves, then all other valves that would vent that air must be closed. If another valve is open, then a noisy audible flow of air through the intended valve will be lessened or eliminated. From this, we would predict that the devoicing . . . of vowels and glides . . . should be blocked by nasalization—the open velopharyngeal port acting to reduce the oral pressure that contributed to these effects.

The velic opening for the nasal preceding final voiceless vowels significantly reduced oral air pressure to a point where the final vowel was no longer audible (cf. Blevins 1997 on Gilbertese).

The quality of final voiceless vowels also plays a role in vowel loss. From the normal forms in d in Table 6, it is clear that nonhigh vowels preceded by high vowels were reduced to schwa prior to loss: for example, **asíla* > **asíələ̥* > *asiəl* 'salty, sweet'. We assume that this centralization and laxing was a consequence of shortening, and that among the voiceless vowels, shorter vowels are lost before longer ones.

repertoire'. Concerning the *f/h* alternations in Table 6, they report that metathesized forms typically show *h*, 'although . . . a native speaker will sometimes preserve the "f" in the metathesized forms'.

The citation forms *lífa* 'teeth' and *núta* 'squid' are interesting. The comparative evidence in Table 6 would lead one to expect **lífo* rather than *lífa*, and citation forms *lího* 'teeth' and *núto* 'squid' are in fact given by Pawley and Gegeo. We suggest the following interpretation: because original **iCo/*iCa* and **uCo/*uCa* contrasts were neutralized under metathesis (to *iəC* and *uəC* respectively), words in **iCo* and **uCo* have been reinterpreted (by some speakers or in some dialects) as ending in *iCa* and *uCa*.

Finally, in aCe sequences, there is some variation in normal forms which suggests that perseveratory as well as anticipatory coarticulation has taken place. In these sequences, the lowness of /a/ results in lowering (and laxing) of [e] to [ɛ]. Again, assuming that lax vowels are shorter than tense vowels, and that shorter vowels are lost before longer ones, we can understand the loss of final [ɛ] in phonetic terms.

The Kwara'ae data provide strong support for a sequence of sound changes where a final unstressed vowel is anticipated articulatorily in a preceding stressed syllable, simultaneous with its prosodic weakening and ultimate loss. But an obvious question arises: what factors distinguish citation forms from normal forms? Why is the final vowel retained fully voiced in the citation form, but weakened or lost elsewhere? Watson-Gegeo & Gegeo (1986:24) suggest a possible answer in their description of salient differences in form and usage between the two forms:

> In ordinary conversation, most Kwara'ae words are metathesized, with underlying forms of words primarily used for emphasis or effect, to mark a pause or 'comma' in a complex sentence or list of items, or to clarify a mishearing . . . In calling out, the underlying form of a word is often used in alternation with the metathesized or contracted form, especially if the addressee does not hear the first time. For example . . . the word for father is *ma'a,* usually spoken as *ma'*. In calling out, the speaker may shout *''Ma'! Ma'a::!''* . . . A shift in stress may help to underscore the contrast between metathesized and underlying form . . . [I]n shifting primary stress to the final syllable in order to be heard (from the Kwara'ae point of view), the phonological shape of the underlying form is also emphasized. We think stresses also call attention to certain aspects of grammar. In calling out, the sentence final position always receives primary or at the least secondary stress.

Marked stress patterns occur in several special contexts: emphasis and effect; in phrase-final positions both in calling-out contexts and lists; in song; and in caretaker speech. Stress is found on word-final syllables in such cases, and possibly in some cases there is secondary stress on all syllables. In contexts where the citation form is used, then, additional stress is placed on syllables targeted for reduction in normal speech, and this stress blocks the prosodically conditioned weakening and coarticulation effects which result in compensatory metathesis. In other words, the existence of otherwise identical phonological strings with differing prosodies has given rise to the synchronic appearance of metathesis in Kwara'ae. As we now show, synchronic metathesis in Rotuman has arisen from a parallel string of events.

3.2. ROTUMAN. Rotuman metathesis is described in detail in the work of Churchward (1940), with additional data presented in Besnier (1987), Blevins (1994), and Geraghty (1995). Content words in Rotuman have two distinct phonological forms, so-called COMPLETE forms as shown in the first column in Table 7, and INCOMPLETE forms as shown in the second column. The incomplete forms in a in Table 7 merely lack the final vowel of their complete-form counterparts, but b-c respectively in Table 7 also

	COMPLETE	INCOMPLETE	
a.	karére	karér	'wild bean'
	leplépi	leplép	'end of a branch'
	makpúlu	makpúl	'soft-bodied sea slug'
b.	súki	sýk	'kind of inflamed patch on the foot'
	tófi	tǽf	'period of six lunar months as the usual length of reign of a Rotuman king'
	ʔóle	ʔǿl	'scaly skin-disease resulting from excessive kava-drinking'
c.	mófa	móaf	'rubbish, refuse, garbage, litter'
	múre	múer	'(of wind) to blow gently'
	péka	péak	'to be scarce or rare'

TABLE 7. Rotuman complete and incomplete phases.

ROTUMAN COMPLETE	ROTUMAN INCOMPLETE	FIJIAN	SAMOAN	TONGAN	
fúfu	fúf	—	tutu	tutu	'light, kindle'
hanúa	hanúa̲	βanua	—	fonua	'earth'
hói	hói	βai	fai	fai	'stingray'
lɔŋi	læŋ	laŋi	laŋi	laŋi	'sky'
mɔnmɔ́nu	mɔnmɔ́n	manumanu	manu	manu	'animal'
ʔána	ʔán	—	ana	ʔana	'cave'

TABLE 8. Rotuman complete and incomplete phases: comparative data.

show umlaut and diphthongization of the stressed vowel. Which treatment is found in a particular word depends on the final -V_1CV_2 sequence of its complete form.[21]

Just as in Kwara'ae forms with final vowel loss (c-e in Table 6), stress falls on the penultimate syllable of complete forms but the final syllable of incomplete forms. As described by Churchward (1940:73–75), tonic vowels are longer than unstressed short vowels, but not as long as surface long vowels. In other words, as in Kwara'ae, there appears to be length associated with tonic vowels in forms where historical final vowel loss has occurred. Also as in Kwara'ae, the treatment of long forms as phonologically conservative is supported by comparative data; a sample is given in Table 8. In *mɔnmɔn* < **manumanu* and numerous similar forms, the relevant sound changes have applied twice within the word, and appear to be prosodically conditioned by the metrical foot—again, just as in Kwara'ae.

The prosodic analysis proposed for Kwara'ae can be directly extended to Rotuman. As shown by Hale and Kissock (1998), the origin of the morphological phase contrasts in Rotuman can be traced back to the suffixal contexts in which stems were found. Complete forms occur in a miscellaneous array of contexts in which they were originally followed by monosyllabic suffixes. The regular penultimate stress rule of Rotuman meant that the final vowels of these suffixed forms would be stressed, blocking the weakening and compensatory coarticulation associated with metrically weak positions. Incomplete forms occur in a miscellaneous array of contexts in which they were originally followed by disyllabic suffixes, or no suffixes. In these contexts, foot-final vowel weakening and anticipatory coarticulation took place, with eventual weak vowel loss, leading to what we call COMPENSATORY METATHESIS. The contexts giving rise to the seemingly idiosyncratic synchronic situation are schematically shown in Table 9. Stems appear in their complete-phase forms (-VCV) in contexts where they were originally followed by monosyllabic suffixes, and in their incomplete-phase forms (e.g. -VVC) in contexts where they were originally followed by disyllabic suffixes or zero.

The historical developments schematized in Table 9 are shown in Table 10 for two typical suffixes, the definite suffix and the gerund suffix *-ŋa*. Rotuman unsuffixed

SUFFIX	STEM STRESS	ROTUMAN CHANGES	STEM PHASE
none	penultimate	* . . . $\acute{V}_1CV_2$ > *. . . V_1V_2C	incomplete
monosyllabic	stem-final	* . . . $V_1C\acute{V}_2$-σ > * . . . V_1CV_2-	complete
disyllabic	secondary	* . . . $\grave{V}_1CV_2$-σ́σ > * . . . V_1V_2C-	incomplete

TABLE 9. Rotuman diachrony: phase contrasts.

[21] Words ending in long vowels show no complete-incomplete contrast. For words ending in VV sequences, the difference between the complete and incomplete forms is that the two vowels are heterosyllabic in the complete form and tautosyllabic in the incomplete form: complete *taknóa* 'kind of clam' but incomplete *taknó̲a*.

original UR	/faliŋa/	/faliŋa-a/	/mose/	/mose-ŋa/
original SR	*fa.lí'.ŋa	*fa.li.ŋá'.a	*mó'.se	*mo.sé'.ŋa
diphthongization	*fa.líă.ŋă	*fa.li.ŋá'.ă	*móě.sě	*mo.séă.ŋă
apocope and monophthongization	falíaŋ	*faliŋá'	mǿ's	moséaŋ
stress levelling		falí'ŋa		
	'ear'	'the ear'	'to sleep'	'sleeping'

TABLE 10. Rotuman diachrony: two suffixes.

definite and indefinite nouns occur in their complete and incomplete forms respectively. As seen by Haudricourt (1957–58) and Grace (1959), this alternation must reflect something like the so-called DEFINITIVE ACCENT in Tongan: at an earlier stage of Rotuman the definite suffix was a short assimilated copy vowel (an empty V-slot). As shown in Table 10, this definite suffix blocked stem-final vowel weakening and the compensatory changes associated with this weakening.[22] In the unsuffixed indefinite form the final vowel was weakened, coarticulated into the stressed syllable, and eventually lost.

There are two notable differences between the Kwara'ae and Rotuman alternations. First, Kwara'ae forms with final vowel reduction and loss are not limited to any morphosyntactic context, whereas the phonologically conditioned distribution of the Rotuman complete and incomplete forms has now been partially obscured. Second, coarticulatory effects in Kwara'ae result in V_1V_2 sequences for all vowels with the exception of /ae/ which is sometimes realized as [æ]. Rotuman shows more tautosyllabic vowel mergers: */ui/ > /y/; */ai/ > /æ/; */oe/ > /ø/.[23] When shortened word-final vowels were ultimately lost, we assume, VV sequences were reinterpreted as shown in 31 in (now) closed syllables.

(31)

RELATION BETWEEN V_1 AND V_2	$\acute{V}_1\breve{V}_2$ PERCEIVED/INTERPRETED AS
V_1 higher than V_2	stressed V_1V_2
elsewhere V_2 front, V_1 not front	stressed V_3 (= fronted V_1)
otherwise	stressed V_1

McCarthy (1995) presents a plausible analysis of these developments.

In addition to its phonologically determined uses, the complete form appears in certain discourse contexts where it 'indicates positiveness, finality, or emphasis, or (in

[22] On the Tongan definitive accent see Clark 1974 and Condax 1989. Grace (1959:55) writes that '[i]f Rotuman once had the same pattern, expressing definiteness by a shift of stress to the final vowel, it is easy to imagine a regular metathesis of final CV sequences in all words except those in which the final vowel bore the stress. This hypothesis provides at once an explanation for the present phases in Rotuman and for the striking analogy between the definite-indefinite distinctions of the two languages.' Other hypotheses include those of K. J. Hollyman, according to whom 'secret languages involving metathesis . . . might have provided the initial stimulus towards the Rotuman short forms' (cited by Biggs 1959:26), and Janda (1984: 100), who speculates that 'Rotuman metathesis could have resulted from some analogical desire to create consonant final surface forms in the incomplete phase that would parallel the consonant final forms produced by apocope of the vowel in the encliticized indefiniteness marker'. For criticism of Hollyman's view see Laycock 1982:278; Janda's speculation is undermined by the actual (i.e. phonological, not morphosyntactic or semantic) distribution of the Rotuman complete and incomplete forms.

[23] It is possible that the anticipatory coarticulation that we describe for final V_1CV_2 strings was not as extreme for vowels which already shared articulatory properties, and that such cases never went through a discrete diphthongal stage. But the distinct behavior of V_1V_2-final words suggests that eventual monophthongization was triggered by the shortening of vocalic nuclei in closed syllables. Compare *tæf* < **tɔ́if* < **tɔ́ifi* < **tɔ́fi* and *hɔ̱́i* < **hɔ́i*, respectively with and without monophthongization. As detailed below, we thus assume for all words a stage where the word-final vowel was fully coarticulated in the penultimate syllable, producing a full-blown diphthong.

questions) the desire to be positive or certain' (Churchward 1940:88). Examples appear in 32, with two incomplete-form counterparts in 33.

(32) a. leume 'come!'
b. ʔe una 'in the middle, did you say?'
c. ia la ala 'he will die (without a doubt)'
d. pa: ta vɔhi 'Is the fence finished?'
(33) a. leum 'come!'
b. ʔe uan 'in the middle'

The complete form in 32a is said to be '[m]ore emphatic or peremptory' than the incomplete form in 33a, and is 'frequently used when one or more calls of *leum!* fails to move the person summoned', while the question in 32d is 'desiring to know with certainty' (Churchward 1940:95).

This description of emphatic speech is nearly identical to that of Watson-Gegeo and Gegeo's (1986:24) for Kwara'ae, and calls for the same analysis. Emphatic and peremptory utterances and echo questions have special prosodic patterns which include final accent. This final accent blocks final vowel weakening, compensatory coarticulation and ultimate vowel loss. This is expected under our account. In fact, in any context in which unmarked penultimate stress is replaced by a marked prosodic pattern, linguistic or extralinguistic, we expect the sound changes giving rise to synchronic metathesis to be blocked. The requirements of poetic meter can also give rise to such anomalies.

> In R[otuman] poetry (native chants) the rules that govern the respective uses of the two phases are largely disregarded. Instead, the general practice is to use each word in its longest possible form, except when the requirements of metre or assonance call for the use of a shorter form . . . [L]ong poetical forms of composite words, though not used in prose, undoubtedly represent the words in their really complete form; and there can be little doubt but that these forms were at one time regularly used even in ordinary speech. Their preservation in poetry is to be explained, I think, not only by the fact that poetry naturally tends to preserve old words and old forms and constructions, but also by the fact that Rotuman poems are habitually chanted in a slow, rhythmic, drawling manner, such as almost inevitably results in the pronunciation, in full, of every possible syllable (Churchward 1940:100–1).

The similarity between this description of Rotuman poetry and Watson-Gegeo and Gegeo's (1986) sketch of Kwara'ae song is striking. In both speech channels, prosodic prominence is found on word-final syllables, and possibly in some cases there is secondary stress on all syllables. This marked accentual pattern blocks the prosodically conditioned weakening and coarticulation effects which normally result in compensatory metathesis, with conservative vowel-final forms retained.

In sum, we propose that Rotuman synchronic metathesis is the result of foot-internal compensatory coarticulation coupled with weak vowel loss. The synchronic conditioning of complete vs. incomplete phases follows directly from the diachronic stress patterns, as shown in Hale & Kissock 1998. Other contexts in which one finds the complete phase (e.g., certain imperatives) are explained by the existence of marked final accent, while other unexpected long forms (e.g. in poetry) appear to be the result of a chanting style which optionally places secondary stress on all syllables.

Recall that our account of phonetic coarticulation associates this sequence of sound changes with prosodic and segmental characteristics: penultimate stress, small vowel inventories, relatively steady-state (as opposed to diphthongal) vowels, and the absence of consonant clusters, long consonants, and consonants with secondary articulations. Since this set of properties (with the exception of the absence of consonant clusters) is found in many Austronesian languages, it is not surprising that most cases of compen-

satory metathesis are found in this family.[24] Before turning to non-Austronesian examples, we briefly review other Austronesian languages with similar sound changes.

3.3. OTHER AUSTRONESIAN EXAMPLES. Rotuman and Kwara'ae are both members of the Oceanic branch of Austronesian. Elsewhere in Austronesian, metathesis has been documented in Meto, a Central Malayo-Polynesian language of West Timor described by Middelkoop (1950; also called Atoni, Dawan, Dawanese, Timorese, and West Timorese). Steinhauer (1993, 1996) and Patrick McConvell and Clemens Kolo (p.c. 1996, based on joint work in progress) report that Meto metathesis is conditioned by what appear to be syntactic and discourse factors. McConvell and Kolo suggest that distinctive intonation contours are probably crucial: final accented vowels resist the reduction (and metathesis) affecting final unaccented vowels. Stress falls on the penultimate syllable in nonmonosyllabic lexical roots, but intonation contours provide the phrase-final syllable with some prosodic prominence. These phrase-final accentual melodies in turn have various discourse and pragmatic functions, according to McConvell and Kolo.

The data in 34 illustrate the syntactically conditioned alternations found in Meto. A final VCV sequence surfaces if a transitive verb is phrase-final because of object preposing, as in 34a, but a metathesized form occurs if no preposing occurs and a transitive verb is followed by the object, as in 34b. (Intransitive verbs raise further complications, discussed by Steinhauer 1993.) As shown in 34c, metathesis is inhibited by a CC-initial object.

(34) Meto metathesis by syntactic context (Steinhauer 1993)

a. phrase-final transitive verb, preposed object
   ʔasu ʔi ʔin n-ami
   dog this s/he/it 3SG-look for
   'this dog, s/he/it is looking for'

b. non-phrase-final, (C)V-initial object
   ʔau ʔ-aem kɔ
   I 1SG-look for you (SG)
   'I am looking for you.'

c. non-phrase-final, CC-initial object
   ʔau ʔ-ami snunaʔ
   I 1SG-look for umbrella
   'I am looking for the umbrella.'

Some verb stems in the three contexts in 34 are given in Table 11. Note that epenthesis occurs when consonant-final stems are followed by CC-initial stems.

In Meto, as in Rotuman and Kwara'ae, foot-final vowel weakening and eventual final vowel loss have occurred with extreme compensatory coarticulation. Final vowel weakening was blocked phrase finally (for transitive verbs), since in this context a

[24] This may also answer the question posed by Thompson and Thompson (1969:214 n.2), who ask 'why metathesis entered the Rotuman picture . . . rather than, say, simple apocope of final unstressed vowels, with perhaps some lingering anticipatory coloring of the preceding vowel. (Anticipatory vowel coloring of this sort can hardly have entered into the picture; else we should expect to find the non-final vowels of the Rotuman long [i.e. complete] forms so effected, especially if they went through an earlier stage in which they were the nucleus of the unstressed syllable preceding a stressed ultima.)' Their implicit assumption that coarticulation is independent of prosodic structure is disconfirmed by the many clearly foot-internal examples of umlaut. It is precisely the fact that nonfinal vowels were nuclei of unstressed syllables preceding stressed ultimas that blocked extreme coarticulation between these two vowels, since they were members of distinct feet.

	/__]$_{Phrase}$	/__(C)V	/__CC	
a.	-ami	-aem	-ami	'search'
b.	-mu?i	-mui?	-mu?i	'have'
c.	-sapu	-saop	-sapu	'sweep'
d.	-mepu	-meup	-mepu	'work'
e.	-inu	-iun	-inu	'drink'
f.	-tepo	-teop	-teop	'hit'
g.	-?boni?	-?boni?	-?boni?a	'hang'
h.	-o?en	-o?en	o?ena	'call'

TABLE 11. Meto metathesis examples (Steinhauer 1993:146).

phrase-final *HL melody occurred (McConvell & Kolo, p.c. 1996). Phrase medially, final vowel weakening and loss were phonologically conditioned, applying only in open syllables. With consonant-final stems, as in g-h in Table 11, no metathesis occurs and C#CC clusters are regularly eliminated by vowel epenthesis across word-boundaries: C#CC > CaCC.

Metathesis has been cataloged by Laycock (1982) as occurring in several Oceanic languages in addition to Rotuman and Kwara'ae. One interesting case is found in Ririo, a moribund language spoken on Choiseul Island (in the Solomons). Penultimate stress was apparently regular, and not affected by morphological, syntactic, or intonational factors; at any rate no synchronic metathesis alternations are described. Laycock (1982: 273) notes that 'to find unmetathesised forms, one has to turn to the closely-related language of Babatana'. Comparative data are shown in 35.

(35)	Babatana	Ririo	
a.	madaka	madak	'blood'
	viri	vir	'tobacco'
b.	pade	pɛd	'house'
	sa^{ŋ}gi	sɛ^{ŋ}g	'bear young'
	vumi	vuim	'beard'
	puka	pua?	'go up'
	piru	piur	'wild'
c.	ni^{ŋ}ga	ni^{ŋ}ga	'egg'
	sire	sire	'housefly'
	pito	pito	'black'
	rupa	rupa	'darkness'

Certain V_1CV_2 constellations result in metathesis, others result in umlaut with V_2 loss, and others yield no change. This is again exactly what we expect if metathesis is actually the result of two complementary sound changes: final vowel weakening and loss, and coarticulation between the penultimate and final vowel. Coarticulation may be extreme (hence e.g. *vuim*), partial (e.g. *pɛd*), or absent altogether (e.g. *sire*). Where no temporal drift of the V_2 articulation into tonic position occurs, there is no weakening of the final vowel articulation, and the final disyllabic foot is maintained intact. Given the little data available from Ririo, we can only speculate at this point on the failure of coarticulation between *i* and a following nonhigh vowel.

A significant phonetic detail supports our account and suggests that in Ririo, as in Kwara'ae, the relevant changes are not yet complete. According to Laycock (1982: 274), all consonant-final words in Ririo have forms with 'an optional echo-vowel; this echo-vowel is frequent in fluent spoken Ririo, but at the suggestion of informants, it is not written'. These echo vowels are apparently the remnants of former final vowels which have lost their color and assimilated in full to the preceding vowel. On this view,

an echo-vowel pronunciation like [piuru] would represent a crucial intermediate form between **piru* and *piur* 'wild'.

3.4. PAMA-NYUNGAN. Our analysis of compensatory metathesis has precursors in work on certain Pama-Nyungan languages of Australia. Hale (1976) demonstrated that metathesis as a sound change occurred in some of the Northern Paman languages which also underwent loss of initial consonants; cf. also Smith 1984. In 36, the sound changes subsequent to initial consonant loss are sketched for languages showing evidence of metathesis.

(36) Metathesis in Northern Paman languages (Hale 1976)
Alŋiṯ, Awŋṯim: regular initial V loss, but initial $*V_1CV_2 > CV_1V_2$ (for $V_1 \neq V_2$) initial *i:C > əCj, *u:C > əCw, *a:C > əCa
Aŋuṯimri dialect of Awŋṯim (Dixon 1980:204): as above plus VV coalescence
Aritinŋiṯiɣ, Mbwiyom: regular initial V loss, but at least initial *uC > Cw /__ {a, u}
Luṯiɣ: irregular initial V loss, but initial *uCa > Cwa
Ngkoṯ: regular initial V loss, but $*V_1CV_2 > CV_1V_2$ (unless V_1 = a and V_2 = a)
Yinwum: regular initial V loss, but initial *uCa > Cwa, *iCV > CjV (for V = a, u)

Illustrative Ngkoṯ data appear in 37. (We have adapted Hale's account.)

(37)

Ngkoṯ		Proto-Paman	
*ali-	> laj-	'to go'	*kali-
*ami	> maj	'MoMo'	*kami
*aŋkául	> *ŋkául > ŋkol	'wallaby'	*páŋkul
*i'na-	> nja-	'to sit'	*nji:na-
*ulan	> lwan	'possum'	*kulan

Data from a southern Paman language, Bariman Gudinhma, suggest that this and other Cape York languages underwent a sequence of changes including vowel copy and subsequent vowel loss: 'The rule in BG is strictly not one of metathesis at all—it is more a simple copying rule. Ignoring certain other rules, the following examples show the extent to which copying, and not metathesis, is the pertinent operation in BG' (Sommer 1976:141; cf. Dixon 1980:204). The examples are given in 38.

(38) a. Extreme coarticulation in Bariman Gudinhma
*juku > ukuó 'tree'
*kuta > utuó 'dog'
*pukan > ukuón 'grass'
*kuŋkar > uguá 'north'
b. Initial vowel loss in Bariman Gudinhma
*wuna > nuó 'lie, sleep'
*kunta > nduó 'hit'

Of interest is the fact that a stress shift has arguably occurred from the first to second syllable in all of the Cape York languages which underwent regular initial consonant loss. As a result, the initial two syllables in Bariman Gudinhma and the Northern Paman languages analyzed by Hale constitute the prosodic mirror image of the foot in the Austronesian metatheses discussed previously. Following Sommer, we suggest that metathesis in Paman is what we refer to as compensatory metathesis. In $*V_1CV_2$ se-

quences where V_1 was unstressed and V_2 was stressed, the gradual reduction of V_1 was part of its temporal shift into the following stressed syllable: $*V_1CV_2 > *V_1CV_1V_2 > *vCV_1V_2 > *CV_1V_2$.

As in Kwara'ae and Ririo, evidence for the intermediate stage of coarticulation without initial vowel loss can be found in languages like Bariman Gudinhma where coarticulation without subsequent initial vowel loss is attested. Additional supporting evidence for the independence of coarticulation and vowel loss comes from Proto-Paman stems with initial long vowels. In at least one language, Yinwum, initial long vowels were shortened with perseveratory coarticulation: Proto-Paman **pu:la* > **u:la* > Yinwum *ulwa* 'father's father'; Proto-Paman **waRi* > **a:ti* > **ataj* > Yinwum *ate* 'to dig'. In Alŋiṯ and Awŋṯim initial long vowels were shortened and further reduced to schwa, but not lost altogether: compare Awŋṯim *əlwa* 'father's father' and *əne* < **inja* < **i:na* < Proto-Paman **nʲi:na-* 'to sit'.[25]

A similar case of compensatory metathesis appears to have occurred in Nganyaywana (Crowley 1976, 1979), a Pama-Nyungan language of Northern New South Wales. As in the Paman languages, initial consonant loss in Nganyaywana was originally triggered by a shift of stress from the first to the second syllable. Following stress shift and initial consonant loss, coarticulation of the word-initial vowel into the tonic syllable occurred, with eventual loss of short word-initial vowels. Nganyaywana forms are shown in Table 12 with comparative data.[26]

NGANYAYWANA		DJANGADI	YUGAMBAL
gjaja < *igaja	'food'	wigaj	
bjana < *ibana	'fat'	biba:n	
gwaŋa < *uganaŋa	'child'		gugaŋa
dwa < *uda	'cry'	wuta	

TABLE 12. Consonant loss and metathesis in Nganyaywana.

A final Pama-Nyungan metathesis occurs in Nyungar, the original language of southwestern Australia (Dench 1990). Nyungar metathesis involves a word-final $*V_1C(C)V_2 > V_1V_2C(C)$ change with subsequent coalescence of certain V_1V_2 clusters. Dench (1990) describes at least three distinct dialects, North, Southwest, and South, with purported full-blown metathesis apparent only in the southern dialect; the southwestern dialect reduces final vowels to schwa. For example, from **kapi* 'water', which is retained as *kapi* in the northern dialect, southwestern dialects show *kapa* [kapə] or *kepa* [kepə], while southern dialects show *kajp* or *ke:p*. Additional data from Dench 1990 are given in 39.

[25] The different behavior of long and short vowels in the Paman languages suggests that what we call coarticulation could actually be a simple timing shift in the articulation of the original peripheral vowel, aligning it more closely with the stressed syllable. On this analysis, the longer the original vowel, the more of it will hang off the edge after temporal realignment has taken place. In other words, original long vowels are not expected to be lost initially, since half of their articulation still occurs prior to the stressed syllable.

[26] The Nganyaywana forms as cited represent Crowley's interpretation of the various source orthographies. Interestingly, Mathews 1901 (from which many of the forms are taken) sometimes writes an initial vowel where Crowley assumes the words to be consonant initial. For example, Mathews spells *indja* 'here' which Crowley interprets as *ndja* (cf. Djangadi *djinda*); and Mathews writes *imbi-ala* 'carpet snake' which Crowley interprets as *mbjala* (cf. Gumbayngir *djumba:l*). In most cases, Mathews's consonant-initial forms correspond well with Crowley's consonant-initial interpretations, so that we must consider the possibility that at least in some instances, the loss of initial vowels in Nganyaywana at the turn of the century was not yet complete, providing further evidence for the two-step development of compensatory metathesis suggested above.

(39) Dialects of Nyungar (Pama-Nyungan)

NORTH	SOME SW	SOUTH	
kata	ka(:)ta	ka:t	'head'
pipi	pi(:)pa	pi:p	'breast'
kartu	ko(:)rta	ko(:)rt	'wife'
kapi	ke(:)pa	ke:p, kajp, kiap	'water'
puja	pwoja	pwoj	'smoke'
kuɟi	kwe(:)ɟa	kwe(:)ɟ	'bone'
walɟa	walɟa	waliɟ	'eaglehawk'

As Dench (1990) argues, it is fairly clear from dialect comparison that metathesis in Nyungar did not occur as a one-step process. As proposed for Rotuman, the penultimate stress pattern of the language gave rise to strong coarticulation between the penultimate and final vowels, with simultaneous weakening of the final vowel articulation. This stage of the sound change is instantiated by the southwestern dialects, where coarticulation between the penult and final vowel has occurred, but final vowels are maintained as reduced schwas. The loss of final unstressed vowels has occurred only in the southern dialects, indicating the independence of this sound change from the coarticulatory event.[27]

Recall our claim that compensatory metathesis will be facilitated by certain phonetic properties of languages, including small vowel inventories, relatively steady-state vowels, and the existence of tonic length in peripheral binary feet, where the peripheral vowel is unstressed. Proto-Pama-Nyungan is reconstructed with three vowels and initial stress in roots, the majority of which were disyllabic (O'Grady & Tryon 1990). Given that most Pama-Nyungan languages show significant length as a correlate of stress, we should not be surprised to find compensatory metathesis occurring in three distinct branches of the Pama-Nyungan language family. Data from each of these language groups support the view of metathesis as a two-step sound change, while the initial stress-shift in the Paman languages and in Nganyaywana strongly supports the independent prosodic conditioning of compensatory metathesis: coarticulation occurs from a peripheral unstressed vowel into the adjacent tonic syllable, regardless of whether the prosodic constituent in question is an iamb, as it is in these languages, or a trochee of the sort seen in the Austronesian languages.

4. PSEUDOMETATHESIS: LETI AND ELSEWHERE. Perceptual and compensatory metathesis, examined in §§2–3, can be regarded as the two NATURAL types of CV metathesis. They are natural in two senses: they arise from the reinterpretation of familiar, phonetically gradient types of coarticulation; and in each case two successive phonological

[27] Unlike Rotuman and Kwara'ae, there is no evidence for a synchronic alternation between long and short forms in Nyungar. This is not surprising, since stress in many Pama-Nyungan languages is initial and on alternate syllables from left to right. Given this general pattern, disyllabic roots would be unaffected by suffixation, since they would constitute single feet themselves. There is very little evidence available about trisyllabic roots. 'For trisyllabic words of various kinds the evidence points to the simple loss of final vowels. If there is a metathesis, it is restricted to disyllabic roots' (Dench 1990:6). This suggests that the prosodic conditioning for metathesis is met only by the word-initial foot, presumably in part because of the tonic length accorded to the initial syllable.

Dench presents an autosegmental analysis of Nyungar metathesis which is similar to ours in having three distinct steps: final vowel reduction (with dissociation of features from the final V-slot), reassociation of these vowel features to the tonic syllable (with subsequent merger in some cases), and final vowel loss in the southern dialects. The main difference is that Dench's phonological reassociation of vowel features from the final to the penultimate vowel corresponds to our proposed step of phonetic coarticulation within the foot.

stages may plausibly involve a simple CV > VC (or VC > CV) replacement. But other synchronic alternations can mimic CV metathesis, even if their histories involve nothing like metathesis. Such PSEUDOMETATHESES, as we will call them (following Mills & Grima 1980), may in some cases betray their nonmetathesis origins by lacking the expected properties of perceptual and compensatory metatheses. For instance, metathesizing consonants may not be limited to a natural class in Table 1, or metathesizing vowels may not be limited (as in the Latin and Greek cases discussed in §2.2) to vowels that are perceptually similar to adjacent consonants. In §§4.1–2 we will discuss a relatively complex example of this type.

We have already described one pseudometathesis.[28] The Najdi Arabic alternations in Table 4 originated via independently motivated epenthesis and deletion processes. This is a common source of pseudometathesis: vowel epenthesis is followed historically by vowel deletion, or vice versa (as in many Arabic dialect examples). In some cases the history is well understood or the discrete processes in question are still recoverable, and there is no question of metathesis; some other cases are more obscure. Obscurity is especially likely for thoroughly morphologized metathesis alternations, where the factors that originally created the alternations may be completely unrecoverable.

An example of this obscure type is found in Klallam, a Salish language belonging to the small Straits branch of Coast Salish. According to Thompson and Thompson (1969, 1971), one mark of the ACTUAL aspect in Klallam is metathesis of the final CV sequence in the nonactual. (Actual aspect is similar to imperfective or progressive aspect.) Some examples appear in 40.

(40)

	NONACTUAL	ACTUAL	
a.	χčʔí–	χíčʔ–	'scratch'
b.	čkʷú-	čúkʷ-	'sting, shoot'
c.	pkʷʔə́-	pə́kʷʔ-	'smoke'
d.	kʷʔsə́-	kʷʔə́s-	'count'

The most common metathesizing vowel is *ə*, as in 40c–d, but Thompson and Thompson (1971:276) remark that 'there are enough other cases to show that metathesis—not simply stress shift with inserted vowel—provides the broader generalization'. By contrast, in at least two dialects of Northern Straits Salish (the other Straits language), apparent metathesis only occurs with *ə*. In these dialects, therefore, metathesis alternations can be attributed to a combination of stress shift, *ə* deletion, and *ə* epenthesis (Demers 1974, Montler 1986:111–30). For Klallam metathesis, the alternations in 40a–b make such an analysis much more problematic. Comparative data in some cases suggest that syncope may have affected historical *CVCV roots in Klallam—e.g. the forms in 40a seem to correspond to Lushootseed *χʷičʔi-d* 'mark it, plow land' and *χʷíčʔ-dup* 'I'm plowing now' (Bates et al. 1994)—but if so, the details are unclear.

The remainder of this section will focus on a single language (with comparative data). In §4.1 we describe synchronic alternations in Leti that have been viewed as metatheses, and in §4.2 we propose a new analysis of their diachrony. Several securely reconstructable changes have interacted in this case to yield pseudometathesis alternations whose ultimate basis, however, is no different from a type of metathesis already investigated.

[28] Another case has been analyzed in unpublished work by one of us (Garrett): in Maltese, morphological changes and straightforward sound changes other than metathesis have yielded a set of synchronic alternations which now (as discussed e.g. by Hume 1994) look very much like metathesis.

4.1. LETI METATHESIS. Leti(nese) is an Austronesian language spoken on the island of Leti, east of Timor. It has been described by Jonker (1932) and van Engelenhoven (1995a, 1996), and its metathesis alternations have been analyzed synchronically by Hume (1997, 1998) and van der Hulst & van Engelenhoven (1995); for a sketch of its diachronic phonology see van Engelenhoven (1995b). Leti belongs to the Central Malayo-Polynesian branch of Austronesian, and specifically to what van Engelenhoven (1995a:17) calls the 'Luangic-Kisaric' group of languages spoken on various islands north and east of Timor. These include the Kisaric languages Kisar and Roma as well as five Luangic languages: Luang (data below cited from Taber 1993), Lakor, Moa, Wetan (de Josselin de Jong 1987), and Leti itself.

Words in Leti have different surface shapes depending on phonological context. Table 13 shows the relevant conditioning factors, the surface forms of representative words, and underlying representations according to Hume's analysis (1997, 1998; but reconstructed for an earlier stage in d-e). The FINAL column of Table 13 shows the surface forms that appear phrase finally and phrase medially before two consonants. The MEDIAL #CV column shows the surface forms that appear phrase medially before a single consonant, and the MEDIAL # V column shows the surface forms that appear phrase medially before a vowel. Parenthesized vowels surface as glides before nonhigh vowels and are lost before high vowels.[29]

	UR	FINAL	MEDIAL # CV	MEDIAL # V	
a.	/mɛtam/	mɛtma	mɛtam	mɛtm	'black'
b.	/ulit/	ulti	ulit	ult(i)	'skin'
c.	/panas/	pansa	panas	pans	'warm, hot'
d.	*/βuʔar/	βu:ra < *βuʔra	βuar < *βuʔar	βu:r < *βuʔr	'mountain'
e.	*/loʔut/	lo:tu < *loʔtu	lout < *loʔut	lo:t < *loʔt	'servant'
f.	/anin/	anni	anin	ann(i)	'wind'
g.	/dudun/	dunnu	dudun	dunn(u)	'rack'
h.	/βalin/	βalli	βalin	βall(i)	'day after tomorrow'
i.	/dudul/	dullu	dudul	dull(u)	'horn'
j.	/mɛra/	mɛra	mɛr	mɛr	'to be red'
k.	/asu/	asu	as # C(u)V	as(u)	'dog'
l.	/tani/	tani	tan # C(i)V	tan(i)	'soil'

TABLE 13. Leti phrasal alternations.

The alternations in Table 13 are illustrated in 41 with some examples from Table 13 and additional examples.

(41) a. /asu/ 'dog' + /daβdaβra/ 'greedy' → asdwaβdaβra 'praying mantis'
b. /asu/ 'dog' + /mɛrmɛra/ 'red' → asmwɛrmɛra 'red dog'
c. /asu/ 'dog' + /nisa/ 'tooth' → asnisa 'dog's tooth'
d. /ulit/ 'skin' + /prai/ 'kind of drum' → ultiprai 'skin for a *prai*'
e. /tranan/ 'south' + /tipur/ 'east' → tranantipru 'south-east'
f. */βuʔar/ 'mountain' + /laβan/ 'big' → βuarlaβna 'Wuarlawan'
g. */βuʔar/ 'mountain' + /ulu/ 'first' → βu:rulu 'Wurulu'

Note that while Leti has seven vowels /i e ɛ a ɔ o u/, only three vowels /i a u/ appear in final syllables. Stress is regularly penultimate.

[29] In some work on Leti these glides are written as superscripts, i.e. secondary features of preceding consonants, but we see no evidence that these are complex palatalized or labialized consonants rather than Cj and Cw clusters. High-vowel metathesis has occurred on either analysis. Note that initial sequences of the type in question behave like CC clusters with respect to the alternations in Table 13: /βatu/ 'stone' + /lja:ra/ 'sole' → *βatulja:ra* 'prop', not ***βatlja:ra*.

All analyses have assumed the existence of two distinct types of metathesis in Leti, which van Engelenhoven (1995a, 1996) and van der Hulst & van Engelenhoven (1995) call INTERNAL and EXTERNAL METATHESIS. Internal metathesis alternations are between phrase-final CV forms and phrase-medial VC forms, such as *mɛtma* vs. *mɛtam, anni* vs. *anin,* and *βu:ra* < *βuʔra* vs. *βuar* < **βuʔar.* External metathesis is the process by which /asu + mɛrmɛra/ surfaces as *asumwɛrmɛra:* a final high vowel appears to surface (as a glide) after a following initial consonant. External metathesis is so called because a segment originating in one morpheme surfaces in an adjacent morpheme. Internal metathesis does not (so to speak) breach the morpheme boundary.

Leti external metathesis is easily interpreted in our framework. It is high-vowel perceptual metathesis of the sort illustrated for Koshin and Birom in 9–11 above, and it results from the resegmentation of elongated palatalization and labialization phases.[30] Originally these were associated with the word-final vowel, but with vowel shortening and loss they were resegmented into post-consonantal position. The absence of metathesis before high vowels is due to the same high-vowel feature which yields metathesis in the first place: palatalization and labialization are phonetically of long duration, taking minimal CV domains in Leti. In VCV contexts where both vowels are high, the second one determines the transition of the consonantal release. The consonantal release is phonetically prespecified because of the duration of high-vowel cues spanning minimal CV domains, and so the migration of a preceding high-vowel articulation is blocked.[31]

4.2. A UNIFIED ANALYSIS. Our historical account of metathesis alternations in Leti (and other Luangic-Kisaric languages) is based on the standard analysis of Mills and Grima (1980), but with several significant differences. We will present our account and then comment on the differences. We suggest that the alternations in Table 13 result from three sound changes: paragogic schwa epenthesis; unstressed phrase-medial vowel loss in open syllables; and the shift of schwa to /a/.

Our first proposed sound change is vowel epenthesis after words ending in consonants. Its effects are shown in 42, with Central Malayo-Polynesian reconstructions cited from Blust 1993.

(42) Leti paragogic schwa epenthesis

a.	*ánin > *áninə	'wind'	(PCMP *haŋin)
	*ápun > *ápunə	'belly'	(PCMP *kampuŋ)
	*βúlan > *βúlanə	'moon'	(PCMP *bulan)
	*dúdum > *dúdumə	'thunder'	(PCMP *ndundum)
	*náʔan > *náʔanə	'name'	(PCMP *ŋajan)
	*úlit > *úlitə	'tail'	(PCMP *kulit)

[30] It is superficially similar to cases of initial compensatory metathesis discussed for some Australian languages in §3, but a significant difference is that the Leti metathesis is not conditioned by stress. Word-final high vowels undergoing external metathesis in Leti are unstressed, but the following vowel can be stressed or unstressed: /do/ is unstressed in /lopu + do/ → *lópdwo* 'dolphin + then', but cf. /lopu mɛra/ → *lópmwɛ́ra* 'dolphin + red' In addition, unlike most examples of compensatory metathesis we examine, where all vowel qualities are coarticulated into stressed syllables, Leti internal metathesis is limited to high vowels.

[31] In her phonological analysis, Hume (1997:92) uses a constraint barring adjacent [+high] segments within a single syllable. Tautosyllabicity is needed because of disyllabic sequences like [li.ur] 'back'. The obvious question is why such vowel sequences are allowed across syllables, but not within syllables. Our account answers this question: there are no syllable-internal [+high][+high] sequences because Ci and Cu coarticulation has blocked perceptual metathesis in these environments, and such sequences have no other potential historical source. Stems like *liur* < **liʔur* 'back' have a distinct history: glottal stop loss has given rise to adjacent high vowel sequences.

b. No change

*βáru	'new'	(PCMP *baqəRu)
*máta	'eye'	(PCMP *mata)
*rúma	'house'	(PCMP *Rumaq)
*rúri	'bone'	(PCMP *zuRi)
*talína	'ear'	(PCMP *taliŋa)

For simplicity we call this a Leti change although it was presumably at least Luangic-Kisaric, and for concreteness we call the epenthetic vowel a schwa; in any case it was a reduced vowel. Stress is marked because its position was not predictable: some nonmonosyllables had final-syllable stress because their final syllables resulted from an earlier merger of two syllables.

Sound changes like the one in 42 are well attested, especially in Central Malayo-Polynesian; within Luangic-Kisaric, Stresemann (1927:219–20) in fact suggests just this for the prehistory of Kisar. We assume that such changes originate phonetically as a reinterpretation of consonantal release. Languages where this phenomenon is attested are too numerous to name; see Sneddon 1993 for a survey of relevant data in Central and other Western Malayo-Polynesian languages. Two typical Central Malayo-Polynesian cases are from Dobel (Hughes 1995) and Kambera (Klamer 1994). In Dobel, a language of the Aru Islands in the Indonesian province of Maluku, an excrescent [u] appears after word-final stops. This supports our view of paragogic vowels as pure release features: oral stops are the prototypical consonant type which include both a closure and release phase. In Kambera, a language of Sumba (west of Timor), roots ending in consonants acquire a paragogic [u]. Klamer refers to this vowel as 'weak' and notes that it may disappear altogether in rapid speech. In Kambera and Dobel the paragogic vowel is [u], but Sneddon (1993) and Stresemann (1927) also cite examples of [i], [e], [a], [o], and [ə], as well as echo vowels.

Our second proposed sound change is not only crosslinguistically commonplace but clearly justified independently for Leti: unstressed vowels in phrase-medial open syllables were lost. (The loss must be treated as iterative from right to left.) This change had an interesting side effect in Leti. When high vowels were affected by syncope, they were not simply lost without a trace. As discussed in §4.1, the elongated palatalization or labialization gesture originally associated with a high vowel was reinterpreted as part of the following syllable (except when the following syllable had a high vowel, as also discussed above). This reinterpretation—this perceptual metathesis, in other words—took one of two forms. If the following vowel was a schwa, the coarticulatory coloring of the high vowel was reinterpreted as intrinsic: such schwas were phonologized as /i/ or /u/. If the following vowel was already fully specified, the palatalization or labialization gesture was reinterpreted as a glide. The effects of syncope are shown in 43 for two phrasal contexts.

(43) Leti syncope

a. PHRASE FINALLY

*áninə > ánni	'wind'
*ápunə > ápnu	'belly'
*βúlanə > *βúlnə	'moon'
*dúdumə > dúdmu	'thunder'
*náʔanə > *náʔnə	'name'
*úlitə > últi	'tail'

b. HIGH VOWEL PHRASE MEDIALLY BEFORE CV (V = [−HIGH])

*βáru # CV- > βár # CwV-	'new'
*rúri # CV- > rúr # CjV-	'bone'

c. NONHIGH VOWEL PHRASE MEDIALLY BEFORE CV (V = [−HIGH])

*áninə # CV-	> ánin # CV- 'wind'
*ápunə # CV-	> ápun # CV- 'belly'
*βúlanə # CV-	> βúlan # CV- 'moon'
*dúdumə # CV-	> dúdum # CV- 'thunder'
*máta # CV-	> mát # CV- 'eye'
*náʔanə # CV-	> *náʔan # CV- (>ná:n #CV-) 'name'
*rúma # CV-	> rúm # CV- 'house'
*talína # CV-	> *tlín # CV- (> tnín # CV-) 'ear'
*úlitə # CV-	> úlit # CV- 'tail'

Phrase medially before vowels, the paragogic schwa was simply lost like all final vowels (except high vowels, which became glides). Note that phrase-final forms like *ánni* and *ápnu* in 43a (vs. the historical forms **ánin* and **ápun*) were created via the SAME SOUND CHANGE which gave rise to external metathesis in sequences like *βár # CwV-* in 43b. In *anni/anin,* that is, internal metathesis has the same cause as external metathesis.

Our third proposed sound change is a trivial one: schwa is now realized as *a* in Leti. This is not only natural but supported by independent evidence. Note first that the Luang cognates of Leti words with posttonic *a* are regularly transcribed with [ə] by Taber (1993): Leti *βúlla* 'moon' = Luang *wóllə;* Leti *máta* 'eye' = Luang *mátə;* and so on. Whether this is a difference in transcription or pronunciation is immaterial here. In Wetan, similarly, '[i]n unstressed final syllables *a* is often replaced by *e,* which may be weakened to the colourless vowel *ə*' (de Josselin de Jong 1987:148). Leti, Luang, and Wetan are three of the five Luangic languages.

Within Leti, moreover, there is independent evidence that *a* is the reduced vowel. Syncope did not occur in closed syllables, but posttonic vowels in word-internal closed syllables are reduced to *a.* This context arises only in suffixation: root-final *VC* → *aC* before a consonant-initial suffix. A few examples are given in 44.

(44) Medial reduction in Leti

/kukis/ 'kind of pastry'	→ kukas-mu 'your (sg.) *kuksi*'
/lutur/ 'wall'	→ lutar-mi 'your (pl.) wall'
/panin/ 'parent'	→ panan-ku 'my parent'
*/nuʔun/ 'banyan'	→ *nuʔan-mu > nuan-mu 'your (sg.) banyan'
*/ruʔin/ 'dugong'	→ *ruʔan-mi > ruan-mi 'your (pl.) dugong'

Comparable Wetan forms are often cited with an *e* by de Josselin de Jong (1987), as in /lidan/ 'friend' → *liden-mu* 'your (sg.) friend' or /ulit/ 'skin' → *ulet-ni* 'his skin'.

The effects of the third and final relevant sound change are shown in 45 for the two relevant forms in 43a.

(45) Leti schwa > /a/

*βúlnə	> *βúlna (> βúlla) 'moon'
*náʔnə	> *náʔna (> ná:na) 'name'

The result of this change is that phrase-final forms like *βúlla* alternate with phrase-medial forms like *βúlan.* Interestingly, therefore, the external metathesis alternation in *βúlla/βúlan* does not have exactly the same source as the one in *ánni/ánin.* Synchronic alternations involving a high vowel have a perceptual metathesis as their origin, but synchronic alternations involving *a* are due to the fact that the paragogic vowel surfaces as *a* in Leti. This accident has left the impression of two distinct metathesis alternations—one involving only high vowels and crossing morphological boundaries, the

other involving all vowels and conditioned by phrasal context. There was in fact only one metathesis, which was of the phonetically natural type investigated in §2 above.[32]

Mills and Grima (1980) cite an argument in favor of the view that phrase-final forms which show internal metathesis in Leti—forms like *ápnu* 'belly' < **ápun*—went through a VCV-final stage. They report that *ánni* 'wind' < **ánin* is 'pronounced, and often written [in Jonker 1932], with a "furtive" vowel between the two *n*'s' (p. 275). In the transition from **áninə* to *ánni,* we suggest, an intermediate form was **ánəni,* with reduction of the medial vowel and resegmentation of its palatal gesture. The same conclusion is suggested by some Luang forms cited by Taber (1993), though this pattern is not fully regular: e.g. *máʔðnu* 'bird' corresponds to Leti *má:nu* 'bird' < **máʔnu,* and *ápðnu* 'stomach' to Leti *ápnu.*[33]

Our analysis of the evolution of Leti metathesis is based on the account of Mills & Grima 1980. They assume vowel epenthesis and syncope in essentially the same contexts as we do, but with one important difference. According to Mills and Grima, the epenthetic vowel was a copy vowel, not a fixed vowel such as the schwa of our analysis. A few historical derivations according to the vowel-copy analysis are given in 46.

(46) Leti historical phonology as per Mills & Grima 1980

a. PHRASE FINALLY

*ápun > *ápunu > *ápnu	'belly'	(PCMP *kampuŋ)
*βúlan > *βúlana > *βúlna	'moon'	(PCMP *bulan)
*úlit > *úliti > *últi	'tail'	(PCMP *kulit)

b. PHRASE MEDIALLY BEFORE CV (V = [-HIGH])

*ápun # CV- > *ápunu # CV- > ápun # CV-	'belly'
*βúlan # CV- > *βúlana # CV- > βúlan # CV-	'moon'
*úlit # CV- > *úliti # CV- > úlit # CV-	'tail'

As noted above, copy-vowel epenthesis is a well-attested alternative to fixed-vowel epenthesis of the kind we assume for Leti. In particular cases copy-vowel epenthesis may or may not develop from an earlier fixed-vowel stage, but it presumably results from perseveratory coarticulation of a preceding vowel. Echo vowels of this sort are found in Yucatec Mayan after all final obstruents (Straight 1976) and in many of the languages surveyed by Stresemann (1927) and Sneddon (1993).

Evidence of two types may seem to support Mills and Grima's copy-vowel analysis. We will discuss this evidence first before turning to other evidence which supports our schwa-epenthesis analysis.

First, within the Luangic-Kisaric group there apparently are (or have been) language varieties in which the epenthetic vowel is attested as a copy vowel with no loss or weakening of the vowel being copied. While the Kisar data in Taber 1993 generally show either the epenthetic vowel or the historical vowel but not both—e.g. *ánne* 'wind'—Stresemann (1927:220) specifically cites Kisar forms in which both occur. For instance, he cites the reflex of PCMP **ma-takut* 'be afraid' as *ma-kaʔuk-u;* its Leti

[32] This metathesis was probably not structure preserving, since it is the only source of CC + glide clusters (or clusters of a plain consonant plus a palatalized or labialized consonant) in the native vocabulary. Examples occur not only in synchronic external metathesis contexts but also morpheme internally, as in PCMP **tinaqi* > **tinɛ́i* > *tnjɛ́i* 'bowels'; cf. e.g. PCMP **i-daləm* > **irárama* > *rjárma* 'inside'.

[33] Note that Leti *má:nu* < **máʔnu* 'bird' reflects earlier CC metathesis from **mánʔu* < **mánuʔə* < **mánuʔ* < PCMP **manuk.* The same regular pattern is seen in Leti *á:na* 'child' < **ánaʔ* < PCMP **anak* and Wetan *mí:na* 'fat, sweet, insipid' < **mínaʔ* < PCMP **miñak.* (Phrase-medial forms like Leti *máun* < **máʔun* have been remodelled based on the phrase-final forms in which CC metathesis occurred.)

cognates are phrase-final *mta:tu* < **mtaʔtu* and phrase-medial *mtaut* < **mtaʔut*. Copy-vowel and fixed-vowel epenthesis are clearly processes that coexist in language families, however, with copy vowels perhaps even evolving from fixed-vowel epenthesis. The presence of copy vowels in Kisar is therefore not evidence that Proto-Luangic-Kisaric had copy-vowel epenthesis rather than fixed-vowel epenthesis.[34]

Second, as Mills and Grima (1980:276–77) observe, there is one context in which some Luangic languages seem to show a copy vowel together with the vowel it has copied. This context is shown in Table 14, where the proximate reconstructions are ours and all forms are phrase final. (Note that final **u* > *i* in Wetan; Proto-Austronesian reconstructions are cited from Zorc 1995.) Mills and Grima suggest that the relative chronology of glottal stop loss and syncope is responsible for the difference between the Leti forms in Table 14 and the Moa and Wetan forms. In Leti, as stated above, syncope occurred first: on their analysis **líʔuru* > **líʔru* > *li:ru*. In Moa and Wetan, glottal stop loss occurred first—**líʔuru* > *liuru*—and syncope did not affect postvocalic vowels.

LETI	MOA	WETAN	ANCESTOR	
a:li	aili	aili	*áʔil	'hook'
a:ru	agru < *auru	airi	*áʔur (< PAN *qápuR)	'lime'
li:ru	liuru	—	*líʔur (< PAN *likúd)	'back'
ru:ni	—	ruini	*rúʔin	'dugong'
ta:li	taili	taili	*táʔil	'weight'

TABLE 14. Luangic comparative data.

On our analysis, a form like Wetan *aili* must reflect **aʔilə* with schwa epenthesis. With the early glottal stop loss posited by Mills and Grima this became **ailə*, and we assume that the vowel weakening underlying syncope affected postvocalic vowels by causing diphthongization. That is, trisyllabic *[a.i.lə] became disyllabic *[aj.li], with reduction of the medial high vowel and partial compensatory reinterpretation of the schwa as a high vowel. Wetan forms like *aili* are said by de Josselin de Jong (1987: 152) to have initial diphthongs. In short, though of course consistent with the copy-vowel analysis of Mills and Grima, the Moa and Wetan data in Table 14 are unproblematic for our analysis as well.

Evidence of two types crucially supports our fixed-vowel epenthesis analysis in preference to Mills and Grima's copy-vowel analysis. First, as Mills and Grima note, their analysis is apparently contradicted by 'words without medial C which reduced to monosyllables in pre-Proto-Lettic times' (1980:283 n. 6). In such words, as shown in

[34] The same observations apply to the sung literary style described by van Engelenhoven, which 'is no longer taught to the youth because of their preference for the modern musical genres in Indonesian and Ambonese Malay' and 'has become almost completely incomprehensible to the younger generations' (1995a: 21–22). This style preserves the two vowels such as in *laniki* 'sky' < **lanit* (PCMP **laŋit*). But it also shows a **t* > *k* change, which is found in Kisar but not in Leti or other Luangic languages (van Engelenhoven 1995b:255), and according to van Engelenhoven (1995a:22) the style 'is . . . exactly the same, from Leti in the west up to Wetan and Tepa (Babar) in the east'. Hence there is no reason to believe that this literary style somehow reflects an earlier stage of Leti; it appears to be based on a Kisaric language variety.

According to Mills and Grima (1980:281) the Kisaric languages lack synchronic external metathesis, but this is not really relevant to our analysis. As a matter of diachronic typology, synchronic boundary-transgressing alternations of the external metathesis type are readily eliminated. Therefore—even if external and internal metathesis have the same perceptual-metathesis origin (as we propose)—it is unsurprising that synchronic external metathesis alternations have been eliminated in Kisaric, but not in Luangic.

47, the epenthetic vowel surfaces as *a* in Leti (forms labelled 'J' are cited from de Josselin de Jong 1987, not van Engelenhoven 1995a).

(47) Paragogic schwa in finally stressed words

a. STRESSED V = /a/

*-át > *-átə > *β(ɔ)-áta 'four' (PCMP *pat)

*lár > *lárə > lára (J) 'hunger' (*lapaɣ [Mills & Grima 1980:283 n.6])

b. STRESSED V = HIGH

*i-lór > *ilórə > ljɔ́ra	'sea(side)'	(PAN *laHud)
*ma-nís > *manísə > mnísa (J)	'thin'	(PCMP *ma-nipis)
*ór > *órə > ɔ́ra	'bamboo'	(PCMP *qauR)
*pitún > *pitúnə > ptúna	'star'	(PCMP *bituqən)
*ún > *únə > úna (J)	'tree trunk'	(PAN *púqun)
*wér > *wérə > wɛ́ra	'water'	(PCMP *waiR)

In words which had final stress at the time of vowel epenthesis, our analysis and Mills & Grima's analysis make different predictions. The forms in 47b (and similar forms attested in Wetan) show that the epenthetic vowel was not a copy but a fixed vowel. On our account, a form like **manísə* did not become ***manísi* because its high vowel was never lost and there was never any ambiguity as to the segmental source of the palatalization gesture. Resegmentalization occurs only when the original cause of palatalization or labialization is obscured (by vowel loss, or by diphthongization as in Moa and Wetan).

Second, the copy-vowel analysis makes incorrect predictions for one phrasal context: phrase medially before a CV-initial word, where V is nonhigh. If **ápun* 'belly' had become **ápunu,* for instance, then **ápunu # CV-* should have become ***ápun # CwV-,* just as *ásu* 'dog' yields *ás # CwV-*. But as shown in Table 13, the epenthetic vowel never undergoes external metathesis. This is mysterious if it was a copy vowel, but our analysis predicts this. A syncopated **ápunə # CV-* is simply *ápun # CV-*: the source of the labialization gesture remains transparent, and in any case the vowel of the following word is too distant to be significantly affected.

We now summarize our diachronic account of Leti metathesis. Metathesis alternations and fossilized epenthesis reflexes point to an earlier fixed-vowel epenthesis. Word-final consonants were audibly released, and this release was interpreted as a reduced vowel. In a subsequent sound change, unstressed vowels were lost in open syllables and (at least posttonically) reduced in closed syllables. High vowel syncope led to resegmentalization of the labialization or palatalization gesture: perceptual CV metathesis. The reduced vowel surfaces as *a* in Leti. This series of events explains the synchronic distribution of internal and external metathesis.

5. CONCLUSIONS. In §4 we discussed alternations that resemble metathesis but result from the interaction of other sound changes like vowel epenthesis and deletion. However, such pseudometatheses do not have the distinctive typological profile of the metatheses discussed in §§2–3. The latter, we have argued, are the two types of regular, phonetically natural CV metathesis.

For cases where inversion of linear CV order is limited to segments or features typically instantiated over multisegmental domains—Ohala's 'stretched out' features—we use the term PERCEPTUAL METATHESIS. The early stages of this development are seen in Cayuga, while Cherokee and Mohawk illustrate its final stages, with the proposed sound changes directly reflected in synchronic alternations. Slavic, Latin,

and Le Havre French also show historical evidence of perceptual metathesis, though synchronic alternations are absent in these languages. Our phonetic perceptual account is supported by the limited range of segment types involved, the symmetry of perceptual metatheses, and the fact that some examples are restricted to vowels whose formant structure is similar to the abutting consonant. These properties are unexplained in accounts based on universal phonological or phonetic markedness.

Perceptual metathesis is closely related to similarly conditioned vowel epenthesis and long-distance movement. All three types of sound change involve the same limited set of segment types and have their origins in these segments' long durational cues, which can span entire syllables or even strings of syllables. The occurrence of perceptual CV metathesis (and the related phenomena of copy-vowel epenthesis and long-distance movement) in numerous language families, with multiple independent developments in some, indicates that this type of sound change is not uncommon. This may be because it has relatively few phonetic prerequisites and involves a historical inversion of CV linear order with no intermediate vowel copying and deletion.

COMPENSATORY METATHESIS is our term for prosodically conditioned inversions of CV linear order independent of segment type. Just as particular phonetic features are spread out durationally in perceptual metathesis, peripheral unstressed vowels in compensatory metathesis spread over neighboring consonants in their migration towards the stressed vowel. Whereas multisegmental durational cues for segments involved in perceptual metathesis are the norm, we suggest that the shift of vowel timing in compensatory metathesis arises from language-specific coarticulation effects. The occurrence and perception of these coarticulation effects are facilitated by phonetic factors such as the following: size and distribution of vowel inventory; degree of vowel variation; absence of secondary consonant articulations; absence of long consonants and consonant clusters; tonic length on stressed syllables; and steady state vowels.

The proposed development involves vowel coarticulation or shift over an adjacent consonant into the tonic syllable, with concomitant reduction and eventual loss of the peripheral vowel. Kwara'ae illustrates the earlier stages, while Rotuman and Meto provide examples of the later stages, with the proposed sound changes directly reflected in synchronic alternations. Nyungar dialects also reflect the initial, intermediate, and final stages of the development respectively: no change, coarticulation with final vowel reduction, and final vowel loss. Finally, Northern Paman languages and Nganyaywana show historical evidence of compensatory CV metathesis, though synchronic alternations are absent.

Our prosodically based account is supported by the fact that exceptional accent on final vowels blocks metathesis in Kwara'ae and Rotuman. Our coarticulatory account is most strongly supported by the Kwara'ae data, where coarticulation with final vowel devoicing is found, and finds secondary support in the dialectal variants of Nyungar. Loss of final vowels in Kwara'ae is not yet complete, and is determined by vowel quality as well as muting effects of preceding consonants; similarly, in Nyungar, the reduction of final vowels in southwestern dialects has progressed to loss in southern dialects.

Compensatory CV metathesis appears to have occurred independently in at least three Austronesian languages, and in three Pama-Nyungan languages. This distribution is unsurprising on our analysis. Within both Austronesian and Pama-Nyungan, the requisite prosodic contours are found, vowel systems are small, diphthongs are for the most part absent, and secondary consonantal articulations are relatively uncommon.

On our account, compensatory metathesis is a gradual development whereby the articulation of a vowel shifts temporally from a weak peripheral position to an adjacent tonic position. We have distinguished three discrete parameters of this gradual sound change: extreme coarticulation or vowel copy; peripheral vowel reduction; and peripheral vowel loss. But these are interconnected changes under our account, all aspects of articulatory migration.

An important general point emerging from our survey is that contrary to the usual view, CV metathesis is just as natural phonetically as other phonological processes. Its segment-transposing effects are phonologically abrupt, but it originates in a very familiar way: an automatic phonetic effect is reinterpreted as phonologically intended or significant. Such reinterpretations often result in segments undergoing some change (including loss). The change in the case of metathesis involves segment transposition, but its underlying phonetic causes are prosaic.

Given this account, an obvious question arises: how should CV metathesis be analyzed synchronically? This depends partly on the type of metathesis. The one-step change involved in perceptual CV metathesis lends itself to phonological analyses whereby multiply linked features (aspiration, glottalization, rhoticization) are linearized via delinking. As discussed in §2.4, we do not attribute the linearization of the feature to phonetic markedness constraints directly, but we do believe that fine aspects of the acoustic signal can determine the contexts in which perceptual metathesis occurs.

Compensatory metatheses and pseudometatheses are more problematic. In particular, recent synchronic analyses of Rotuman and Leti raise at least three difficulties for modern phonological theories. One is the necessary introduction of parochial constraints in an optimality theory framework where constraints are claimed to be universal and phonetically natural. For instance, Hume's analysis of Leti posits a constraint '*V: the final vowel of a morpheme in the input may not occur in an open syllable in the output' (1997:75). She comments that

> The formulation of *V is admittedly awkward. While it correctly captures the generalization, formalizing it in terms of Optimality Theory is not straightforward. For example, while *V appears to be a type of anti-alignment constraint, it is unclear how to refer to the final vowel of the input, i.e., the entity that cannot be aligned with a syllable edge. The problem stems from the fact that the vowel need not be morpheme-final, but only the rightmost vowel of the input. In addition, to the best of my knowledge, Optimality Theory does not yet provide a straightforward means of forcing apocope, a problem also recognized in Prince & Smolensky 1993 in their analysis of apocope in Lardil (1997:98 n.8).

To add to the problem, Hume proposes a conflicting constraint: 'Align the right edge of a phrase with a vowel' (1997: 89). The phonological grounding of this constraint and *V is unclear, and Hume treats them as 'morphologically-driven syllable structure constraints' (1997:89).

A second problem stems from certain representational attempts to eliminate metathesis rules of the form AB → BA from the grammar. Following McCarthy (1989), van der Hulst and van Engelenhoven (1995) have proposed that consonants and vowels are underlyingly unordered in Rotuman and Leti. But the phonotactics of these languages require linear order between consonants and vowels, since syllable structure is not uniform. In particular, Rotuman and Leti both have vowel-initial words and medial onsetless syllables, and Leti has word-initial consonant clusters: cf. e.g. Rotuman *aso* 'to kiss' vs. *sao* 'to grasp . . .', or Leti *ami* 'we (excl.)' vs. *mai* 'to come'.

A third problem is the level of abstractness of representations proposed. In their government phonology account of Leti metathesis, van der Hulst and van Engelenhoven

(1995) suggest that all words undergoing CV metathesis have an underlying /CVCVCV/ template. One problem is that the CVCVCV template is never satisfied. Furthermore, it is claimed that CVCvCV occurs phrase finally, while CVCVCv occurs phrase medially ('v' is an empty nucleus.) However, apart from the metathesis alternations themselves, there is little synchronic evidence for empty V-slots in words like *ulitV/ulVti* 'skin'. To some extent these templates reify the historical analysis we propose, but at the cost of assuming synchronically underlying trisyllabic templates. The more general point is that while the synchronic properties of compensatory metatheses and pseudometatheses raise a series of problems, our diachronic analyses give natural explanations of these properties.

In principle our account does have points of contact with optimality theory analyses of synchronic metathesis alternations. Such contact may conceal a major conceptual difference, however, one we would like to discuss explicitly. An apparent virtue of some optimality theory analyses is that they combine the traditional phonotactic optimization approach to metathesis with the results of experimental phonetic research. These may be the same as results we rely on in our account. Yet if the two approaches invoke the same explanatory device, how do they differ?

A hypothetical concrete example will answer this question very clearly. Suppose a language undergoes a metathesis whereby *CVh > ChV (a simplified version of the Cayuga and Cherokee metatheses). In an optimality theory analysis, such a change might be attributed to a constraint against Vh sequences. If this is more highly ranked than constraints that preserve underlying linear order, metathesis will be the result. The crucial constraint might be motivated by the phonetic fact that [h] is harder to hear in [CVh] contexts than in [ChV] contexts. Perceptual optimization is thus the cause of metathesis: a change happens because the resulting sequence is easier to hear.

Our analysis of this hypothetical example might invoke the same phonetic fact, but with an entirely different explanatory connection to the laryngeal metathesis. In our view, sound changes result from misinterpretation: X changes to Y when X is misinterpreted—and phonologically internalized, and therefore later produced—as Y. The cause of misinterpretation is perceptual similarity (which may itself have articulatory or other causes). Given this view, the cause of the *CVh > ChV change is that the phonetic output of /CVh/ was misinterpreted as the phonetic output of /ChV/. The similarity underlying this misinterpretation has two causes in turn. One is the stretched out quality of the laryngeal, and the other is the fact that [h] is harder to hear in [CVh] contexts than in [ChV] contexts. Because postvocalic [h] is relatively hard to hear, it is sometimes not heard (or perceived). This can result either in /h/ loss or in resegmentation of aspiration in prevocalic position; in the second case, metathesis has occurred.

In sum, our account and the optimization account both contend that some changes occur because their input is relatively hard to hear. But the optimization account treats perceptual ease as the GOAL of the change, requiring that language learners have some knowledge of the relative perceptual ease of sound patterns (e.g. in the form of optimality theory constraints). This need not be assumed in our account. We assume only that what is hard to perceive is sometimes not perceived, and that misperception leads to misinterpretation and change—assumptions which are independently needed (unless language learning is uniquely error-free among human activities). Our account thus offers a more economical model of phonological diachrony than the phonetic optimization approach. It invokes perceptual ease only once, whereas the optimization approach

assumes that perceptual ease plays a role not only in perception (where its relevance is undeniable) but also in grammatical knowledge. The simpler approach may be preferable a priori to one which complicates the grammar.

Synchronic metathesis continues to resist a unified and constrained theoretical account. In this study we hope to have illuminated the diverse historical origins of CV metathesis. For each type of metathesis, we have suggested phonetically natural and plausible sound changes which are independently evidenced in numerous languages. We hope that future work in phonetic and phonological theory will lead to a synthesis of empirically motivated synchronic analyses with the diachronic explanations proposed here.

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Juliette Blevins
Centre for Linguistics
University of Western Australia
Nedlands, WA 6009
Australia
[juliette@cyllene.uwa.edu.au]

Andrew Garrett
Department of Linguistics
1203 Dwinelle Hall
University of California
Berkeley, CA 94720
[garrett@socrates.berkeley.edu]

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