

Diachronic evidence for the synchronic grammar: The case of long-distance liquid metathesis

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Abstract

Recurrent sound patterns in the synchronic phonological typology often find analogs in diachronic development, and thus any account of this typology must include a set of explanatory principles to account for their existence over others in both domains. While most accounts acknowledge the importance of substantive phonetic factors such as articulatory ease and perceptual robustness, there is disagreement in the literature concerning whether these biases are due directly to aspects of speech production/perception or whether they are encoded abstractly in the mental grammar. Here I argue on the basis of a particular diachronic phenomenon, long-distance liquid metathesis in South Italian Greek, Gascon, and Sardinian, that a grammatical bias encoding (i) a desire for the enhancement of prominent positions and (ii) knowledge of perceptual similarity is crucial in explaining the nature of the sound change and its actuation. An analysis incorporating these biases is compared to two alternative, non-teleological accounts of actuation that have been proposed to explain the phenomenon: innocent misperception and the phonologization of motor planning errors. It is found that neither of these approaches alone adequately account for all aspects of the data. I suggest that while misperception events and motor planning errors are likely sources of innovative variants that may give rise to the sound change, selection among these variants ultimately relies on grammatical analysis.

Keywords: Analytic bias, metathesis, phonologization, similarity

1. Introduction

A fundamental problem in the analysis of sound changes and their synchronic outcomes is that only a subset of logically possible phenomena is attested (Weinreich et al. 1968). For example, palatalization of [k] to [tʃ] before high front vowels is widely observed as a diachronic change, but the reverse operation, i.e., de-palatalization of [tʃ] to [k] in the same environment, is not attested (Garrett and Johnson 2013). Palatalization of this sort is also widespread in the synchronic phonologies of many languages, both in terms of phonotactic restrictions such that [tʃ] is found to the exclusion of [k] before high front vowels, and also by way of alternations at morpheme boundaries where this restriction may be productively extended. Any explanatory account of this sort of asymmetry must identify a set of principles that can derive these facts and others like them. Many such accounts typically frame their explanations, either explicitly or implicitly, in terms of the model of sound change in (1).

- (1) Components of the model of sound change
 - a. External factors
 - b. Translation
 - c. Grammaticalization

The first component, ‘external factors,’ typically refers to aspects of speech production or perception that are not regulated by a speaker’s core phonological competence, e.g., articulatory or perceptual biases, motor planning errors, etc. The ‘translation’ component of the model is

responsible for interpreting these external factors into a format consistent with that of linguistic knowledge – this is how, for example, coarticulation between [k] and a following [i] might come to be interpreted phonologically as the sequence /tʃi/. In ‘grammaticalization,’ the work of the translation component may ultimately become solidified as a feature of one’s linguistic competence, meaning that the translated version of a particular external factor may be elevated to represent a fact about the language generally – continuing with the example from above, the consequence in this case would be a grammatically regulated process of velar palatalization. The general scenario just described is what Hyman (1976) terms *phonologization*.

The existence of all three of these components is uncontroversial. For example, the non-existence of vowels that are simultaneously [+high] and [+low] is easily explained by the fact that the vocal apparatus cannot physically achieve such an articulation, and this likely has little to do with translation or grammaticalization. The translation component is similarly indispensable: the physical correlates of speech (e.g., variations in air pressure) are not the same as their mental representation, and thus some mechanism must intervene between the two. Finally, every modern school of thought in linguistics recognizes that speakers possess detailed knowledge of their language and its use, so some version of a grammaticalization component must be posited to organize and deploy this knowledge.

While all explanations for typological asymmetries may acknowledge the basic elements of the model in (1), they typically diverge depending on how the factors responsible for a given asymmetry are distributed among them. Returning to the velar palatalization example, a significant portion of the explanation for this phenomenon may be attributed to external factors: because the tongue dorsum anticipates a following front vowel, the point of lingual-palatal contact will be more anterior than if a back vowel were anticipated, so a [k] preceding [i] is already closer to [tʃ] than a [k] preceding [u] (Keating and Lahiri 1993; Recasens and Espinosa 2009). Similarly, Guion (1998) provides evidence that [k] and [tʃ] are more easily confused when preceding a front vowel as opposed to a back vowel, perhaps as a consequence of the fact that [k] and [tʃ] are acoustically more similar in the former context. It is conceivable that these factors alone are responsible for a typological asymmetry: if a listener confuses [tʃ] for [k] they could decide that [tʃ] was actually intended by the speaker and adjust their knowledge accordingly – this is what Ohala (1981, 1993) calls *innocent misperception*. If this happens more often before high front vowels than low back vowels, then an asymmetry will ultimately be encoded in the synchronic grammar. In this case the bulk of the work rests with the translation component, while the grammaticalization component has relatively little to do since the direct outcome of a confusability event is reflected as knowledge in a speaker’s grammar. This sort of explanation has been notably pursued within the Evolutionary Phonology program (Blevins 2004, 2006; Blevins and Garrett 1998, 2004; see also Ohala 1981, 1983, 1993; Hyman 2001), where the general proposal is that typological regularities can be explained with reference to external factors and the translation component alone.

An alternative possibility is that a speaker’s grammar actively imposes constraints that reflect the undesirability of [k] in the environment of high front vowels, and thus palatalization to [tʃ] may occur as a sound change for precisely this reason. In marked contrast to the explanation for palatalization discussed above, the grammaticalization component now generally has the responsibility of selecting among results of the translation component only when they would conform to the well-formedness conditions imposed by the grammar (Kiparsky 1988, 1995; Lindblom et al. 1995; see also deLacy and Kingston 2013). If the grammar does not expressly forbid the occurrence of [k] before low back vowels (or places relatively less importance on such

a constraint), then the typological asymmetry is derived as palatalization is more likely to occur only before high front vowels. Proponents of this general approach may argue for it on conceptual grounds, citing the fact that language change is necessarily filtered through individuals with existing knowledge of grammatical well-formedness (Joseph and Janda 1988; see also Moreton 2008; Weinreich et al. 1968 for discussion; cf. Blevins 2007:152ff), or it may be argued that some aspects of language change cannot be fully understood without an intervening grammar to encode well-formedness. Kiparsky (1995, 2006) takes up this latter point by noting that a series of sound changes could possibly conspire to subvert so-called grammatical universals (e.g., implicational laws), yet this never seems to occur.

It is also possible to maintain that the grammar might play an active role in sound change while acknowledging the importance of the phonetic factors relied on by approaches such as Evolutionary Phonology. This is often accompanied by the claim that the consequences of the speech production and perception mechanisms are recast as *knowledge* of those consequences in the synchronic grammar. Under this line of reasoning, the existence of a synchronic constraint disfavoring [k] before high front vowels is not arbitrarily stipulated: speakers implicitly know that [k] and [tʃ] are more confusable in this environment than in others and allow the contrast to be neutralized here because of this fact (Steriade 2001). This is the general position taken by proponents of Phonetically Based Phonology (Hayes, Kirchner and Steriade 2004; Hayes and Steriade 2004; Wilson 2006; Zuraw 2007a, b), which holds that the constraints active in a speaker's synchronic phonological grammar are shaped by phonetic factors such as articulatory ease and perceptual similarity.

Deciding among these alternative approaches to sound change has proven difficult because the outcomes they predict are largely the same, meaning that arguing for one approach over another on the basis of the synchronic typology alone is not feasible (Zuraw 2007). Recognition of this fact has led to a variety of methodologically distinct research programs for each of the options considered above. Models of sound change that place a large burden on the external factors and translation components derive their evidence from general facts about the speech production/perception mechanisms and their possible role in particular instances of sound change (e.g., Ohala 1981, 1983; Blevins 2004; Garrett and Johnson 2013). Approaches relying on synchronic knowledge of these external factors have generally utilized novel methods of investigation by showing that, for example, in experimental settings speakers prefer phonetically natural patterns or operations in language games, (Wilson 2006; Zuraw 2007a, b), or that certain paraphonological phenomena such as literary invention seem to rely on this sort of knowledge, here perceptual similarity (Steriade 2003; Fleischhacker 2005; Kawahara 2007). In any case, the general strategy for the latter researchers is to show that putative instances of phonetic knowledge cannot reasonably be due to language transmission.

With respect to the methodologies described above, the present study takes a different approach by evaluating the role of grammatical knowledge, including knowledge of substantive phonetic factors, directly in the domain of sound change. Situating the analysis in this way provides a useful perspective on the issue of explanation in phonology generally. If it is assumed that the role of the grammar is limited to representing the results of misperception events or articulatory biases at face value, then a logical problem of *redundancy* emerges, stated succinctly by Blevins (2004:5): "In all cases where clear diachronic explanations exist for a particular synchronic pattern, this diachronic explanation makes a synchronic account redundant, since the optimal description should not account for the same pattern twice." Importantly, however, the redundancy problem exists only when the domains of synchronic and diachronic explanation are

sharply delineated; if grammatical analysis can be shown to play an active role in diachronic change, then any redundancy between the two modes of explanation can in principle be weakened if not eliminated entirely.

I argue in this article that an adequate understanding of a particular diachronic phenomenon, long-distance liquid metathesis in South Italian Greek, Gascon, and Sardinian, must rely on grammatical bias in addition to external factors. The particular bias argued for encodes two general principles that are both well-motivated on the basis of analyses of comparable synchronic phenomena: *enhancement of prominent positions* (de Lacy 2001; Smith 2005) and *knowledge of perceptual similarity* (Steriade 2001; Zuraw 2007a, b). The analysis is compared with two alternative approaches that do not include such a bias: innocent misperception and the direct phonologization of motor planning errors, both of which attempt to explain the phenomenon with external factors alone. Neither is found to explain all aspects of the sound change because they over-predict the types of long-distance liquid metathesis found in the languages considered, whereas the grammatically biased model of sound change does not. However, it is suggested that external factors do play an important role in introducing innovative variants that may ultimately result in sound change; I argue in particular that motor planning errors (i.e., speech errors) and the outcomes of misperception events may give rise to a pool of variants that are evaluated by the grammar, but only those variants accepted by the grammar are phonologized. A formal model of sound change is developed in which the grammar has the ability to compare these innovative variants with established pronunciations and select only those that are in line with the proposed grammatical biases.

1.1 Outline

This article is organized as follows: in section 2, the data to be analyzed are presented and discussed. Section 3 develops an analysis of long-distance liquid metathesis that incorporates a grammatical bias. Section 4 compares this analysis with alternative explanations for the sound change. Section 5 concludes by identifying some implications of the analysis and a number of residual issues.

2. Data and empirical generalizations

This section introduces data from South Italian Greek, Gascon, and Sardinian, three languages that have undergone a diachronic process of long-distance liquid metathesis. The generalizations relevant to the process and additional evidence in support of them are presented in section 2.2. Finally, section 2.3 discusses some empirical issues that must be resolved before an adequate analysis of the data can proceed.

2.1 Data

The first language considered in this study that displays diachronic long-distance liquid metathesis is South Italian Greek, a name for the Bova and Otrano dialects of Modern Greek spoken in the Salento and Calabria regions of Italy respectively. Representative data for this language come from Rohlfs' (1964) *Lexicon Graecanicum Italiae Inferioris*, an Ancient Greek – South Italian Greek dictionary; some of these data are confirmed in Rohlfs (1950). See also Blevins and Garrett 2004 for discussion.

(2)

	<u>South Italian Greek</u>	<u>Ancient Greek</u>		<u>Target context</u>	<u>Source context</u>
a.	grambó	gambrós	‘son-in-law’	g_a	b_o
	xrondó	k ^h ondrós	‘thick’	x/k ^h _o	d_o
	prástiko	pástrikos	‘clean’	p_a	t_i
	trástina	tágistrón	‘food bag’	t_a	t_o
	krúpana	kópranon	‘dung’	k_u	p_a
	frevári	Lat. februárus	‘February’	f_e	b_u
	plembáci	*biblákion	‘oleander’	p/b_e	b_a
b.	krapisti	kapístrion	‘halter’	k_a	t_i
	plétiko	pédiklon	‘fetter’	p_e	k_o
	klonúka	Lat. konúkula > *konúkla	‘distaff’	k_o	k_a

In the South Italian Greek words, liquids in the initial syllable are found to have arrived there from non-historical positions. The data in (2a) show that liquids moved leftward into the initial syllable when a single syllable nucleus intervened, while (2a) shows that this process could occur when an entire syllable intervenes. Metathesis is seen to occur when only the source and target environments were of the type [obstruent]__[vowel] (T_V). As the negative examples in (3) illustrate, metathesis did not apply when this environmental condition was not met:

(3)

	<u>South Italian Greek</u>	<u>Ancient Greek</u>		<u>Target Context</u>	<u>Source Context</u>
a.	kaló	kalós	‘attractive’	k_a	a_o
	kardía	kardía	‘heart’	k_a	a_d
b.	lutró	lūtrón	‘bath’	l_u	t_o
	métro	métron	‘measure’	m_e	t_o
	áθropo	ánt ^h rōpos	‘man’	#_a	t ^h /θ

(3a) illustrates that metathesis did not occur when the source environment was not of the type T_V, whereas (3b) indicates the same restriction for the target environment. As Blevins and Garrett (2004:131) point out, metathesis would sometimes fail to occur even when the phonotactic prerequisites in the target environment are apparently in place: metathesis involving /l/ was not conditioned when the word began with [tʃ], and neither liquid would metathesize when either the target environment contained an initial [ð] or, in the case of two-syllable metathesis, when another liquid intervened between source and target environments (e.g., *xaráðra* < *k^haráðra* ‘fissure’). The first restriction may be attributed to the fact that initial [tʃ] + [l] clusters are phonotactically illegal in South Italian Greek (these clusters are not in Rohlfs’ *Lexicon*), but the other two cases cannot be explained this way: initial [ðr] clusters are found as inheritances from Ancient Greek [dr] (e.g., *ðráco* < *drácōn* ‘dragon’), and instances of two liquids flanking a vowel are found as well (e.g., *pleráto* ‘ripe’), which in all cases would be the outcome of metathesis over an intervening liquid.

Long-distance liquid metathesis is also found in Gascon, a dialect of Occitan spoken in the Gascony region of France.¹ My sources on this language are Grammont 1905-06, Rohlfs 1935, and Duménil 1983, 1987, see also Blevins and Garrett 1998 and Mielke and Hume 2001 for discussion. The data in (4) show a general pattern identical to that of South Italian Greek: liquids metathesize to the initial syllable's onset when the source and target environments are of the type T_V.

(4)

	<u>Gascon</u>	<u>Latin</u>		<u>Source</u>	<u>Target</u>
				<u>Context</u>	<u>Context</u>
a.	trénde	ténerum > *téndro	'tender'	d_o	t_e
	krábo	kápra	'goat'	p_a	k_a
	trúho	*túfera > *túfra	'potato'	f_a	t_u
	klóske	kúskoliu > *kúskliu	'shell'	k_i	k_o
	práwbe	páwpereum > *páwpru	'poor'	p_u	p_a
	eskrumba	*ekskombrá:re	'sweep'	b_a	k_u
	esplíngo	*spíngla	'needle'	g_a	p_i
	blóka	búkkula > *búkla	'mouth'	k_a	b_u/o
	brembá	memorá:re > *bembrás	'to remember'	b_a	b_e
	brespálh	*wesperá:kulum > *bespráklu	'evening snack'	p_a	b_e
b.	hriéste	fenéstra > *frenésta	'window'	t_a	f_e
	krabéste	kapístru	'head'	t_r	k_a
	hlorónc	furúnkulu > *furúnklu	'abscess'	k_u	f_u

As indicated in many cases, metathesis occurred only after vowel syncope in the environment T_L; this either created an obstruent + liquid cluster or a nasal + liquid cluster, the latter of which was later resolved by stop excrescence (e.g. *kámara* > **kámra* > **kambra*). There are three types of source environment where metathesis from post-obstruent position was permitted, as identified by Duménil (1983): the intervocalic environment (i.e., VTLV), clusters preceded by /s/, and clusters preceded by a nasal.² Metathesis was limited to occurring only from these source environments. As in South Italian Greek, the target environment also required an obstruent to support a metathetic liquid.

The final language displaying long-distance metathesis considered in this study is the Nuorese dialect of Sardinian (Wagner 1957-58; Geisler 1994). The data indicate that rhotics metathesized over long distances as in South Italian Greek and Gascon.³

¹ This language is called “Bagnères-de-Luchon French” by Grammont (1905-06) and “Luchonnaise Gascon” by Blevins and Garrett (2004).

² Metathesis did not occur from intervocalic coronal + /r/ clusters as these were subject to a neutralization process that obscured the source environment for would-be metatheses (Duménil 1983:36): *patrínus* > *payri* ‘godfather,’ *cádere* > **cadre* > **caye* > *cay* ‘to fall.’ An /s/ or nasal preceding coronal clusters blocked neutralization and metathesis was therefore conditioned, e.g., *fenéstra* > **frenésta* > *hriéste* ‘window.’

³ Prior to this sound change, Latin /l/ changed to /r/ in all environments except word-initially and occasionally intervocalically.

(5)

	<u>Sardinian</u>	<u>Latin</u>		<u>Source</u> <u>Context</u>	<u>Target</u> <u>Context</u>
a.	krápa	kápra	‘goat’	p_a	k_a
	krínga	kíngula > *kingla	‘public’	g_a	k_i
	bríðu	víttru	‘glass’	t_u	b/v_i
	bróstu	*vóstru	‘your.PL’	t_u	b_o
	krónta	kóntra	‘opposed’	t_a	k_o
	ispríku	*spíkulu > *spíklu	‘stab’	k_u	p_i
	fraþíle	fábrum	‘workman’	b_u	f_a
b.	krapístu	kapístrum	‘halter’	t_u	k_a
	prannúka	panúkulu > *panúklu	‘ear of grain’	k_u	p_a
	krapíku	kapítulum > *kapítrum	‘capitulum’	t_u	k_a

As in South Italian Greek and Gascon, liquids metathesized into the onset of the initial syllable, in some cases skipping two syllables to arrive there. Similar to Gascon, a process of vowel syncope occurred as well, and metathesis seems to have occurred only after this sound change had taken place. These data are also in line with the generalization that metathesis must occur from and into the environment T_V.

2.2 Generalizations

As already highlighted, there are two main generalizations that hold for the metathesis process in the languages considered above, both made explicit by Blevins and Garrett (2004) on South Italian Greek. The first is what I call the Directionality/Prominence generalization. This means that metathesis proceeds only right-to-left and into the leftmost syllable, which I consider a prominent position (see for example Beckman 1998; Barnes 2006); the status of the left edge of the word as a prominent position and its relation to metathesis will be discussed further in section 3).⁴ This is illustrated schematically below.

- (6) a. CVCVCLV > CLVCVCV b.

CVCV <u>CL</u> V > *CV <u>CL</u> V <u>CV</u>
<u>CL</u> VCV <u>CV</u> > *CV <u>CL</u> V <u>CV</u>

(6a) indicates that liquids only metathesized from word medial positions and into the leftmost syllable, while (6b) indicates that liquids were not transposed into medial (or final) syllables, either from the right or the left.

The second generalization, noted for each language in the data presentation, is what I call Cluster Maintenance. Metathesis was conditioned only when both source and target environments were of the type [obstruent]__[vowel] (T_V):

⁴ One set of possible exceptions to this generalization is that of words such as Gascon *esplingo* < Lat. **spíngla*, where the modern form displays a metathetic liquid in a non-initial syllable. These words also underwent a process of vowel prothesis at some point in their history, so these metatheses could have targeted the initial syllable with prothesis occurring at a later time.

- (7) a. TV ... TLV > TLV ... TV b.

nVCVTLV	>	*nLVCVTV
TVCVLV	>	*TLVCVV
VCVTLV	>	*LVCVTV
etc.		

(a) represents the fact that there must be identity between source and target environments for metathesis to occur, while (b) gives a few examples of the transpositions that do not occur when this identity is not present.

The diachronic dimension associated with these data provides additional evidence in support of the Cluster Maintenance generalization along the following lines: if a historical form of a word does not contain one of the environments necessary for metathesis to occur, but a later sound change creates such an environment, we can observe a preference for particular source or target environments on the basis of whether the later form conditioned metathesis. For example, in both Gascon and Sardinian, a prior process of vowel syncope fed some instances of metathesis: Gasc. *kompará:re* > **kompráre* > *kromba* ‘to buy,’ Sard. *panúkulu* > **panúklu* > *prannúka* ‘ear of grain.’ We may take the fact that metathesis occurred after syncope but not before as a preference for T_V over V_V as a source environment. Similarly, this same process of syncope in Gascon sometimes created nasal + liquid clusters (e.g., *ténerum* > **ténro*), but metathesis occurred only after stop excrescence: **ténro* > **téndro* > *trénde* ‘tender.’ Again in Gascon, initial /m/ > /b/ fortition would condition metathesis, but not in forms where this change did not occur: *miscláre* > **miscláre* > *mesclá* ‘to mix’ vs. *memorá:re* > **membrá:re* > *brembá* ‘remember.’

As indicated above, metathesis did not occur when the prerequisites required by the Directionality/Prominence generalization and the Cluster Maintenance generalization were not met. Below are some concrete illustrations of this fact, repeated from sections above (“*” = logically possible but unattested result):⁵

			<u>Comment</u>
kainorgós	>	kinurgo	‘new’ (SIG) /r/ in source C ₁ position
*miscláre	>	mesclá	‘to mix’ (Gasc.) non-obstruent in target environment
támaros	>	támaru	‘tamarisk’ (SIG) intervocalic /r/ in source position
*espinglo	>	*lespingo	‘pin’ (Gasc.) word-initial target /l/
kapistrum	>	*karpistu	‘halter’ (Sard.) /r/ in target C ₁ position
kapistrum	>	*karpistu	‘halter’ (Sard.) /r/ metathesis to word-medial position

The failure of some metatheses may be attributed to the fact that their results would have created phonotactically illegal clusters (e.g., SIG *métron* > **mréton*; **mr/#_*), but not all can be explained this way. In South Italian Greek, for example, metathesis was blocked when the outcome would be an initial [ðr] cluster, despite the fact that these are nonetheless attested in the language as inheritances from Ancient Greek (e.g., *draco:n* > *ðrakon* ‘dragon’; cf. *dakri* > *ðakri* ‘tear’; Blevins and Garrett 2004). Along with the restrictions on particular cluster types in the target environment, there are legal positions for the liquid to occupy that intervene between its

⁵ SIG = South Italian Greek; Gasc. = Gascon; Sard. = Sardinian.

historical location and its modern position in the initial syllable: the /r/ in Pre-Sardinian **kapítrum* ‘capitulum,’ for example, could legally occur in any position between its attested location in *krapiku* and its historical source, but the outcome of metathesis was only an /r/ in the initial syllable’s onset. Based on these facts we must conclude that long-distance metathesis was subject to a similar but non-identical set of conditions that govern the overall well-formedness of phonotactic patterns in the language.

Before moving on, it should be noted that from a cross-linguistic perspective there are reports of long-distance liquid metathesis that are not in line with one or both of the generalizations presented above. For example, in sound changes from Latin to certain varieties of Popular Spanish, some apparently long-distance metatheses show rightward movement (Lipski 1990), and Judeo Spanish in particular displays leftward long-distance metathesis that seems to have been limited to a single intervening syllable, e.g., *catedral* > *catredal* ‘cathedral,’ even though the obstruent in the initial syllable could have supported a metathetic liquid (Lipski 1990; Bradley 2007). This restriction is reported to have been active in a diachronic metathesis process from Latin to Algerese Catalan as well (Torres-Tamarit et al. 2012). While an explicit analysis of the differences between these languages and those analyzed here is beyond the scope of this paper, it is worth noting that one feature distinguishing the two groups is the presence of local CV or CC metatheses: local metatheses were pervasive in the histories of Popular Spanish and Algerese Catalan, whereas in the development of South Italian Greek, Gascon, and Sardinian, local metathesis seems to have been rare or non-existent.⁶ Below I demonstrate on the basis of dialectal differences in Sardinian how the presence of local metathesis may lead to apparently exceptional long-distance metathesis types.

2.3 The nature of long distance metathesis

This section addresses two empirical issues with the data that must be resolved before an adequate analysis of long-distance metathesis may proceed. The first issue concerns reports of long-distance metathesis that seem not to be in line with the Cluster Maintenance generalization in the Campidanian dialect of Sardinian. The second issue addressed is the question of whether long-distance metathesis took place as a series of successive local CC and CV metatheses or instead was instantiated as a single, fell-swoop transposition of the liquid from its historical position to its modern position in the onset of the initial syllable.

2.3.1 The cluster maintenance generalization in Sardinian

There appear to be some counterexamples to the generalization that metathesis took place exclusively from the environment T_V. Long-distance metathesis is well documented in the Sardinian dialect of Campidanian along with the Nuorese dialect presented above, but here a number of correspondences seem to indicate that liquids could metathesize from pre-obstruent positions, contradicting the Cluster Maintenance generalization (examples from Frigeni 2009:144ff):

⁶ There are no instances of local metathesis in the Nuorese dialect of Sardinian, but in Gascon, leftward VC metathesis is reported to occur by Grammont (1905-06) when a coda rhotic preceded a prevocalic /s/, /m/, /w/, or /b/ derived from historical /v/; most examples of long-distance metathesis provided above could not have been subject to this process since these environments are not present. Finally, South Italian Greek displays sporadic instances of VC metathesis, but these occur only rarely.

(9)

<u>Etymological comparison</u>	<u>Campidanian</u>	
Latin <i>kōpertura</i>	kroβettura	‘roof’
Italian <i>governo</i>	gruvennu	‘government’
Italian <i>divertimento</i>	drivetimentu	‘fun, entertainment’
Old Sardinian <i>akusorgu</i>	skruzo3u	‘hidden treasure’

Since there are no reports to my knowledge of this sort of long-distance metathesis occurring in the Nuorese dialect, before deciding that the Cluster Maintenance generalization does not hold for Sardinian, we should first determine whether other differences between the two dialects may have contributed to this situation. I suggest that such a difference does exist, based on the differential treatment of liquids in the historical syllable coda:

(10)

	<u>Campidanian</u>	<u>Latin</u>	
a.	práma	pálma	‘palm’
	krattfjina	kalkina	‘lime’
	prappái	palpáre	‘to touch’
b.	prókku	pórkus	‘pig, pork’
	drómme	dórmire	‘to sleep’
	kruβái	curváre	‘to bend’

The data in (10a) show that in Campidanian, Latin coda /l/ is not tolerated and resolved via local CV metathesis, and in (b) we see that Latin /r/ is subject to the same process; that both sounds seem to have undergone this sound change may be a result of the fact that the change of /l/ to /r/ took place prior to metathesis. Importantly, however, this markedness affecting liquids in coda position is not reflected in the Nuorese dialect (data from Geisler 1994):

(11)

<u>Nuorese</u>	<u>Campidanian</u>	<u>Latin</u>	
fárke	frákke	falke	‘face’
dúrke	druttjì	dulke	‘sweet’
karkitare	krakkiðare	kalkitarte	‘kick’
parma	prama	palma	‘palm’

Coda /r/ is tolerated in the Nuorese words above: they are left in place rather than metathesized to the syllable onset as in Campidanian. These facts may be taken to imply a degree of opacity in the development of some modern Campidanian forms: the exceptional behavior demonstrated in (9) could be explained if we posit that *two* discrete metatheses took place, one local CV metathesis (*kōpertura* > **kōprettura*) followed by a long-distance metathesis of the sort that is in line with the Cluster Maintenance generalization yielding *kroβettura* ‘roof.’ Both of these metathesis types have been documented for Campidanian, but the Nuorese dialect does not display local CV or CC metathesis, and its long-distance metatheses are in line with the Cluster Maintenance generalization. While it is difficult to say for certain whether this series of events

actually took place, I argue that based on the general treatment of coda liquids in Campidanian coupled with the dialect's exceptional metathesis types, the analysis just presented is justified.

2.3.2 Successive vs. fell-swoop metatheses

Difficulties such as those discussed above are not limited to the Sardinian facts, especially when the precise nature of long-distance metathesis is under question. To illustrate, consider Gascon *krábo* < Lat. *kápro* 'goat.' While we can be relatively certain that the sound change was metathesis (and not, for example, separate events of liquid deletion followed by insertion), multiple events in the course of *krábo*'s history could have conspired to yield what we interpret here as long-distance metathesis: the change may have consisted of two discrete local transpositions (e.g., *kápro* > **kárpo* > *krábo*), or a form with an intermediate local metathesis (**karpō*) could have been borrowed from another dialect with CV metathesis subsequently completed by speakers of Gascon to yield *krábo*, etc. The successive local metatheses position is taken explicitly by Mielke and Hume (2001), who consider the Gascon data and note that two geographically related dialects of French, Le Havre and Jersey, show CV and CC metathesis respectively involving rhotics.⁷

Lacking a complete historical record, we cannot definitively rule out the possibility that some metatheses may have resulted from one of the scenarios described above, but a number of general empirical arguments can be made for an analysis of long-distance metathesis as a single, fell-swoop process and not one of successive iterations of local metatheses. Establishing this point is important because it provides a better understanding of the phenomenon that will in turn shape the analyses under comparison in later sections.

First, if long-distance metathesis had been comprised of successive operations on the way to the initial position, this process would have sometimes created phonotactically ill-formed clusters. Similar to Campidanian Sardinian, Gascon does not allow historical /l/ in coda position, where it was labialized to /u/ (Rohlf's 1935:106, 109): *alterum* > *aute* 'other,' *galbanum* > *gáubi* 'yellow,' *kalkea* > *káusso* 'women's stockings.' Given this phonotactic restriction on /l/, it is necessary to ask whether a form like *blóka* 'mouth' could have been derived via successive metatheses. If we assume that labialization took place prior to metathesis, a coda /l/ must have been created in this process: *bukkula* > **bukla* > **bulka* > *bloka*. In this situation the language would have created a phonotactically illegal cluster *and* maintained it long enough for another iteration of metathesis, at no point resolving it via /l/ labialization as in the examples above.⁸ The best option here seems to be the interpretation of metathesis as a one-step process where such problems are not an issue.

Second, it is unclear how successive metatheses involving triconsonantal clusters would proceed, e.g. SIG *gambrós* > *grambó* 'son-in-law.' The options here are either of the following: *gambrós* > *gamrbós* or *gambrós* > *garmbós*, depending on whether the /r/ skips a single segment

⁷ Mielke and Hume (2001:12) refer to Le Havre and Jersey as "other varieties of French." They may have been misled by Grammont's (1905-06) labeling of Gascon as Bagnères-de-Luchon French. This is not quite accurate as Gascon is in fact a dialect of Occitan, calling into question the supposed relatedness of Gascon to Le Havre and Jersey French.

⁸ In addition to this fact, there are no documented cases of local metathesis involving /l/.

or the entire cluster.⁹ This same situation is an issue for both Gascon and Sardinian as well, where source environments for metathesis include both sTL and nasal + TL clusters. In addition to these specific situations, a fairly extensive cross-linguistic search of local CC metathesis patterns involving all segment types returned no support for this type of reordering of elements in a triconsonantal cluster.¹⁰ The successive metatheses position seems untenable when this would necessarily rely on a metathesis type that is to my knowledge unattested.

Third, there are the occasional cases in which two versions of the same lexical item are simultaneously attested in the source material, one displaying metathesis and the other not (e.g. Sard. *kingla* > *krínga*, *kíngra* ‘girdle,’ CG *gambrós* > SIG *grambó*, *gambró* ‘brother-in-law’). Although the authors reporting these metatheses do not precisely state what is meant by the inclusion of two forms (e.g., whether they are variants given by a single speaker or multiple speakers, etc.), the implication is important: in every case where two variants of a lexical item are reported, metathesis has either not taken place, or if it has, it is in line with the Directionality/Prominence and Cluster Maintenance generalizations. If long-distance metathesis were really a process of successive local metatheses, we might expect to find pairs with one item displaying an intermediate metathesis (e.g., *gambrós*, *garmbós*), but no such pair is reported. Given that the variant pairs were recorded at the same period of time, the most straightforward explanation is that metathesis was a one-step, long-distance process, and it has simply applied in one case and not in another when two versions of a lexical item are reported.

The strongest argument for metathesis as a single long-distance operation is based on what may be described as “look-ahead”: long-distance metathesis is all-or-nothing, meaning that if the phonotactic prerequisites at the target environment are unmet, *no* metathesis occurs, long-distance or otherwise. Consider the case of South Italian Greek *dákryon* > *ðakri* ‘tear.’ There are two possible (leftward) local metatheses here: *dákryon* > *ðarki* followed by *ðarki* > *ðraki*, which I call metathesis A and metathesis B respectively. As noted above, long-distance metathesis did not occur here because it would create an initial *ðr* cluster, despite the fact that these are phonotactically legal. Even if this markedness was known to a generation South Italian Greek speakers, this should not have influenced their choice to initiate metathesis A because an *ðr* cluster would not result; on the other hand, failure of metathesis B makes more sense as this would have created a marked structure. But metathesis B would rely on successful completion of A, and we know that A never occurred (e.g. *dákryon* > **darki*). The best explanation here is that long-distance metathesis in South Italian Greek is a one-step process.¹¹ This argument can

⁹ Neither of these resulting medial sequences (/mrb/, /rmb/) are attested in Liddell and Scott’s (1940) *Greek-English Lexicon*, so here the problem of triconsonantal metathesis also involves the creation of an illegal cluster as discussed above.

¹⁰ Sources included Elizabeth Hume’s metathesis database (located at <http://www.ling.ohio-state.edu/~ehume/metathesis/>) and several cross-linguistic studies of metathesis (Ultan 1979; Wanner 1989; Blevins and Garrett 1998, 2004; Hume 2004). One instance of local metathesis affecting a triconsonantal cluster is found in a sound change from Old English to Late West Saxon (various sources cited in Blevins and Garrett 2004:139): *muskle* > *muksle* ‘mussel,’ but none were found involving a segment at the edge of a cluster skipping the other two, e.g. *xyz* > *zxy*.

¹¹ Another option is that Metathesis A occurred and later reversed: *dákryon* > **dárki* > *ðakri*. This seems unlikely as I am unaware of any cases of rightward metathesis in South Italian Greek,

be generalized to all languages displaying the phenomenon, regardless of specific conditions on the target environment. If an incompatible environment was present at the beginning of the word, no metathesis occurred, even if a local leftward metathesis was possible.

2.4 Summary

This section has introduced data from South Italian Greek, Gascon, and Sardinian and presented the generalizations emerging from them, namely that long-distance metathesis proceeded exclusively right-to-left and into the onset of the initial syllable (Directionality/Prominence), and that metathesis was only conditioned when the liquid could move from and into post-obstruent positions (Cluster Maintenance). Several empirical facts concerning the diachronic dimension associated with the data were discussed, where it was established that (i) processes of local metathesis may give rise to putative instances of long-distance metathesis that are not in line with the proposed generalizations, and that (ii) long-distance metathesis in these languages is best understood as a single, fell-swoop process and not one of iterative successive local metatheses.

3. Analysis

With the empirical facts established I turn my attention to their analysis. The account of long-distance liquid metathesis presented in this section argues that the sound change was actuated with reference to a grammatical bias encoding (i) a desire for the enhancement of prominent positions and (ii) knowledge of perceptual similarity. Sections 3.1 and 3.2 argue that these biases are well-motivated based on certain aspects of the sound change and its comparison to comparable processes in the synchronic domain. Section 3.3 shows how these insights can be formalized in an Optimality-Theoretic grammar (Prince and Smolensky 1993/2004). Finally, Section 3.4 extends the analysis by proposing a model of sound change actuation in which the grammar has the ability to compare variant forms with established pronunciations and select only those that are in line with the biases mentioned above.

3.1 Explaining the Directionality/Prominence generalization

In this section I motivate the claim that the Directionality/Prominence generalization, i.e., the fact that metathesis proceeds only right-to-left and into the initial syllable, results from a grammatical pressure for the enhancement of prominent positions. The prominent domain relevant to long-distance metathesis is the initial syllable, which along with stressed and root-initial syllables is often considered a prominent position due to the exceptional phonological behavior associated with it (Beckman 1998; de Lacy 2001; Smith 2004; Barnes 2006).

Prominence Maximization is a specific type of this exceptionality, which holds that prominent domains must incorporate as much phonological material as possible (Beckman 1998). Since the outcomes of long-distance metathesis serve to bring more segments into a prominent position, the phenomenon can be viewed as an instance of this principle. To my knowledge the full range of facts in support of Prominence Maximization have not received a unified analysis under this heading, so I briefly present one by identifying three general reflexes of it: asymmetric inventory

and we would have to stipulate as well that rightward metathesis occurred in all cases that have an incompatible target environment.

licensing, resizing of prominent domains, and movement of phonological material.¹² Long-distance liquid metathesis is argued to be reflected in all three categories but is a direct consequence of the third.

Asymmetric inventory licensing refers to the fact that in some languages, certain marked segments or combinations of segments are permitted to occur only in specific parts of the word that tend to be prominent. The consequence of such restrictions is that prominent domains host a greater amount of phonological material, whereas other positions in the word host less. In English, for example, the full vowel inventory is licensed only in stressed syllables, whereas vowels are typically neutralized to [ə] in unstressed non-final syllables. Maximization of this sort is found in initial syllables as well. Tamil allows distinctive place of articulation in codas only in the initial syllable; in non-initial syllables nasal place is neutralized to that of the following heterosyllabic consonant (Christdas 1988): *ṭaṇ.bã* ‘teacher’ illustrates the former of these facts, while *ma.rɔṇ.dɔṅ* from underlying /maram+ṭaan/ ‘tree.EMPH’ shows that nasals are neutralized in non-initial syllables. I suggest that because long-distance metathesis moves segments into the initial syllable only, this may be an instantiation of the fact that languages generally prefer to license contrasts in prominent positions over others.

The second reflex of Prominence Maximization noted above involves the resizing of prominent domains so that more material can be included within them. Evidence for such processes involve the syllabic domain and are typically instantiated as violations of the Onset First principle (Kahn 1976) in intervocalic environments, meaning that the outcome of a maximization process is a string parsed CVC.V over the expected CV.CV. Kahn proposes that the non-occurrence of aspirated onset /k/ and /p/ after stressed vowels in English can be explained by assuming that these segments are parsed into the coda of the stressed syllable, a position where aspiration is not licensed (e.g., *bák.it* vs. **bá.kʰit* ‘bucket’)¹³. Along with capturing a phonotactic generalization about English, this analysis also demonstrates that the size of a prominent domain can be increased to incorporate additional segments. Beckman (1998) presents a similar analysis of Ibibio, where a process of closed-syllable vowel laxing is undergone in the initial syllable even when the string is of the type CVCV. If speakers of Ibibio interpret such strings as containing a closed syllable, then it must be the case that the second C has been parsed into the coda of the first syllable. If these are the correct interpretations of the phenomena under question, it suggests that the desire for more material in prominent positions is so great that the positions themselves may expand in order to achieve this goal.

The final and most relevant form of Prominence Maximization is the occurrence of movement into a prominent position, which is in every case an instance of metathesis. Blevins and Garrett (1998) note that in long-distance metathesis generally the participating segment tends to be realized in a position of relative prominence. For example, the stressed syllable as the domain of attraction is illustrated in the process of long-distance pharyngeal movement in Colville (Mattina 1979; Blevins and Garrett 1998, 2004):

¹² Beckman (1998:211 ff) explicitly analyzes prominent domain resizing as a case of Prominence Maximization, but she does not include the other two categories under this heading even though she discusses asymmetric inventory licensing.

¹³ Kahn (1976) technically proposes that these intervocalic segments receive an ambisyllabic parse.

(12)

<u>Base</u>		<u>Suffixed form</u>	
cʰʃan	‘tight’	c-ən-cʰən-cʰən-m-ʃás-əm	‘he keeps his eyes tightly shut’
pʃas	‘scared’	c- <u>ps</u> -ʃáyaʔ	‘senseless’
pʃat	‘boil’	s-ən-pə- <u>pt</u> -ʃálaʔqʷ	‘dumplings’

The pharyngeal /ʃ/ moves from its position in the base (underlined) to a position immediately preceding a stressed (unreduced) vowel but not elsewhere. A similar phenomenon involving stressed syllables is found in Shuswap, another Salish language. Here a suffixal /ʔ/ will move into the root to glottalize a sonorant immediately following a stressed vowel: a root such as *xʷúl* ‘rub fire’ when occurring with the instrumental suffix *-keʔ* surfaces as *xʷúl-ke* ‘fire drill,’ whereas the glottal stop remains in place in words like *xíc-keʔ* ‘scythe’ when the root does not contain a posttonic sonorant (Kuipers 1974; cited in Steriade 1997). I am aware of no other long-distance metathesis types that move segments into the initial syllable exclusively, but I argue that the long-distance liquid metathesis analyzed in this paper is an instance of the type of movement discussed above.

The point of the preceding discussion was to establish that languages may actively prefer the maximization of prominent positions, and that different features of a language may conspire to accomplish such a system. I suggest that long-distance liquid metathesis is a general reflex of Prominence Maximization and a specific instance of phonological movement in service of this goal. I account for Prominence Maximization with the OT constraint COINCIDE-σ1 (Beckman 1998; Zoll 1998; Alber 2001), presented below along with an expository violation tableau.¹⁴

(13) COINCIDE-σ1: Output segments are in the initial syllable

kapros		COINCIDE-σ1
a.	ka.pri	***
b.	kra.pi	**
c.	kar.pi	**
d.	kpa.ri	**

COINCIDE-σ1 is better-satisfied when more segments are parsed into the initial syllable, and I propose that satisfaction of this constraint derives the Directionality/Prominence generalization in which liquid metathesis proceeds only right-to-left and into the initial syllable. The means by which violations of this constraint are avoided will depend on how others are ranked with respect to it, and I turn to this issue in the next section.

¹⁴ Zoll (1998) states COINCIDE constraints in terms of alignment, which if relativized to liquids could provide a more restrictive definition:

(i) COINCIDE((r, l), σ1)
 $\forall x(x = (r, l) \rightarrow \exists y(y = \sigma 1 \wedge \text{COINCIDE}(x, y))$

I do not formulate the constraint this way because the analysis will be able to derive the fact that only liquids are allowed to move into the first syllable.

3.2 Explaining the Cluster Maintenance generalization

Given that Prominence Maximization can in principle be satisfied by the transposition of *any* segment to the left word edge (e.g., candidate (d) in (13) above), an analysis based on this idea must provide a means of constraining possible metathesis types such only those that obey the Cluster Maintenance generalization in (7) are predicted. This is done by an appeal to similarity: long-distance metathesis is tolerated only when the reflex is maximally similar to its corresponding form in the source language. This will turn out to mean that (i) only liquids may metathesize and (ii) they may only do so from post-obstruent environments, in line with the Cluster Maintenance generalization.

Similarity is formalized here with reference to *minimal perceptual disruptiveness*: if a phonological operation is minimally perceptually disruptive, it is preferred (Steriade 2001; Fleischhacker 2005; Zuraw 2007a,b). The specific claim in this section is that the string TV is maximally similar to TLV relative to similar comparisons between other cluster types, and for this reason inserting or removing L in the environment T_V but not others is minimally disruptive.

In addition to the proposal that similarity can explain these particular features of long-distance metathesis, I claim that knowledge of this similarity is also crucial for an adequate analysis of the phenomenon. I begin this argument by reviewing a particularly relevant line of work on ‘cluster splittability,’ and in particular the generalization that obstruent + sonorant clusters are more likely than others to be split (e.g., by anaptyxis, base-reduplicant correspondence, etc.; Fleischhacker 2001; 2002, 2005, Zuraw 2007a,b; Broselow 1983; Steriade 1982, 1988). This generalization is relevant to the present analysis because the phenomenon finds an analog in long-distance metathesis: since liquids may only metathesize from and into post-obstruent environments, this may also be conceived of as TL ‘splitting’ and ‘adding’ for source and target environments respectively.

Fleischhacker (2002) and Steriade (1988) examine the typology of reduplicative onset transfer involving cluster simplification in the reduplicant and find that obstruent + sonorant clusters in particular are more likely to be split. In these situations, any consonant cluster in the reduplicant is marked, and the material transferred depends on the type of cluster in the base:

- (14) Onset transfer in reduplication
- a. Gothic perfect: fe-fres ‘tired, tempted’ (cf. ste-stald ‘possessed’)
 - b. Attic Greek perfect: ge-grap^ha ‘wrote’ (cf. e-sparmai ‘sowed’)

(14a) shows that Gothic perfect reduplication selectively copies /f/ from a cluster /fr/ into the reduplicant, whereas the component segments of other cluster types such as /sT/ both surface in the reduplicant. A similar pattern is seen in the Attic Greek perfect: /g/ is selectively copied from base /gr/, while for clusters like /st/, neither component segment surfaces in the reduplicant. While both languages preferentially split TL clusters in this process, Gothic overrides its general ban on consonant clusters in the reduplicant by transferring sT so that these clusters will not be split, while Attic Greek accomplishes the same goal by not allowing anything to surface in the reduplicant when the base begins with sT.

Fleischhacker (2001) finds a similar pattern concerning asymmetries between anaptyxis and prothesis in loanword adaptation. Her general finding is that stop + sonorant clusters are

more likely to be split by an epenthetic vowel than other cluster types, which often receive prothetic material instead of a medial segment.

- (15) Prothesis-anaptyxis asymmetries (Fleischhacker 2001)
- a. Egyptian Arabic non-native clusters: *bīlastik* ‘plastic’ (cf. *ʔiskii* ‘ski’)
 - b. Sinhalese: *t̪irividā* < Skt. *trividā* ‘triple’ (cf. *iskul* ‘school’)

In Egyptian Arabic’s resolution of phonotactically illegal non-native initial clusters, TL sequences receive an anaptyctic /i/, while other cluster types such as /St/ are resolved via prothesis of /ʔi/. Similarly, in a sound change from Sanskrit to Sinhalese, initial TL clusters were broken up by a medial /i/, whereas other clusters are inherited with a prothetic /i/.

Fleischhacker’s (2001, 2002, 2005) explanation for these asymmetries relies on perceptual similarity: because the perceptual difference between strings such as TL and TVL is smaller than that between sT and sVT, speakers prefer operations that involve the former correspondence rather than the latter. The basic idea behind the perceptual similarity hypothesis is that in a string TL, the transition from T to L is similar enough to a transition between T and V so that the addition of V into T_L (or loss of L yielding TV) results in a string that sounds relatively similar to the original. On the other hand, this cannot be said of the transition from s to T in a string sT (or any obstruent + obstruent cluster generally) and therefore splitting this sequence with a vowel constitutes a relatively robust perceptual departure. The idea that similarity underlies splittability thus explains the typological generalization that TL clusters are more likely to undergo such processes than sT clusters.

A series of speech perception tasks by Fleischhacker (2002, 2005) confirm the general hypothesis that TL-type clusters are more similar to their anaptyctic counterparts than are sT clusters, but this still leaves open the question of whether such generalizations are psychologically real. Zuraw (2007a, b) devises a way to determine the extent to which knowledge of cluster splittability’s phonetic underpinnings is a part of speakers’ grammars. She does this by presenting Tagalog speakers words with a range of initial cluster types including TL and sT, both of which are not attested in the language’s native phonology. Speakers are then asked to rate the well-formedness of these words when their initial clusters have been split by either of the infixes /-in-/ or /-um-/. Zuraw finds that speakers prefer words in which the infixes split TL-type clusters rather than sT-type clusters. This result is important because it requires participants to make a judgment about the splittability of clusters they are unfamiliar with, suggesting that substantive knowledge encoding their preferences exists in the grammar.

3.2.1 *Relating liquid metathesis to the splittability typology*

Retuning to the phenomenon at hand, the question that needs to be addressed is why metathesis occurs only when the source and target environments are of the type T_V when (i) liquids are phonotactically legal in other positions and (ii) COINCIDE-σ1 requires all segments, regardless of their input position, to be realized in the first syllable. Following previous research on cluster splittability, I propose that this is because speakers both desire to maintain similarity among competing forms and possess the knowledge that TL clusters can be split with relatively little perceptual consequence.

A complication arises from the fact that long-distance liquid metathesis affects the word-medial environment (in addition to the initial syllable), whereas previous research has focused only on the outcomes of processes affecting word-initial clusters. The specific problem that

must be addressed is why L may be removed from and inserted only into T_V and not V_T. If the solution to this issue is to be grounded in perceptual similarity, it must be argued that the correspondence VLT ~ VT is more perceptually invasive than the correspondence TLV ~ TV. I will suggest two factors that may be responsible for this asymmetry: differences between prevocalic and postvocalic coarticulation and differences in duration between TL and LT consonantal interludes. Each of these is discussed in turn below.

I suggest that removing or adding L in the environment V_T is more perceptually invasive than adding L in T_V because the former operation introduces or removes robust coarticulatory information from the preceding vowel and is thus more disruptive. This claim is supported by Kelly and Local (1986), who find that liquid coarticulation in English is more robust in the anticipatory rather than perseveratory direction. Additionally, Stevens (1998:554) notes that in general liquids tend to more strongly disrupt preceding vowel formants rather than those that follow.

Another measure of perceptual disruption may concern asymmetries in the vowel-to-vowel interlude duration of TL vs. LT clusters. McCrary (2004), in a study of the durations of various cluster types in Italian, finds that TL clusters are roughly half as long as LT clusters, while an intervocalic T is about half as long as the former. What this means is that removing L from the environment V_T alters the duration of the consonantal interlude more than removing L from T_V does. More generally, Chitoran et al. (2002) find that consonant clusters with a greater degree of perceptual recoverability (which may be the case for TL clusters), these clusters will have a higher degree of gestural overlap leading to shorter durations. Along with the discussion of the relative robustness of coarticulation above, I suggest that the duration-based facts allow for greater similarity between the strings TLV and TV, while the strings VLT and VT are more dissimilar.

3.3 Formal analysis

The facts reviewed above suggest a hierarchy of perceptual invasiveness according to which the correspondence TLV ~ TV is the least disruptive unfaithful mapping. This hierarchy can be expressed as a fixed ranking of OT constraints from Zuraw's (2007a, b) *MAP family:

(16) Invasiveness hierarchy and translation:¹⁵

$$\begin{array}{ccccccc} \Delta(\text{TV}, \text{TTV}) & > & \dots & > & \Delta(\text{VLT}, \text{VT}) & > & \Delta(\text{TLV}, \text{TV}) \\ \Downarrow & & & & \Downarrow & & \Downarrow \\ *_{\text{MAP}}(\text{TV}, \text{TTV}) & >> & & >> & *_{\text{MAP}}(\text{VLT}, \text{VT}) & >> & *_{\text{MAP}}(\text{TLV}, \text{TV}) \end{array}$$

*MAP constraints are similar in effect but formally distinct from Steriade's (2001/2008) contextual faithfulness constraints. Under this general approach, speakers know the perceptual robustness of a given contrast across phonological environments (e.g., L ~ Ø in T_V). Steriade refers to this body of knowledge as the P-map. Differences in perceptibility are projected as a fixed hierarchy of constraints in which higher-ranked constraints penalize changes that are more

¹⁵ Although the paper so far has not specifically mentioned correspondences such as TV, TTV, it is assumed that they are more perceptually invasive than those involving liquids discussed above. This fact follows from the discussion of the perceptual motivation behind cluster splittability in section 3.1.

perceptually robust. The tableau below provides a basic illustration of how such a ranking works for long-distance metathesis.

(17) *MAP(X, Y) = X in string S_1 must not correspond with Y in string S_2

kapra	*MAP(TTV, TV)	*MAP(VLT, TV)	COINCIDE- $\sigma 1$	*MAP(TLV, TV)
a.  krabo			**	**
b. kabro			***!	
c. karbo		*!	**	*
d. kbaro	*!		**	

Candidate (a) wins as it violates COINCIDE- $\sigma 1$ only twice and minimally violates the *MAP constraint representing the least perceptually invasive correspondence, TLV ~ TV. Candidate (b) fatally violates COINCIDE- $\sigma 1$ as metathesis has not taken place. Candidates (c) and (d) do not survive this ranking because their transpositions involve correspondences that are too perceptually invasive according to the *MAP hierarchy.

*MAP constraints are utilized here instead of contextual input-output faithfulness constraints for reasons of parsimony: as pointed out by Zuraw (2007b), the general phenomenon that TL clusters in particular are preferentially split possibly implicates the activity of many different faithfulness constraints, as the table below, adapted from Zuraw, indicates.

(18)

General phenomenon	Possible faithfulness violations	Shared *MAP violation
TLV ~ TV	DEP(V)/TR, MAX(V)/TR, CONTIG-TV, ANTICONTIG-TR, CONTIG-TR, ANTICONTIG-TV, LINEARITY, LINEARITY-L, etc.	*MAP(TLV, TV)

Standard Correspondence Theory seems to miss something that *MAP constraints do not: they state the general splittability facts directly with reference to their perceptual motivations by relating particular correspondences to Steriade's P-map. An analysis relying on standard faithfulness constraints relativized to particular segments and environments would seem to introduce unnecessary complexity given this feature of the *MAP family.

*MAP constraints may also be necessary because it is unclear how any single constraint from the standard faithfulness battery could account for the mappings required by long-distance liquid metathesis. Context-sensitive versions of MAX (no deletion) and DEP (no insertion) could be posited for the source and target environments respectively, but this requires two constraints to be ranked closely together instead of one that only needs to be ranked to others of a similar kind. Additionally, a constraint such as CONTIGUITY-TL (no splitting TL clusters) could be violated by metathesis at the source environment, but this constraint would say nothing about the arrival of a liquid at the target environment; for this we would need to posit CONTIGUITY-TV (no splitting stop + vowel sequences) as well, but here we lose sight of how the constraints relate to each other in terms of perceptual similarity. Relativizing LINEARITY (no metathesis) to liquids and ranking it appropriately low could account for the fact that only they metathesize and

possibly that they only do so from and into particular environments, but LINEARITY regulates precedence, and it is difficult to imagine why this constraint would evaluate alterations of precedence only when particular environments are involved. *MAP constraints seem to be the only means of straightforwardly evaluating the type of correspondence required by long-distance metathesis.

3.3.1 Summary

To briefly summarize the main points of the analysis so far, it has been argued that the Directionality/Prominence generalization can be explained by a grammatical pressure for more segments in prominent positions, here the initial syllable. The Cluster Maintenance generalization is accounted for with reference to similarity: the forms under comparison must be as perceptually similar as possible, and this is achieved only when liquids metathesize from and into post-obstruent environments. Finally, the formal analysis established that constraints reflecting these two principles can be appropriately ranked to account for the observed data.

3.4 Other accounts of the phenomenon

While the focus of this paper is a comparison of the analysis presented above to non-teleological accounts of long-distance liquid metathesis, other accounts of the phenomenon that do not fit this description should be mentioned. Duménil's (1983, 1987) analysis of Gascon and Geisler's (1994) analysis of metathesis patterns in Sardinian generally both recognize the exceptional nature of the initial syllable as a position of attraction, which they formalize in terms of "weight" or "strength": both syllables *and* segments can vary along this dimension, and the strongest segments (obstruents) in the strongest position (the onset of initial syllable) will draw liquids away from medial word positions. While this approach correctly predicts that the metathesis will result in an initial obstruent + liquid cluster, it cannot explain the Cluster Maintenance generalization at the source environment, i.e., the fact that liquids will only move from post-obstruent positions.¹⁶ The analysis presented above addresses this issue by requiring a degree of perceptual similarity between competing forms such that only metatheses from and into post-obstruent positions are allowed.

Another approach to long-distance liquid metathesis generally is found in Bradley's (2007) analysis of Judeo Spanish, which could be extended to the languages under consideration here. This account relies on an OT-implementation of positional markedness, where a fixed ranking of constraints encodes the principle that liquids are progressively more marked the further away from the initial syllable's onset they are. When an output candidate with a liquid in the leftmost position is compared to others with liquids in non-initial position, the former will incur the least serious violation of the positional markedness hierarchy and therefore be optimal.¹⁷ There are two issues with this approach that make it untenable as an explanation for

¹⁶ This point may be less important for Geisler, who analyzes the Campidanian Sardinian data displaying long-distance metathesis from *pre*-obstruent positions as true instances of long-distance metathesis, whereas I argued in section 2.3.1 above that these cases of metathesis are only apparent, with local VC metathesis feeding the metathesis pattern, the latter of which is in line with the Cluster Maintenance generalization.

¹⁷ This is somewhat of an oversimplification; Bradley analyzes cases of long-distance metathesis that seem to have been limited to a single intervening syllable, where the target environment was

the data analyzed here. First, similar to the problem with the “strength”-based approaches of Duménil (1983, 1987) and Geisler (1994), the positional markedness account has difficulty explaining restrictions on metathesis at the source environment: since liquids in *any* non-initial position can improve on Markedness by moving leftward, this would predict both local and long-distance metatheses from pre-obstruent position, against the Cluster Maintenance generalization. Second, Bradley’s approach cannot account for the “look-ahead” aspect of the phenomenon, i.e., the generalization that in the case of an incompatible target site, no metathesis, long-distance or local, occurred. Under the positional markedness hierarchy, any leftward movement of a liquid better satisfies the constraint ranking, so this analysis predicts that local metathesis will occur when long-distance metathesis is not possible. The grammar in (17) accounts for this restriction as maintaining an adequate degree of perceptual similarity among candidates requires metathesis from and into post-obstruent environments, and any candidate with metathesis of a liquid to a medial position is harmonically bounded by COINCIDE- σ 1, which assigns a violation mark to any segment not in the initial syllable.

3.5 The analysis in a model of sound change

The grammar proposed above in (17) relies on correspondence between a historical form and its possible changes in the descendant language. It would be unreasonable to suppose that language change proceeds in this fashion generally or, for example, that speakers have access to the historical versions of words in their language. We therefore must propose a more realistic model of sound change before the analysis can be compared to alternative explanations, and this is undertaken in what follows.

The model presented here is based on the commonly held view that sound change begins with variation (e.g., Ohala 1989), and we further require that sound change actuation results from selection among those variants (Kiparsky 1995; Lindblom et al. 1995).¹⁸ The formal instantiation of this idea is that speakers can control multiple lexically- and contextually- specific grammars (e.g., Pater 2000; Inkelas and Zoll 2003) one of which specifically compares outputs (i.e., the established pronunciations of words) with encountered variants of those words (cf. Kawahara 2001). For this to serve as a general model of sound change actuation it must minimally be assumed that a speaker is willing to accept certain alternative pronunciations, and in particular those alternatives that are generated by a grammar in which Markedness is promoted into the *MAP hierarchy.

To illustrate this idea, consider the synchronic grammar of a speaker before long-distance metathesis has taken place for a particular lexical item. This will require some assumptions about what constitutes the underlying representation in such a situation, but none of these are likely to impact whether or not metathesis will occur at a particular time. We assume that the Input-Output grammar is in a state where no metathesis occurs in the mapping from underlying to surface form; this is shown below for South Italian Greek *kapistri* ‘halter’ when the *MAP hierarchy outranks COINCIDE- σ 1.

not always initial (e.g., *catredal* < Lat. *catedral*). Bradley accounts for this distance-based restriction by ranking LINEARITY within the positional markedness hierarchy.

¹⁸ The issue of what these variants actually are is returned to in later sections. For now we assume only that they exist for the purposes of developing the model.

(19) Input-Output grammar

/kapistri/		*MAP(VT, VLT)	*MAP(TV, TLV)	COINCIDE-σ1
a. 	[kapistri]			*****
b.	[kapristi]		*!*	*****
c.	[karpisti]	*!	*	*****
d.	[krapisti]		*!*	*****

Now, if a speaker's Output-Variant grammar is configured differently from her Input-Output grammar, then it is possible for a variant form to fare better than the conservative pronunciation (as derived from the Input-Output grammar). (20) shows how this works when COINCIDE-σ1 is promoted above *MAP(TV, TLV), allowing a variant candidate (flanked by |pipes|) with metathesis into the initial syllable but only from post-obstruent environments to win:

(20) Output-Variant grammar

[kapistri]		*MAP(VT, VLT)	COINCIDE-σ1	*MAP(TV, TLV)
a.	kapistri		*****!	
b.	kapristi		*****!	**
c.	karpisti	*!	*****	*
d. 	krapisti		*****	**

The focus here is not on how Output-Variant grammars are extended to long-term phonological or lexical change; instead I am concerned only with how innovative variants may be compared with conservative pronunciations and either selected or rejected based on grammatical analysis. It is possible that over time, Output-Variant grammars may involve themselves in competition to supplant the standard Input-Output grammar, as in models of how variation can lead to linguistic change such as Yang 2001. Another issue I do not concern myself with is the nature of the ranking differences between the Input-Output grammar and the Output-variant grammar; whether this can be explained by some meta-principle such as a preference for minimal re-ranking between grammars (Zubritskaya 1997) or as a direct consequence of a desire for perceptually minimal changes, for example, is left for future work.

Another consequence of different rankings between grammars is that restrictions specific to Output-Variant comparisons receive a straightforward explanation. Recall that long-distance metathesis would sometimes fail to apply if the result would create a particular consonant cluster that is nonetheless phonotactically legal in the language (e.g., [ðr] clusters in South Italian Greek; *dakryon* > *ðakri* 'tear' but *draco:n* > *ðrako* 'dragon'). With a single grammar, it is puzzling why these clusters are systematically avoided as the results of metathesis yet tolerated in the language generally if the same Markedness is relevant for both situations. The Output-Variant grammar affords an explicit analysis of this situation:

(21) Output-Variant grammar

[ðakri]		*MAP(ð, ðr)	COINCIDE-σ1	*ðr
a. 	ðakri		***	
b.	ðraki	*!	**	*

For illustrative purposes high ranking $*MAP(\delta, \delta r)$ is posited to show how under an appropriately configured Output-Variant grammar the creation of an $[\delta r]$ cluster via metathesis can be blocked.¹⁹ Because this constraint outranks COINCIDE- $\sigma 1$, metathesis will not occur. On the other hand, the Input-Output grammar can allow underlying $/\delta r/$ to surface:

(22)

$/\delta rako/$	$*MAP(TV, TLV)$	$*MAP(\delta, \delta r)$	$*\delta r$
a.  $[\delta rako]$			*
b. $[\delta akro]$	*!*	*	
c. $[\delta ako]$	*!	*	

In (b-c) various unfaithful departures from the input are ruled out in favor of the candidate that minimally violates $*\delta r$ (a). This scenario may be exploited as a general solution to the problems posed by South Italian Greek.

3.5.1 Source of the variants

Until now nothing has been said regarding the source of the variants utilized by the Output-Variant grammar. I do not commit myself to any particular answer to this question but note that there exist a number of possibilities that are compatible with the model; some of these are discussed in following sections. Variants may be misheard tokens (see section 4.1), meaning that the sound change's actuation is listener-based, or a speaker-based scenario could be responsible, perhaps if variant candidates faithfully represent speech encountered speech errors (see section 4.2). In any case, an assumption made here is that these variants can be represented as candidates in grammatical competition.

3.5.2 Summary

This section developed a model of sound change actuation incorporating the grammatical biases proposed earlier in the analysis. This was done by positing that the grammar can compare output variants to established pronunciations by way of a grammar that specifically compares outputs to encountered variants. When constraints are appropriately ranked in this grammar, a variant can be less marked than the output. In this case the speaker may choose to produce the variant output rather than the conservative form.

4. Alternatives

The primary claim defended in this paper is that long-distance liquid metathesis in the languages considered here is best understood when the phonological grammar intervenes in the sound change, and that approaches that do not acknowledge this possibility cannot adequately explain all aspects of the phenomenon. In this section I demonstrate this by comparing the analysis

¹⁹ $*MAP(\delta, \delta r)$ is utilized to show the general effect that OV-correspondence can demand different outcomes from what may be generally unmarked in the language. Since this constraint is from the $*MAP$ family it comes along with a statement about perceptual similarity, which here is that at least $\Delta(\delta, \delta r) > \Delta(TV, TLV)$. I do not motivate this particular scale or any of its implications but instead treat it as an assumption the analysis must make.

developed in Section 3 with two non-teleological approaches to sound change actuation: innocent misperception (4.1) and the phonologization of motor planning errors (4.2). The former of these is determined on general grounds to be an unlikely explanation for the phenomenon; the latter is similarly found to be inadequate as a theory of long-distance metathesis and its actuation, but I suggest that both of these alternatives may give rise to the outputs that form the pool of variation that the grammar selects from.

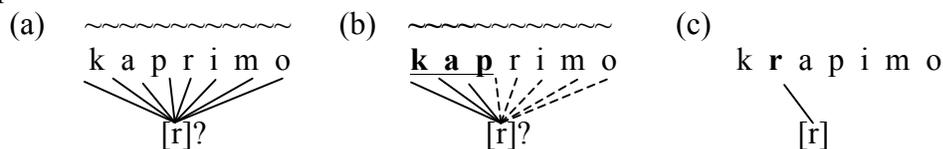
4.1 Innocent misperception

In marked contrast to the analysis developed above, Ohala (1981, 1993) proposes that the primary source of sound change is ‘innocent misperception’: if facts about the speech production or perception mechanisms make it difficult to accurately perceive an utterance, listeners may fail to do so and reinterpret what was originally intended by the speaker in a manner consistent with their misperception. The outcome of the misperception event is thus taken at face value as a representation of what the speaker intended.

Blevins and Garrett (1998, 2004) provide an explanation for long-distance liquid metathesis along these lines. They argue that because liquids are characterized phonetically in part by their long-distance acoustic cues, usually a perturbation of vowel formants that spans adjacent syllables, listeners may have difficulty localizing the liquid’s linear origin. If this difficulty causes a listener to reinterpret the liquid as belonging to a non-historical position, then metathesis has taken place. There are two issues that this approach must confront, which are the Directionality/Prominence generalization and the Cluster Maintenance generalization. I begin with how the Evolutionary Phonology approach accounts for the fact that liquids metathesized only into the initial syllable.

Blevins and Garrett explain the Directionality/Prominence generalization by appealing to certain asymmetries in the nature of the perceptual system, claiming that liquids are “likelier to be misperceived as originating in a more perceptually salient (prominent) position” (2004:134). I interpret this to mean that because word-initial positions are sites of increased perceptual salience, the extended phonetic cues of liquids are possibly amplified in this position, leading to a bias for their reinterpretation as originating from the initial syllable.²⁰ This process is shown schematically below for the nonce word *kaprimo* > *krapimo*:

(23) [~] = liquid cues



In (a), long-distance phonetic cue extension causes confusability with respect to the liquid’s linear origin. (b) shows how liquid cues are amplified (shown with boldface) in the initial

²⁰ An alternative interpretation is that listeners prefer analyzing ambiguously located liquids as belonging to prominent positions, regardless of any possible perceptual amplification effect. In this case the claim is difficult to distinguish from the account of the Directionality/Prominence generalization proposed above in section 3, whereby the grammar exerts a pressure for parsing phonological material into prominent positions.

syllable, a perceptually prominent position, which leads to reinterpretation of the liquid /r/ as originating from this location as shown in (c).

Some acoustic studies confirm that liquids do in fact have long-domain resonances; for example, Kelly and Local (1986) find that these cues for English /l/ and /ɹ/ extend robustly over a following foot-sized domain, and Heid and Hawkins (2000) similarly report that English liquid cues are acoustically detectable up to five preceding syllables away. Given that liquids can be characterized by long-domain cues in this way, this explanation for the Directionality/Prominence generalization then crucially relies on listener sensitivity to these cues: they must be able to preferentially detect them in the initial syllable and reinterpret them as belonging to this position. There is experimental work that bears on this issue. In a series of speech perception tasks, Cole (1973) and Cole and Jakimik (1980) find that listeners are especially sensitive to changes (mispronunciations) in the initial syllable, and Marslen-Wilson (1975) finds that in a speech shadowing task, listeners are less likely to repeat mispronunciations in initial syllables than elsewhere. What these results seem to show is that listeners are hypersensitive to the content of initial positions, and further it seems that they are unwilling to acknowledge changes here as they would have to be if the misperception/reanalysis approach were to explain the Directionality/Prominence generalization.

The second feature of long-distance liquid metathesis that any analysis must account for is the Cluster Maintenance generalization, i.e., the fact that liquids only metathesized when the source and target environments were of the type T_V. Since misperception of elongated phonetic cues and reanalysis are the only principles motivating metathesis, under this line of reasoning the existence of such restrictions is unexpected. Unless immediately preceding obstruents somehow amplify long-domain anticipatory cues for liquids (and word initial obstruents somehow increase the probability that such cues will be reanalyzed), we would expect metathesis to apply regardless of whether a liquid begins or ends in a post-obstruent environment. Considerations of perceptual similarity like those discussed in section 3 could potentially be incorporated into the misperception account, but as just discussed the requisite notion of similarity is unlikely to be equivalent to perceptual uncertainty.

The analysis pursued here addresses these issues. Even if listeners are especially aware of changes in the initial syllable and avoid them for this general reason, I propose that there is another pressure for changes in the initial syllable: the grammatical principle of Prominence Exhaustion. Since prominent positions are treated as grammatical entities rather than sites of perceptual enhancement only, in principle it is possible for a listener to evaluate changes abstractly, and the evaluative criteria here may be different from those brought about by the experimental setting. On the other hand, the innocent misperception explanation does not have access to this level of abstraction by necessity. With respect to the Cluster Maintenance generalization, I propose that liquids only metathesize from and into post-obstruent environments because this is required to maximize similarity between innovative and conservative forms; the innocent misperception approach has no obvious explanation for this aspect of the phenomenon.

4.1.1 Uncertainty with probabilistic resolution

Somewhat of a departure from the innocent misperception approach is the possibility that an ambiguously located liquid may be reinterpreted as belonging to a non-historical position based on probabilistic expectation. This means that if the location of a liquid is under question, a listener may resolve this ambiguity by locating it where it has the highest probability of

occurring based on the language's lexical statistics. If the probability of a liquid following an obstruent is greater in initial than medial positions, this could explain the fact that long-distance metathesis proceeds exclusively right-to-left and into the onset of the initial syllable. The general idea that ambiguity in the speech signal may be resolved based on knowledge of preexisting structure in the language is the central premise of Hume's (2004) Indeterminacy/Attestation model of metathesis.

To examine this possibility, the probabilities of liquids occurring after obstruents in various word positions were calculated from digitized versions of Lewis and Short's (1879) *A Latin Dictionary* for Latin and Liddell and Scott's (1940) *Greek-English Lexicon* for Ancient Greek. Morphologically related forms were included in the corpus, but proper nouns were not.

	Latin	Ancient Greek
Total words in corpus	59,021	114,026
pr(L in initial T V)	.18	.20
pr(L in medial T V)	.09	.12
Test	$\chi^2(1) = 1333; p < .0001$	$\chi^2(1) = 1743; p < .0001$

Table 1 - Transitional probabilities in Latin and Ancient Greek

The results show that in both Latin and Ancient Greek, the probability of a liquid following an obstruent is greater in initial than medial positions. Before accepting this as an explanation for the identified generalizations, i.e. Directionality/Prominence and Cluster Maintenance, a few comments are in order. First, while the statistical findings may provide a reasonable explanation for why liquids move into post-obstruent positions in the initial syllable and not elsewhere, they have difficulty accounting for restrictions on metathesis at the source environment: presumably, liquid cues extend over long domains regardless of their position in the word, meaning that *any* liquid could give rise to uncertainty about its linear origin. Assuming this to be true, there would need to be some sort of mechanism in place to only allow liquids to move from post-obstruent positions. Like the innocent misperception account discussed above, the idea that the only factor responsible for the sound change is ambiguity resolved via knowledge of lexical statistics seems untenable when this feature of the phenomenon cannot receive a straightforward explanation.²¹

Second, when appealing to statistical regularities to explain a particular phenomenon, it is desirable to have an understanding of the factors responsible for those regularities. The results in Table 1, namely that the onset of initial syllable is the preferred location for liquids, bear a similarity to the consequences of the grammatical principle of Prominence Maximization discussed above in which certain marked sounds or sound combinations are preferentially licensed in prominent positions, here the initial syllable. My suggestion is that lexical statistics may directly reflect such grammatical principles, in which case the grammar and lexicon are not sharply delineated (see for example Frisch et al. 2004).

²¹ This analysis assumes that speakers form statistical generalizations over environments stated with natural classes (here, [obstruent], [liquid], and [vowel]). An alternative possibility is that specific segments are tracked for statistical analysis. See Appendix I for frequency-based well-formedness when specific obstruents are evaluated for the probability of a following liquid, where it is found that metathesis may occur even when a particular target obstruent is *less* likely to have a following liquid.

4.2 Speech errors and motor planning

Garrett and Johnson (2013) discuss the importance of the role that biases emerging from the nature of the speech production system play in sound change. Their general reasoning is that if these biases closely resemble the outcomes of documented sound changes, then in principle any other knowledge that a speaker may possess has little to do with the origin of the sound change. Along with Wanner (1989), they explicitly suggest that long-distance liquid metathesis has its roots in such a phonetic bias, here motor planning errors (see also Hansson 2001). This position requires attention given that speech errors mirroring the long-distance liquid metathesis pattern have been documented:

(24)

<u>Target:</u>	Bunsenbrenner	Meringer and Mayer 1895:91
<u>Error:</u>	Brunsenbenner	
<u>Target:</u>	Fenway Franks	Fromkin 2000 ID 373
<u>Error:</u>	Frenway Fanks	
<u>Target:</u>	fit on my plate	Vousden et al. 2000:112
<u>Error:</u>	flit on my pate	

The speech errors in (24) show transposition of a liquid in accordance with both the Directionality/Prominence generalization and the Cluster Maintenance generalization. Given that motor planning errors can give rise to such patterns, it is crucial to determine whether this fact alone could be responsible for the sound change.

The first issue to address concerns the nature of speech errors and their relationship to diachronic change. Most speech error corpora contain many examples of errors that never seem to result in sound change; for example “**cue fr**iticisms” for “few criticisms” (Fromkin 2000 ID 352) displays long-distance interchange of [k] and [f] as the first member of a complex onset, but to my knowledge this particular error has not been phonologized as a sound change in any language.

The reason for this may be that these types of errors are actually produced relatively infrequently while those in (24) are more common. If the frequency of a speech error determines the likelihood of its phonologization, then this may be a reasonable explanation for why sound changes like long-distance liquid metathesis occur to the exclusion of others. Examining the general distribution of the speech error types in Vousden et al.’s (2000) corpus of English speech errors, however, casts doubt on this hypothesis:

(25)

Error type	Example	Occurrence
Anticipation	Target: members only Error: memblers only	804; 35.1%
Preservation	Target: chip time Error: chip chime	595; 26%
Non-contextual substitution	Target: sharp Error: sarp	397; 17.3%
Exchange	Target: sick as a parrot Error: pick as a sarrot	242; 10.6%
Migration	Target: flavored toothpaste Error: favored tooth plaste	25; 1%

Not included in this table are errors termed ‘ambiguous’ and ‘complex’ by Vousden et al., which together account for the remaining tokens.²² The most frequent error types involve repetition of sound or features of a sound in the anticipatory and perseveratory directions, respectively. The type of error closest to long-distance liquid metathesis, ‘migration,’ occurs just with the lowest frequency, at a rate of about 1%. Crucially, although long-distance metathesis as well as the most frequent error type in Vousden et al.’s corpus both involve anticipatory alterations, these constitute different kinds of change because in the later case an element is repeated rather than moved.²³ Similarly, Santiago et al. (2007) report that in a corpus of Spanish speech errors consisting of 1,384 tokens, the occurrence of transposition errors that mirror long-distance metathesis (termed ‘anticipatory shift with loss of source environment’) is only 1.6%. If these corpora only somewhat accurately represent the occurrence of speech errors in the history of the languages considered here, it would seem that many error types could have occurred with great frequency but were not phonologized, whereas the putative error underlying the metathesis change would have been quite rare. My suggestion is that if such errors initially gave rise to the sound change, they were not directly phonologized but rather subject to analysis such that some, such as ‘migration’ errors, but not others were deemed suitable for phonologization (as formalized in section 3).

When migration errors did occur, and when they involved liquids, I further suggest that only those in line with the Directionality/Prominence and Cluster Maintenance generalization were selected by the grammar and phonologized. It is worth noting that if the grammar was responsible in this way, it may have duplicated some of the structure already present in speech errors, particularly in its encoding of perceptual similarity: speech errors tend to involve similar segments and syllable positions (Dell 1984; McKay 1970; Walker 2007). Dell (1984) finds in addition that speech errors are more likely even when vocalic contexts are similar (the *repeated*

²² ‘Ambiguous’ errors are those that have an unclear directional source, and ‘complex’ errors are those that display more than one of the categories in (26).

²³ Another possibility is that long-distance liquid metathesis did proceed this way originally but was then followed by deletion of the liquid at the source environment. This seems unlikely as I am aware of no instances of a sound change involving liquid ‘copying,’ and even supposing that this may have happened, the typical resolution of identical liquids in a word is dissimilation rather than deletion.

phoneme effect); for example the error “heft “lemisphere” for “left hemisphere” is more likely than others because the participating segments both precede [ɛ]. Taken together, these facts may derive the attested patterns of long-distance metathesis: only relatively similar segments are transposed, and both source and target positions involve syllable onsets as well as similar phonotactic context, as all are of the type [obstruent]__[vowel].

While migration errors generally may have been biased towards this particular type of error, there are still aspects of long-distance liquid metathesis that are not explained by assuming that this bias alone is responsible for the phenomenon. For example, elicitations of speech errors in experimental settings (Dell 1984; Walker 2007) find that the relationship between similarity and speech error frequency is close to a linear function: the more similar two structures are, the more likely they are to participate in speech errors. If speech errors are directly phonologized, we would then expect that this function would be mirrored in the typology as well: some languages would display long-distance metathesis when the participating segments occurred only in the environment of identical vowels or consonants, for example.²⁴ I suggest that grammatical analysis of speech errors imposed a categorical structure on this similarity function such that the sound change was generalized to metatheses occurring from and into the environment [obstruent]__[vowel].

Another distinguishing prediction relies on comparing the proposed involvement of perceptual similarity as opposed to the kind of similarity utilized to explain speech errors. If similarity is correlated with the likelihood of phonologization, we would expect that errors such as “cue fricisms” for “few criticisms” noted above to be reflected in the typology since the participating segments involve similar sounds (obstruents), comparable syllable positions (C1 in a complex onset), and similar phonotactic environments (__[sonorant][vowel]). If similarity is evaluated in perceptual terms, on the other hand, it is not clear that such a speech error would be phonologized despite the existence of this general similarity: transposing obstruents at the beginning of words may be more perceptually disruptive than displacement of a cluster-internal glide in the same fashion. The grammar proposed above in section 3, when evaluating similarity in perceptual terms, can therefore possibly make distinctions that are not present in the similarity structure of speech errors.

The overall generalization is that speech errors must be analyzed in terms of tendencies, whereas the long-distance metathesis patterns studied here are subject to a set of strict and absolute conditions. Speech errors tend to be anticipatory in nature, but long-distance metathesis is exclusively anticipatory. This is explained by the fact that the grammar exerts a preference for segments in the initial syllable, and this preference is satisfied only when metathesis proceeds right-to-left. Similarly, the structures that participate in speech errors tend to be similar, but I argue that the grammar imposes constraints on similarity that determine its nature and precisely

²⁴ I am aware of one case of metathesis that seems to reflect this kind of specificity: in Turkana, onset segments with the same [sonorant] value are reported to optionally metathesize in fast speech only when flanked by identical vowels (Dimmendaal 1983; Buckley 2011):

(i)	<u>Normal speech</u>	<u>Fast speech</u>	
	ŋa-kēm̄ɛr-a	ŋa-kēr̄ɛm̄-a	‘mole’
	ŋi-kwaŋɔ̄r̄om̄ok-à	ŋi-kwaŋɔ̄m̄or̄ok-à	‘a kind of tree’
	ɛ-sik̄im̄-à	ɛ-kis̄im̄-à	‘breast’

Considering the phenomenon’s dependence on register (where it is still only optional), whether these transpositions should be interpreted as systematic processes of metathesis is unclear.

when it is sufficient for the purposes of variant selection. Again, speech errors tend to respect the phonotactic constraints of a language, but long-distance metathesis never creates unattested structure. This is because output variants are evaluated by a ranking of Markedness constraints more stringent than that governing the well-formedness of surface phonotactics derived from underlying representations. The conclusion is that despite some degree of overlap, the principles underlying the structure of speech errors and the principles determining selection are not the same.

Despite these issues, as mentioned earlier it is possible that speech errors were responsible for introducing innovative variants into the pool of variation from which grammatically-based phonologization took place. While the structure inherent to speech errors may have played some role in determining the outcomes of phonologization, I have argued that the biased model of sound change actuation proposed above is nonetheless necessary to constrain selection of these innovative variants.

5. Conclusion

This article has argued that an adequate analysis of long-distance liquid metathesis in South Italian Greek, Gascon, and Sardinian relies on the incorporation of a grammatical bias proposed to encode two general principles: enhancement of prominent positions and knowledge of perceptual similarity. A model of sound change was proposed in which the grammar has the ability to compare pronunciation variants of a given form with its conservative pronunciation and phonologize only those in line with these biases. This analysis was compared with two alternative accounts that do not rely on grammatical analysis: innocent misperception and the direct phonologization of motor planning errors. Neither was found to adequately explain all aspects of the phenomenon, but it was suggested that pronunciation variants may nonetheless originate from such processes.

The theory presented here is a first-order one and as such is incomplete. For example, as Garrett and Johnson (2013) stress, the sort of phonetic variation that leads to sound change is often inherently structured (e.g., as discussed above for speech errors), and determining the relative weight of this structure vs. grammatically-based structure will be an important undertaking. Additionally, Flemming (in press) and Goldrick and Daland (2009) present studies indicating that the class of phenomena classified here as ‘external factors’ (coarticulation and speech errors, respectively) may in fact be under grammatical regulation. If these analyses are on the right track they will undoubtedly have important implications for the nature of the variant-selection model proposed here. Future work will hopefully resolve such issues.

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Appendix I: Probabilities of individual stops followed by liquids in Latin and Ancient Greek

Values for each cell in the tables below correspond to the log transformation of the probability of a liquid occurring after a given obstruent in word-initial position divided by the same probability in word-medial position; positive values thus indicate a higher probability for a liquid following an initial obstruent, whereas negative values mean that a liquid is more likely to follow a medial obstruent. Documented metathesis types are emphasized in boldface, showing that they could occur even when a liquid following a particular is less likely in initial than medial position.

Initial \ Medial	p	t	k	b	d	g	f
p	1.93	1.17	1.93	1.93	2.89	2.42	2.71
t	0.73	-0.04	0.73	0.73	1.69	1.22	1.50
k	0.38	-0.39	0.38	0.38	1.34	0.86	1.15
b	-0.26	-1.03	-0.26	-0.26	0.69	0.22	0.51
d	-2.56	-3.33	-2.56	-2.56	-1.61	-2.08	-1.79
g	0.00	-0.77	0.00	0.00	0.96	0.49	0.77
f	0.33	-0.44	0.33	0.33	1.28	0.81	1.10

Table 2. Log probability ratio of L in T_V by obstruent in Latin

Initial \ Medial	p	p ^h	t	t ^h	k	k ^h	b	d	g	f
p	1.64	2.62	2.14	2.51	1.62	2.74	2.42	2.33	2.37	2.62
p ^h	-0.88	0.11	-0.37	0.00	-0.90	0.22	-0.10	-0.18	-0.14	0.11
t	0.21	1.19	0.71	1.08	0.19	1.30	0.99	0.90	0.94	1.19
t ^h	-1.47	-0.49	-0.97	-0.60	-1.49	-0.37	-0.69	-0.78	-0.74	-0.49
k	0.06	1.04	0.56	0.94	0.04	1.16	0.84	0.75	0.80	1.04
k ^h	-0.47	0.51	0.03	0.41	-0.49	0.63	0.31	0.22	0.27	0.51
b	-0.61	0.37	-0.11	0.26	-0.63	0.49	0.17	0.08	0.12	0.37
d	-1.31	-0.33	-0.80	-0.43	-1.33	-0.20	-0.53	-0.61	-0.57	-0.33
g	-0.88	0.11	-0.37	0.00	-0.90	0.22	-0.10	-0.18	-0.14	0.11
f	-0.88	0.11	-0.37	0.00	-0.90	0.22	-0.10	-0.18	-0.14	0.11

Table 3 – Log probability ratio of L in T_V by obstruent in Ancient Greek