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Citation for published version:
Ramsammy, M 2015, 'The life cycle of phonological processes: accounting for dialectal microtypologies' Language and Linguistics Compass, vol. 9, no. 1, pp. 33-54. DOI: 10.1111/lnc3.12102

Digital Object Identifier (DOI):
10.1111/lnc3.12102

Link:
Link to publication record in Edinburgh Research Explorer

Document Version:
Peer reviewed version

Published In:
Language and Linguistics Compass

The life cycle of phonological processes: accounting for dialectal microtypologies

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[Author's post-editing version, accepted for publication January, 2015.
Published version: *Language and Linguistics Compass* 9: 33–54.
DOI: 10.1111/lnc3.12102]

This article reviews and exemplifies the theory of the life cycle of phonological processes and illustrates how diachronic phonological changes can be accounted for in a stratal/cyclic model of phonology. The life cycle captures the fact that sound change operates in orderly stages and that phonological processes become increasing integrated with morphosyntactic structure as they age. Phonological rules also often display different rates of application across a given dialect continuum. Thus, the developmental phases that a phonological innovation goes through in its life cycle define a template of language change; and these stages of change reflect synchronic patterns of microtypological variation.

1 Introduction

'Man betrachte auch eine beliebige Gruppe von verwandten Mundarten; man wird sehen wie die Bedingungskreise der Lautgesetze sich von Ort zu Ort mannigfach verändern, man wird hier gleichsam die räumliche Projection zeitlicher Unterschiede erkennen' (Schuchardt 1885: 24).*

The idea that phonological processes have a life cycle is not new. As early as in Schuchardt (1885) and Baudouin de Courtenay (1895), it was recognised that phonological changes proceed in orderly stages, and that the synchronic grammar of a language is but a snapshot of an ever-evolving system. This idea, in turn, is central in the work of contemporary scholars who have sought to develop an *amphichronic* approach to phonology (Kiparsky 2006; see also Bermúdez-Otero 2013a). As its title suggests, this enterprise has a two-fold goal. Firstly, it aims to account for phonological phenomena that are synchronically active in a given language; and secondly, it aims to relate the operation of synchronic processes to pathways of phonological change that have shaped the grammar of the language throughout its history.

At the heart of an amphichronic theory of phonology, therefore, is the objective of mutual complementarity between synchronic and diachronic types of explanation: and a particularly fruitful line of enquiry in this regard has been investigating how patterns of interdialectal phonological variation originate from series of micro-level sound changes. Given that the synchronic grammars of all languages are shaped both by previously completed sound changes and also by younger, ongoing changes, questions relating to the development and variability of microtypological phonological phenomena continue to have a core focus in the discipline of historical phonology. Indeed, many questions that occupy scholars working on dialect phonology and phonological change today echo those that were asked about sound change by theoreticians working in early generative frameworks (e.g. Kiparsky 1965, 1968; Vennemann 1972, 1974, 1978, 1984). Within the generative paradigm, some of the most significant theoretical advances in the study of phonological change and dialectal variation coincided with the advent of Lexical

* 'Just consider any particular group of related dialects. You will see how the conditional environments of the sound laws change from place to place. You will, as it were, perceive the spacial projection of temporal differences' (translation by Theo Vennemann and Terence H. Wilbur, published as Schuchardt 1972: 56).

Phonology and Morphology (LPM hereafter, see Kiparsky 1982a, 1982b, 1985; Kaisse & Shaw 1985; see also Mohanan 1986 and Rubach 2008 for detailed overviews of LPM). This theory provided a new way of looking at processes of historical phonological change and fuelled lively debates about the mechanisms underlying sound change cross-linguistically (see Kiparsky 1988: 374ff.; McMahon 1991, 2000; Dresher 1993; Kaisse 1993; Zec 1993). For example, phonologists working in LPM benefited directly from the results of experimental phonetic work of the time on sound change. This led to an awareness that phonological changes do not spring up from nothing: as Ohala (1993) argues, many phonological innovations begin life as automatic phonetic effects which over time mature into fully fledged phonological rules. Moreover, this maturation process itself has different phases to it: LPM as a model of morphophonological computation enabled phonologists to account for processes of change involving an increasing integration of phonological rules with morphosyntactic structure. Capturing how phonological changes occur at interfaces between different modules of grammar — i.e. interactions between phonetics and phonology, and between phonology and morphology — was therefore a significant contribution of theoretical work in LPM.

In time, however, focus shifted away from questions relating to the diachronic development of phonological systems. With the advent of Optimality Theory — which so strongly emphasised the role of macrotypological generalisations and markedness theory — research into the diachronic origins of synchronic sound patterns diminished in rigour. However, this is not to say that the advances achieved under LPM have been forgotten: on the contrary, under the rubric of Stratal Optimality Theory (Bermúdez-Otero 1999, 2007; Bermúdez-Otero & Trousdale 2012; Kiparsky 2000, 2013) a re-examination of many of the key issues in the theoretical study of morphophonological change that occupied researchers in LPM has unfolded.

This is the point of departure for this article. I first aim to provide an overview of the life-cycle model proposed by Bermúdez-Otero (1999, 2007; Bermúdez-Otero & Trousdale 2012) which represents an important contribution to sound-change theory that has grown out of decades of research in generative phonology. Secondly, I aim to exemplify the explanatory strengths of the life cycle, both by examining linguistic phenomena which support its core claims and by scrutinising other phenomena which raise challenges for the model. Pursuing these goals leads to a third consideration: specifically, how to account for the fact that innovative phonological processes often display distinct patterns of application across a given dialect continuum. Since the neogrammarians, it has been understood that sound changes frequently occur in related dialects of a language; however, the outcome of change may also differ from variety to variety.[1] This is to say that phonological innovations can take hold very quickly in some dialects and more slowly in others. Thus, the synchronic phonology of one variety may reflect a historical stage of a more advanced dialect or a potential future stage of a more conservative dialect. In this regard, the life-cycle model offers a crucial insight: the phases of change that a phonological process goes through in its life cycle define a template of language change that is synchronically observable in patterns of microtypological variation.

The article is organised as follows. In §2, I present the life-cycle model in detail. Two challenges to the model are then discussed in §3, and §4 is dedicated to exemplifying how the life cycle can be applied to account for a phonological microtypology in Ibero-Romance. §5 concludes the paper.

2 The model

The life-cycle model that I shall defend here is schematised in Figure 1 below. As shown, the model relies on two architectural ingredients: (i) a modular feedforward grammar, and (ii) a stratified phonology.

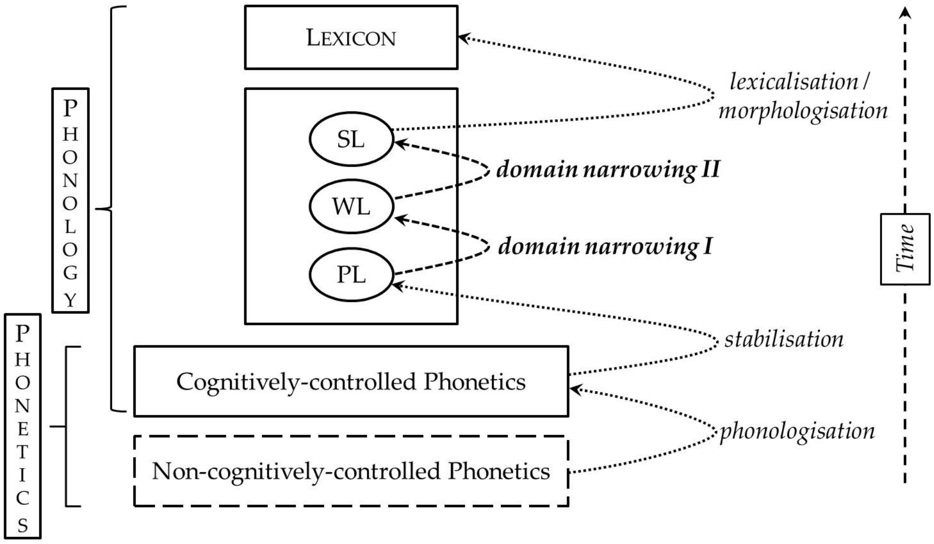

Figure 1: The life cycle of phonological processes: adapted from Bermúdez-Otero & Trousdale (2012).

In this model, phonological computation comprises a series of categorical operations that apply in a top-down fashion. Underlying structures stored in the lexicon are submitted to the phonological module, which itself is composed of three derivational strata. Phonological representations first pass through the stem-level phonology (SL); thereafter, they are fed forward through the word-level (WL) and phrase-level (PL) strata in sequence. Surface structures generated by the cumulative application of all phonological processes in the three strata are then fed into the phonetic module. The cognitively-controlled phonetic module contains the set of language-specific phonetic implementation rules: it is here that the assignment of phonetic targets and gestural planning takes place (Keating 1988, 1990, 1996; Cohn 1993). The execution of implementation plans is, nevertheless, sensitive to constraints that are beyond the cognitive control of the speaker: i.e. automatic, non-cognitively-controlled phonetic events that arise from physiological and/or perceptuo-auditory limitations.

This model provides a framework for modelling synchronic phonological operations: it is particularly well suited to handling opacity effects arising from the interleaving of morphological and phonological structure (Bermúdez-Otero 2007, 2011, 2013b, forthcoming; Ramsammy 2012b; Turton 2012). Additionally, a central advantage is that it makes restrictive, empirically verifiable predictions about the implementation of phonological change. In this connection, let us consider each of the phases of change indicated in Figure 1 in more detail.

2.1 The life cycle of phonological processes

2.1.1 Stage 1: Phonologisation

As already noted, a primary assumption of the life cycle is that the phonetic module is the cradle of phonological change. More specifically, at the very core of this model is the assumption that phonological innovations first emerge from gradient phonetic effects that are beyond the conscious control of the speaker. As Vennemann (1974: 137) argues, such effects typically involve some natural by-product of speech: these may include, for example, coarticulatory effects arising from *anatomical/physiological* constraints (Baudouin de Courtenay 1895: 22) on speech production,[2] or perceptual effects, arising from errors in auditory processing.[3] Whatever the origin of the change, the development by which a phonetic effect is first set on the pathway towards becoming a phonological rule necessarily involves a *change in status* (Anderson 1981: 514). This change in status is *phonologisation*: it occurs when *reinterpretation* of an epiphenomenal phonetic effect causes the creation of a new, systematised phonetic process whose application is crucially under cognitive (i.e. grammatical) control.

2.1.2 Stage 2: Stabilisation

At stage 1, the innovative process is a gradient one: its application is predicted to be variable, and it will perhaps manifest itself more or less robustly depending on a combination of linguistic and extra-linguistic factors. At stage 2, however, the innovation undergoes a second change in status as it begins to *stabilise*: that is, it develops from being a continuous phonetic process into a discrete phonological rule. The model illustrated in Figure 1 makes a strong claim about stabilisation, namely, that phonological processes born out of phonologised phonetic effects first apply in the maximal, *phrasal* domain. In other words, stabilisation involves the reinterpretation of a gradient phonetic process as a phrase-level (i.e. postlexical) phonological rule.

2.1.3 Stage 3: Domain narrowing I

After stabilisation, the innovative process is under the control of the categorical phonology. Yet since it applies only in the phrasal domain, it does not display sensitivity to morphosyntactic structure.[4] Nevertheless, sensitivity to morphosyntax may emerge in a later phase of innovation. As we see in Figure 1, this involves another change in status: the new rule“climbs up” a level in the stratified phonology and comes to apply at the word level.

$$[\![_{\text{Phr}}\mathscr{R}\,]\!] \xRightarrow{\textit{Domain narrowing I}} [\![_{\text{Phr}}[\![_{\text{Wrd}}\mathscr{R}\,]\!][\![_{\text{Wrd}}\mathscr{R}\,]\!][\![_{\text{Wrd}}\mathscr{R}\,]\!]\ \ldots\ ]\!]$$

Figure 2: The domain of application of the new rule, $\mathscr{R}$, shrinks: at stage 3, it becomes sensitive to grammatical word edges.

This development is driven by what Bermúdez-Otero refers to as *input restructuring*: a schematic illustration of this change is given in Figure 3 below. As shown, the cause of input restructuring is a reinterpretation of the stage 2 grammar: that is, the output structures generated by the innovative phrase-level rule at stage 2 (i.e. instances of [β]) are taken to be present already in the input of the phrase-level phonology at stage 3.

	Stage 2	$\xRightarrow{\textit{Domain narrowing I}}$	Stage 3
WL input	$[\![_{\text{Wrd}}\ \alpha\ ]\!]$		$[\![_{\text{Wrd}}\ \alpha\ ]\!]$
	$\downarrow$		$\downarrow$
	$\mathscr{R}$ does not apply		$\mathscr{R}$ applies
	$\downarrow$		$\downarrow$
WL output	$[_{\text{Wrd}}\ \alpha\ ]$		$[_{\text{Wrd}}\ \beta\ ]$
PL input	$[\![_{\text{Phr}}\ldots\alpha\ldots]\!]$		$[\![_{\text{Phr}}\ldots\beta\ldots]\!]$
	$\downarrow$		$\downarrow$
	$\mathscr{R}$ applies		faithful mapping
	$\downarrow$		$\downarrow$
PL output	$[_{\text{Phr}}\ldots\beta\ldots]$		$[_{\text{Phr}}\ldots\beta\ldots]$

Figure 3: Domain narrowing I by input restructuring at the phrase level.

Let us suppose that $\mathscr{R}$ is a glide-hardening rule that generates fricatives from high front vocoids in /C__V/ environments, as in Modern Greek (Newton 1972b: 154ff.; see

§3.1 below for further discussion). At stage 2, this rule applies across-the-board such that any /CIV/ sequence is a potential target. Accordingly, an example like $\llbracket_{\mathrm{Phr}}$...spitia...$\rrbracket$ 'houses' is predicted to display the effects of hardening in the phrase-level output: hence, [$_{\mathrm{PL}}$ spitça]. However, the sequence [spitça] is a grammatical word: confronted with this evidence, children acquiring the grammar of Modern Greek may posit a grammar in which a forms like these do not arise from unfaithful mapping in the phrasal stratum (i.e. as at Stage 2 above), but rather that an output like [$_{\mathrm{PL}}$ spitça] is a faithful reflex of the input $\llbracket_{\mathrm{Phr}}$ ...spitça...$\rrbracket$. Under this scenario, the child constructs a word-level grammar capable of deriving forms with hardening which, in turn, are fed forward into the phrase-level grammar as inputs. Thus, in this reanalysis of the hardening pattern, the domain of application of the hardening rule has narrowed from the phrase to the word (see §4.1.2 for further exemplification of domain narrowing and input restructuring; see also Bermúdez-Otero 2011 and Bermúdez-Otero & Trousdale 2012 for relevant discussion).[5]

2.1.4 Stage 4: Domain narrowing II

The outcome of the first phase of domain narrowing is that a categorical phrase-level rule comes to apply at the word level: this in turn makes the innovative rule sensitive to any morphological operations that occur at the word-level, and to grammatical word boundaries. Over time, the innovative process may become further embedded in morphosyntactic structure. At stage 4, a second phase of domain narrowing causes the new rule apply in the smallest morphosyntactic domain, i.e. the stem.

$$\llbracket_{\mathrm{Phr}}\llbracket_{\mathrm{Wrd}}\mathscr{R}\;\rrbracket\llbracket_{\mathrm{Wrd}}\mathscr{R}\;\rrbracket \;\dots\; \rrbracket \xRightarrow{\textit{Domain narrowing II}} \llbracket_{\mathrm{Phr}}\llbracket_{\mathrm{Wrd}}\llbracket_{\mathrm{Stm}}\mathscr{R}\;\rrbracket \;\dots\; \rrbracket\llbracket_{\mathrm{Wrd}}\llbracket_{\mathrm{Stm}}\mathscr{R}\;\rrbracket \;\dots\; \rrbracket \;\dots\; \rrbracket$$

Figure 4: The domain of application of $\mathscr{R}$ shrinks further: at stage 4, it becomes sensitive to stem edges.

This change also comes about because of input restructuring. In the same way that the first phase of domain narrowing is driven by reinterpretation of the surface effects generated by the innovative rule at the phrase level as already being present in the word-level output representation, domain narrowing II occurs by restructuring of the word-level input and a modification of the phonological processes that apply in the stem stratum. This is illustrated schematically in Figure 5 below (see §4.1.3 for an example from Galician).

	Stage 2	$\xRightarrow{\textit{Domain narrowing I}}$	Stage 3	$\xRightarrow{\textit{Domain narrowing II}}$	Stage 4
SL input	$[\![_{\text{Stm}}\ \alpha\ ]\!]$		$[\![_{\text{Stm}}\ \alpha\ ]\!]$		$[\![_{\text{Stm}}\ \alpha\ ]\!]$
	$\downarrow$ $\mathscr{R}$ does not apply $\downarrow$		$\downarrow$ $\mathscr{R}$ does not apply $\downarrow$		$\downarrow$ $\mathscr{R}$ applies $\downarrow$
SL output	$[_{\text{Stm}}\ \alpha\ ]$		$[_{\text{Stm}}\ \alpha\ ]$		$[_{\text{Stm}}\ \beta\ ]$
WL input	$[\![_{\text{Wrd}}\ \alpha\ ]\!]$		$[\![_{\text{Wrd}}\ \alpha\ ]\!]$		$[\![_{\text{Wrd}}\ \beta\ ]\!]$
	$\downarrow$ $\mathscr{R}$ does not apply $\downarrow$		$\downarrow$ $\mathscr{R}$ applies $\downarrow$		$\downarrow$ faithful mapping $\downarrow$
WL output	$[_{\text{Wrd}}\ \alpha\ ]$		$[_{\text{Wrd}}\ \beta\ ]$		$[_{\text{Wrd}}\ \beta\ ]$
PL input	$[\![_{\text{Phr}} \ldots \alpha \ldots]\!]$		$[\![_{\text{Phr}} \ldots \beta \ldots]\!]$		$[\![_{\text{Phr}} \ldots \beta \ldots]\!]$
	$\downarrow$ $\mathscr{R}$ applies $\downarrow$		$\downarrow$ faithful mapping $\downarrow$		$\downarrow$ faithful mapping $\downarrow$
PL output	$[_{\text{Phr}} \ldots \beta \ldots]$		$[_{\text{Phr}} \ldots \beta \ldots]$		$[_{\text{Phr}} \ldots \beta \ldots]$

Figure 5: Domain narrowing II by input restructuring at the word level.

2.1.5 Stage 5: Lexicalisation/Morphologisation

After completion of stage 4, the new rule is deeply integrated in the phonology of the language: any stem-structure submitted to the phonological module from the lexicon may potentially trigger its application. This can therefore cause another change in status over time: the output structures that the innovative rule generates may be reinterpreted as underlying. Thus, *lexicalisation* is the final phase of input restructuring. This occurs when underlying morphemes are restructured in accordance with the surface effects that the innovative rule creates. Alternatively, the innovative rule may undergo *morphologisation*, thereby evolving from a stem-level phonological rule into a purely morphological one.[6]

Whether by lexicalisation or morphologisation, the innovative phonological rule becomes inert at stage 5: if it does not actively generate alternations, it is eliminated from the grammar.[7] Once it is no longer part of the grammar of the language — i.e. it is no longer acquired by the youngest generation of speakers (McMahon 2000: 10) — the innovative process has reached the end of its life cycle.

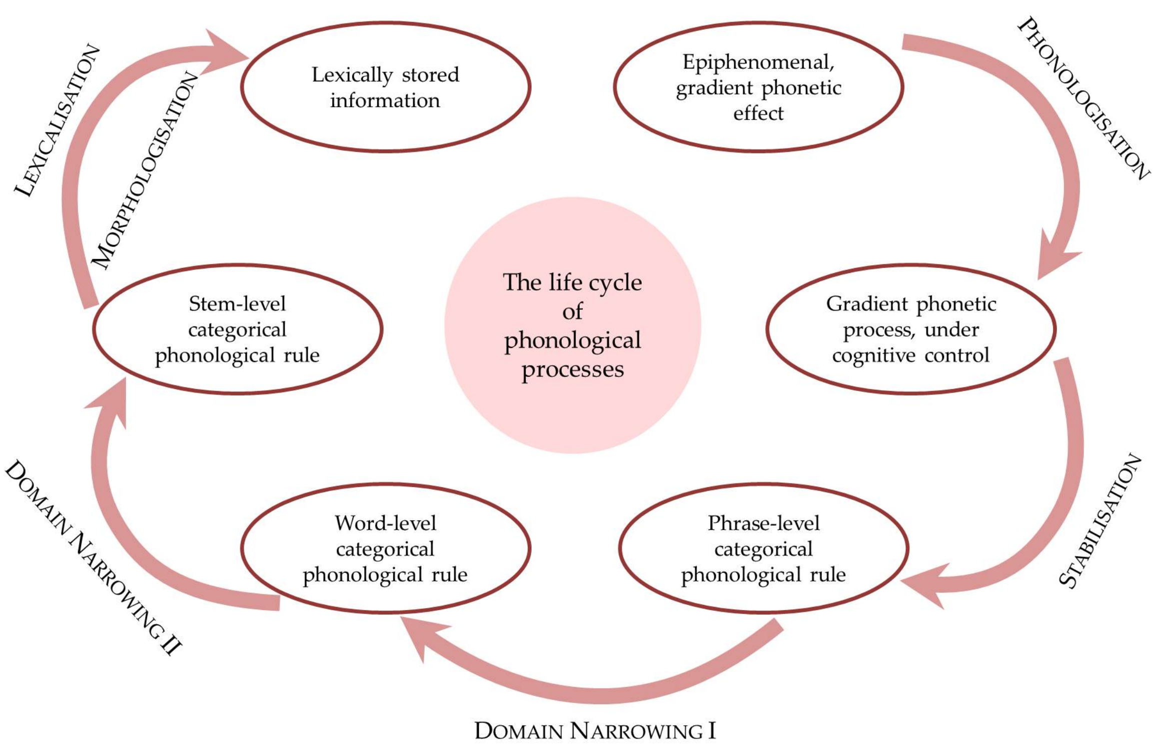

Figure 6: The life cycle.

2.2 Summary

The life cycle highlights two key facts about phonological change. Firstly, assuming a *modular* grammatical architecture captures the fact that sound change happens in ordered stages: older phonological rules are more closely integrated with higher-level grammatical structure, whereas newer rules are typically conditioned by phonotactic factors and therefore do not display sensitivity to morphosyntax. Secondly, the pathway of change defined by the life cycle is *unidirectional*: categorical operations that emerge from gradient phonetic effects climb up the modular grammar over time. Thus, a pathway of change where an innovative rule emerges in the higher strata and gradually filters downwards into the lower strata (and thence, into the phonetic module) is not predicted to occur, at least in cases of internally-induced phonological change.[8]

3 Two challenges to the model

The two core assumptions of the life cycle, modularity and unidirectionality, provide crucial insights into the mechanisms of sound change cross-linguistically. Nevertheless, it is fitting to consider some examples of language change reported in the literature which appear to contradict these assumptions. Here, I examine two cases: (i) continuancy dissimilation in Cypriot Greek (§3.1), and (ii) /o/-lowering in Swiss German (§3.2).

3.1 Diachronic rule descent

Kaisse (1993) discusses a dissimilation process in Greek which prevents members of a consonant cluster from having an identical surface specification for [±cont]. Athenian Greek also has a separate process which hardens /j/ in /Cj/-clusters to [ç] or [ɟ] depending on the voicing of the preceding consonant (Newton 1972b: ch. 6). In Cypriot Greek, by contrast, glide hardening generates palatal stops (Newton 1972a): as illustrated by the data in (1), this produces an interesting interaction with continuancy dissimilation.

(1)			*Athenian Greek*	*Cypriot Greek*	*Gloss*
	a.	/xaɾak-s-a/	[xaɾaksa]	[xaɾaksa]	‘engrave.1SG.PAST’
	b.	/xaɾak-tis/	[xaɾaxtis]	[xaɾaxtis]	‘engraver’
	c.	/ek-tim-o/	[extimo]	[extimo]	‘esteem.1SG.PRES’
	d.	/mati/~/mati-a/	[mati]~[matça]	[mati]~[maθca]	‘eye/eyes’
	e.	/spiti/~/spiti-a/	[spiti]~[spitça]	[spiti]~[spiθca]	‘house/houses’

Consider, firstly, the operation of dissimilation in (1)a–c. Continuancy dissimilation is neutralising: in these examples, it applies in heteromorphemic CC-clusters and causes the coda consonant to have the opposite surface specification for [±cont] to the following onset. Secondly, note that the application of glide hardening in the Athenian dialect in (1)d–e does not trigger dissimilation because [tç] is a licit cluster. However, continuancy dissimilation does apply in the Cypriot dialect to repair the illicit $*[C_{[-\text{cont}]}C_{[-\text{cont}]}]$ sequence that hardening generates.

Given that continuancy dissimilation bears all the hallmarks of a high-level lexical rule (Kaisse 1993: 349), we would expect under the life cycle that the younger, innovative rule of glide hardening ought to apply in a lower stratum. However, contrary to the predictions of the life cycle, Kaisse argues that the emergence and stabilisation of glide hardening has caused continuancy dissimilation to undergo *rule descent* in Cypriot Greek.

(2)

	Proto Cypriot Greek I	⟹	*Proto Cypriot Greek II*	⟹	*Synchronic Cypriot Greek*
Lexical Rules	Continuancy Dissimilation		Continuancy Dissimilation		Glide Hardening
Postlexical Rules			Glide Hardening		Continuancy Dissimilation

The trajectory of change that Kaisse assumes is shown in (2). In a rule-based framework, this analysis captures the fact that the application of dissimilation in examples like [maθca] is dependent upon the prior application of glide hardening.[9] However, whereas glide hardening first stabilises as a postlexical rule,[10] continuancy dissimilation is argued to have evolved from a lexical rule into a postlexical one as glide hardening has undergone domain narrowing in a further phase of change. This type of change is a challenge to the life cycle because putative cases of diachronic rule descent by "domain broadening" are predicted to be impossible under strict adherence to the principle of unidirectionality.

Nevertheless, an alternative analysis of the facts reveals that Cypriot Greek is consistent with the life cycle. Consider the alternative trajectory of change illustrated in (3).

(3)

	Proto Cypriot Greek I	⟹	*Proto Cypriot Greek II*	⟹	*Synchronic Cypriot Greek*
Stem/Word level	Continuancy Dissimilation		Continuancy Dissimilation		G. Hardening C. dissimisation
Phrase level			Glide Hardening		
Phonetics	Gradient Glide Hardening		Gradient Glide Hardening		Gradient Glide Hardening

Under this analysis, glide hardening first emerges as a gradient phonetic process. In the phase of change between proto-grammar I and proto-grammar II, this process stabilises: all instances of /j/ in prevocalic /Cj/-sequences thus become targets for a phrase-level categorical hardening rule. Domain narrowing in a later phase of change then causes the hardening rule to ascend into the lexical strata: at this point, it may now interact with the existing lexical processes including continuancy dissimilation. With regard to the synchronic grammar, the essential observation here is that the interaction of glide hardening and continuancy dissimilation need not be *interstratal* in Cypriot Greek. By constrast, assuming LPM, the data in (1)b–d can be straightforwardly accounted for if one posits a stratum-internal feeding effect (cf. Newton 1972b: 164).

(4) Synchronic Cypriot Greek

		/mati-a/ 'eyes'	/spiti-a/ 'houses'
Stem/Word level	Glide formation	matja	spitja
	G. Hardening	matca	spitca
	C. Dissimilation	maθca	spiθca
Phrase level		—	—
Surface form		[maθca]	[spiθca]

In (4), both glide hardening and continuancy dissimilation are lexical rules in synchronic Cypriot Greek. As in standard LPM analyses, the application of hardening creates a new input which triggers the application of a later rule, i.e. dissimilation. Under this analysis, there is no diachronic rule descent: in agreement with the predictions of the life cycle, the innovative process phonologises, stabilises and then undergoes domain narrowing. Crucially, domain narrowing brings about a synchronic interaction between the newer rule (hardening) and the older rule (dissimilation) *without* a concomitant broadening of the domain of application of the older rule.

Whilst relying on extrinsic rule ordering to generate the Cypriot Greek pattern might be viewed as undesirable, this is only problematic for rule-based frameworks like LPM. Indeed, the grammar of synchronic Cypriot Greek as given in (3) can straightforwardly be modelled in an OT framework where the application of dissimilation is not dependent upon the prior application of hardening.

(5)

ONSET	Assign one violation mark for every onsetless syllable in the output.
*Cj	Assign one violation mark for every occurrence of [Cj] in the output.
OCP[±cont]	For every C_1C_2 sequence in the output, assign one violation mark where C_1 bears the same specification for [±cont] as C_2.
FAITHFULNESS	Assign one violation mark for every unfaithful output mapping of an input segment.

(6) Stem/Word-level grammar in synchronic Cypriot Greek

/spiti-a/		ONSET	OCP[±cont]	*Cj	FAITHFULNESS
a.	[spitia]	*!			
b.	[spitja]			*!	*
c.	[spitca]		*!		*
d.	[spiθja]		*!	*!	*
e. ☞	[spiθca]				**

Here we see that the demands of the top-ranked markedness constraints favour the application of both hardening and dissimilation. ONSET militates against the fully faithful candidate (a) in which the final syllable is onsetless. The continuancy dissimilation constraint, OCP[±cont], then prevents the selection of candidate (c) exhibiting a sequence of two stops and of candidate (d) with a sequence of two continuants. *Cj is therefore decisive is choosing the candidate in which both dissimilation and hardening apply: hence, [spiθca].

Furthermore, note that the diachronic development schematised in (3) can also be modelled with this set of constraints. As glide hardening becomes categorical in the stabilisation phase between proto-grammar I and proto-grammar II, all that is required is the demotion of FAITHFULNESS relative to *Cj in order for the historical phrasal pattern to be generated. The change after proto-stage II then requires precisely the same reranking of the word-level constraint hierarchy for the synchronic pattern to emerge. This entails a crucial advantage for modelling the synchronic grammar of Cypriot Greek: specifically, the life cycle does not make the incorrect prediction that phonological processes apply in a serial order synchronically that matches the order that they are incorporated into the grammar diachronically (McMahon 1991, 2000: 9).

(7)

	Proto Cypriot Greek I
SL/WL:	ONSET, OCP[±cont] ≫ FAITH ≫ *Cj
PL:	ONSET, OCP[±cont] ≫ FAITH ≫ *Cj
	⇓
	Proto Cypriot Greek II
SL/WL:	ONSET, OCP[±cont] ≫ FAITH ≫ *Cj
PL:	ONSET, OCP[±cont] ≫ *Cj ≫ FAITH
	⇓
	Synchronic Cypriot Greek
SL/WL:	ONSET, OCP[±cont] ≫ *Cj ≫ FAITH
PL:	ONSET, OCP[±cont] ≫ *Cj ≫ FAITH

This interpretation of the diachronic facts means that both glide hardening and continuancy dissimilation can be modelled as transparent lexical processes in synchronic Cypriot Greek. As Kaisse asserts, a young, categorical phrase-level rule of glide hardening has undergone domain narrowing historically. This has brought it into the same domain as the older process of continuancy dissimilation, with which it interacts synchronically. Most importantly, the alternative analysis sketched above is entirely consistent with the life cycle and the principle of unidirectionality: it does not presuppose that the narrowing of the domain of application of glide hardening brings about a *broadening* of the domain of application of dissimilation diachronically.

3.2 Rule scattering

Another apparent challenge for theoretical models based on the premise that phonological change involves a gradual migration of a rule from one module or domain to another is that of rule scattering. A classic example is the interaction between /o/-lowering and umlaut in Swiss German, data from which are given in (8) and (9).[11]

(8) /o/-lowering in Swiss German (Kesswil and Schaffhausen dialects)

a.	/ops/	[ops]	'fruit'	e.	/bodə/	[bɔdə]	'floor'
b.	/bokx/	[bokx]	'ram'	f.	/trottə/	[trɔttə]	'sidewalk'
c.	/holts/	[holts]	'wood'	g.	/forə/	[fɔrə]	'Scots pine'
d.	/wonə/	[wonə]	'live'	h.	/horn/	[hɔrn]	'horn'

(9)

		Schaffhausen dialect	*Kesswil dialect*	*Gloss*
a.	/bogə/~/bogə-PL/	[bogə]~[bøgə]	[bogə]~[bøgə]	'bow/bows'
b.	/bodə/~/bodə-PL/	[bɔdə]~[bødə]	[bɔdə]~[bœdə]	'floor/floors'
c.	/trottə/~/trottə-li/	[trɔttə]~[trøtli]	[trɔttə]~[trœtli]	'sidewalk/ sidewalk.DIM'
d.	/torn/~/torn-PL/	[tɔrn]~[tœrn]	[tɔrn]~[tœrn]	'thorn/thorns'
e.	/xorb/~/xorb-li/	[xɔrb]~[xœrbli]	[xɔrb]~[xœrbli]	'basket/basket.DIM'

The examples in (8) illustrate that /o/ lowers to [ɔ] when followed by a coronal obstruent ((8)e–f) or /r/ ((8)g–h) in both dialects. However, the data in (9) reveal that /o/-lowering interacts differently with umlaut — i.e. back-vowel fronting — in the two varieties. In the Kesswil dialect, any /o/ that undergoes lowering in the monomorphemic examples surfaces as [œ] in the polymorphemic examples ((9)b–e); but in monomorphemes where /o/-lowering does not apply ((9)a), the corresponding polymorphemic item surfaces with [ø].

The two rules generate a different pattern in the Schaffhausen dialect. In (9)d–e which contain /or/ sequences underlyingly, we observe the application of lowering and umlaut in the polymorphemic items, just as in the Kesswil dialect. However, in (9)a–c, /o/ fails to lower before a coronal obstruent in the polymorphemes: the output of umlaut in all three of these examples is [ø]. Thus, [ø] corresponds both to [o] in monomorphemes like [bogə] and to [ɔ] in monomorphemes like [bɔdə] and [trɔttə].

Drawing upon analyses first discussed by Kiparsky (1965, 1968), Robinson (1976) proposes that the Schaffhausen alternations can best be accounted for by assuming a scenario of diachronic *rule generalisation*. Under this view, an old, pan-dialectal rule of /o/-lowering before /r/ has expanded over time: this has resulted in the emergence of a new lowering rule that targets /o/ before all coronal obstruents. In the pre-LPM generative framework, Robinson (1976: 155, 159) claims that the innovative rule is added at the very end of the dialect-specific list of ordered rules. Kaisse (1993: 356–357), in turn, interprets this as meaning that the generalised version of lowering applies postlexically. Consequently, the two versions of the lowering rule are synchronically *scattered* between the highest stratum and the lowest stratum in the synchronic phonology of the Schaffhausen dialect (see (10) below).

(10)

	Conservative Swiss German	⟹	*Synchronic Schaffhausen German*
Stem level	/o/-lowering before /r/		/o/-lowering before /r/
Word level	umlaut		umlaut
Phrase level			generalised /o/-lowering

In the conservative dialects,[12] we shall assume that /o/-lowering before /r/ applies in the highest stratum. Since umlaut is triggered by inflectional operations like pluralisation (9)a,b,d and diminutive formation (9)c,e, we shall assume that this rule applies at the word level. Thus, the phonological change in the Schaffhausen dialect involves the emergence of an innovative version of /o/-lowering: an old, high-level rule whose application is restricted to a single context appears to have evolved into a phrasal rule whose contextual application is far less restricted. At first sight, therefore, it is not clear how the Schaffhausen innovation can be accounted for with respect to the principles of unidirectionality and modularity.

Nevertheless, if we consider the microtypology as a whole, we see that these dialects exhibit a domain-narrowing effect that follows precisely the trajectory of change predicted by the life cycle.

(11)

	St.Galler Rheintal	$\Longrightarrow$	*Schaffhausen*	$\Longrightarrow$	*Kesswil*
Stem level	pre-/r/ lowering		pre-/r/ lowering		pre-/r/ lowering gnrl. lowering
Word level	umlaut		umlaut gnrl. lowering		umlaut

In the Schaffhausen variety, the critical difference in (11) compared to (10) is that generalised lowering is already a stable word-level process rather than a phrasal one. In the Kesswil variety, the innovative lowering rule has advanced even further, and now applies at the stem level. Generalised lowering may therefore interact synchronically with existing word-level rules in the Schaffhausen dialect and with the existing stem-level rules in the Kesswil dialect.

Crucially, the pathway of change shown in (11) explains the gradual increase in the application of /o/-lowering across morphophonological contexts in this group of dialects. In (12)a below, we see that /o/-lowering is highly restricted in the most conservative variety. Lowering occurs at the stem-level only before /r/: therefore, it applies transparently in monomorphemes like (12)a-i and opaquely in the corresponding polymorphemes (i.e. (12)a-ii) where it is in a counterbleeding relationship with word-level umlaut. By the time generalised lowering has reached the word level in the Schaffhausen dialect, lowering also applies in monomorphemes like [trɔttə] ((12)b-iii); the prior application of umlaut at the word level, however, prevents the application of lowering in examples like (12)b-iv. Yet in a subsequent phase of innovation, narrowing of the domain of application of generalised lowering in the Kesswil dialect causes this final restriction to be eliminated. Specifically, observe in (12)c-iv that word-level umlaut counterbleeds the stem-level generalised lowering rule. Thus, /o/-lowering overapplies in morphologically complex forms both before /r/ ((12)c-ii) and before coronal obstruents ((12)c-iv) in this variety.

What this reveals is that although the scattering of the /o/-lowering rules in

Schaffhausen Swiss German appears problematic from the viewpoint of the life cycle, the diachronic development of this dialect continuum in fact ties in exactly with the predictions of the model. Whereas lowering is restricted to a single context in most the conservative variety, we observe a gradual expansion in the contextual application of /o/-lowering rule in the advanced dialects. In the Schaffhausen dialect, the application of generalised lowering at the word level causes /o/-lowering to apply in morphologically simple words, but not in morphologically complex words which are targets for word-level umlaut. However, in the most advanced variety, i.e. the Kesswill dialect, a historical extension of the innovative process from the word level to the stem level by domain narrowing means that generalised lowering is integrated even further into the high-level grammatical structure. This therefore results in increased overapplication of /o/-lowering synchronically: lowering and umlaut both apply in morphologically complex forms containing /or/ or /o$C_{[\text{COR, –cont}]}$/ sequences underlyingly.

(12) a. St. Galler Rheintal dialect

		i.	ii.	iii.	iv.
		⟦$_{\text{Wrd}}$⟦$_{\text{Stm}}$xorb⟧⟧	⟦$_{\text{Wrd}}$⟦$_{\text{Stm}}$xorb⟧-li⟧	⟦$_{\text{Wrd}}$⟦$_{\text{Stm}}$trottə⟧⟧	⟦$_{\text{Wrd}}$⟦$_{\text{Stm}}$trottə⟧-li⟧
		‘basket’	‘basket.DIM’	‘sidewalk’	‘sidewalk.DIM’
Stem level	pre-/r/ lowering	xɔrb	xɔrb	—	—
Word level	umlaut	—	xœrb-li	—	trøttə-li
	syncope	—	—	—	trøtli
Surface form		[xɔrb]	[xœrbli]	[trottə]	[trøtli]

b. Schaffhausen dialect

		⟦$_{\text{Wrd}}$⟦$_{\text{Stm}}$xorb⟧⟧	⟦$_{\text{Wrd}}$⟦$_{\text{Stm}}$xorb⟧-li⟧	⟦$_{\text{Wrd}}$⟦$_{\text{Stm}}$trottə⟧⟧	⟦$_{\text{Wrd}}$⟦$_{\text{Stm}}$trottə⟧-li⟧
Stem level	pre-/r/ lowering	xɔrb	xɔrb	—	—
Word level	umlaut	—	xœrb-li	—	trøttə-li
	gnrl. lowering	—	—	trɔttə	—
	syncope	—	—	—	trøtli
Surface form		[xɔrb]	[xœrbli]	[trɔttə]	[trøtli]

c. Kesswil dialect

		⟦$_{\text{Wrd}}$⟦$_{\text{Stm}}$xorb⟧⟧	⟦$_{\text{Wrd}}$⟦$_{\text{Stm}}$xorb⟧-li⟧	⟦$_{\text{Wrd}}$⟦$_{\text{Stm}}$trottə⟧⟧	⟦$_{\text{Wrd}}$⟦$_{\text{Stm}}$trottə⟧-li⟧
Stem level	pre-/r/ lowering	xɔrb	xɔrb	—	—
	gnrl. lowering	—	—	trɔttə	trɔttə
Word level	umlaut	—	xœrb-li	—	trœttə-li
	syncope	—	—	—	trœtli
Surface form		[xɔrb]	[xœrbli]	[trɔttə]	[trœtli]

4 Expansion with and without domain narrowing

As noted above, rule-generalisation effects are important because they involve the diachronic expansion of phonological processes without domain narrowing. This fact has not been discussed in great depth in the existing literature on the life cycle: accordingly, it is appropriate here to question precisely what rule generalisation implies for the model.

As far as the existing impressionistic descriptions of Swiss German allow us to determine, rule generalisation entails a single extension of the old /o/-lowering rule: a new, generalised version of /o/-lowering emerges whose structural description is *less restrictive* than the original rule. However, other generalisation patterns provide evidence for a series of extensions to an established rule. For example, consider the following data (from Vennemann 1978: 260–261).[13]

(13) /s/-palatalisation in Germanic dialects
  a. *Oslo Norwegian*: /s/ → [ʃ] / [$_{\sigma}$___ l
  b. *Northern German*: /s/ → [ʃ] / [$_{\sigma}$___ {l, r, m, n, v}
  c. *Standard German*: /s/ → [ʃ] / [$_{\sigma}$___ {l, r, m, n, v, p, t}

The data in (13) form a microtypology of preconsonantal /s/-palatalisation. In the most conservative variety, i.e. Oslo Norwegian, /s/ palatalises in a single context, namely before tautosyllabic /l/. /s/-palatalisation before /l/ also occurs in Northern and Standard German, but in these dialects we also observe its application in other preconsonantal contexts. However, the increase in use of palatalisation in the more advanced dialects does not involve a change in the domain of application of the palatalisation rule; on the contrary, palatalisation remains a purely phonotactic process.

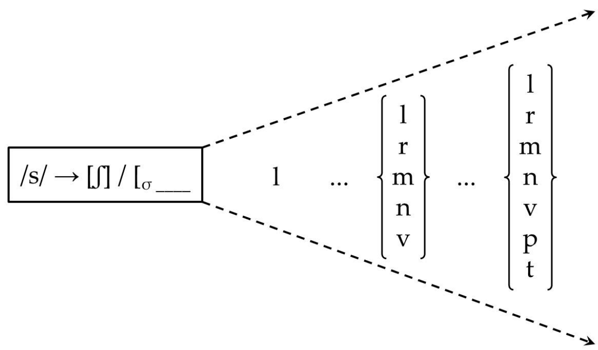

Figure 7: Generalisation of /s/-palatalisation.

Given that rule generalisation does not involve an upward modular migration of a rule, it is important to consider how effects like these fit into the life cycle. In the following sections, we shall turn our attention to a microtypology of Ibero-Romance dialects which exhibit different stages of advancement of a coda nasal velarisation process. This phenomenon is particularly interesting because its application in the dialect continuum that we shall consider spans almost the whole life cycle, and there is evidence of rule generalisation in the more advanced dialects.

4.1 The life cycle in action: nasal velarisation in Ibero-Romance

Word-final nasal velarisation — i.e. the neutralisation of nasal place contrasts to [ŋ] word-finally — has been documented for numerous sociolinguistically unconnected dialects of Spanish.[14] As Harris (1984) shows, velarisation involves the assignment of a [DORSAL] place feature to nasals in the word-final neutralisation context: *velarising* dialects of Spanish therefore differ from the more conservative, *alveolarising* dialects in which the output to neutralisation is [CORONAL]. Since velarisation is an innovative process, close examination of members of the dialect continuum in which it occurs provides interesting insights with regard to the life cycle. The following sections describe the trajectories of change that have produced certain dialect-specific patterns of velarisation diachronically.

4.1.1 Emergence, phonologisation, stabilisation

Tracing the origins of coda nasal velarisation is not a straightforward matter because we cannot observe the effect directly.[15] In accordance with the predictions of the life cycle, we shall work from the assumption that this process first emerged as a gradient phonetic phenomenon. Thus, let us suppose that in the dialects ancestral to the varieties of Spanish which exhibit synchronic caterogical nasal velarisation, a reinterpretation of phonetic cues caused speakers to create a new rule of phonetic implementation that assigns a secondary dorso-velar occlusion target to word-final nasals in non-preconsonantal position. This yields the following patterns.

(14) Proto Velarising Spanish I: gradient coda nasal velarisation undergoes phonologisation

a.	⟦$_{\text{Phr}}$... panaθo ...⟧	→	[panaθo]	'bread.AUG'
b.	⟦$_{\text{Phr}}$... pan#aθimo ...⟧	→	[panaθimo]	'unleavened bread'
c.	⟦$_{\text{Phr}}$... kome#pan⟧	→	[komepan͡ŋ‖]	'eat.3SG.PRES bread'

Once velarisation has undergone phonologisation, it is no longer an aberrant phonetic effect, but rather a cognitively-controlled phonetic process. Through regularised use and inter-generational transfer, speakers come to reinterpret the gradient velarisation pattern: the secondary dorso-velar occlusion gesture that is assigned to phrase-final instances of /n/ is reanalysed as primary. This phase of stabilisation is the birth of a new, categorically velarising variety of Spanish. Place contrasts in prepausal nasal codas now neutralise to [DORSAL] thereby yielding a pattern of phrase-final velarisation.

(15) Proto Velarising Spanish II: coda nasal velarisation stabilises

a.	⟦$_{\text{Phr}}$... panaθo ...⟧	→	[panaθo]	'bread.AUG'
b.	⟦$_{\text{Phr}}$... pan#aθimo ...⟧	→	[panaθimo]	'unleavened bread'
c.	⟦$_{\text{Phr}}$... kome#pan⟧	→	[komepaŋ‖]	'eat.3SG.PRES bread'

4.1.2 Domain narrowing I: PL ⇒ WL

After stabilisation, the next stage of change predicted by the life cycle is that the pattern of phrase-final velarisation will extend to the word level. This occurs because of analogical pressures for the word-level grammar to conform to phrase-level pattern where [DORSAL] is assigned to nasals in the domain-final neutralisation context.

(16) Peninsular Velarising Spanish (Ramsammy 2012a)

Stem level: domain-final coda nasals neutralise to [CORONAL]

a.	⟦$_{\text{Stm}}$pan⟧	→	[pan]	'bread'

Word level: domain-final coda nasals neutralise to [DORSAL]

b.	⟦$_{\text{Wrd}}$pan⟧	→	[paŋ]	'bread'
c.	⟦$_{\text{Wrd}}$pan-aθ-o⟧	→	[panaθo]	'bread.AUG'

Phrase level: domain-final coda nasals neutralise to [DORSAL]

d.	⟦$_{\text{Phr}}$... panaθo ...⟧	→	[panaθo]	'bread.AUG'
e.	⟦$_{\text{Phr}}$... paŋ#aθimo ...⟧	→	[paŋaθimo]	'unleavened bread'
f.	⟦$_{\text{Phr}}$... kome#paŋ⟧	→	[komepaŋ‖]	'eat.3SG.PRES bread'

As stated in §2.1.3, the driving force behind domain narrowing is input restructuring. In (15), the velarisation rule targets any nasal that occurs in domain-final position at the phrase-level: i.e. word-final prepausal coda nasals. Over time, however, this pattern is subject to reinterpretation. Confronted with the historical adult pattern, a younger generation of speakers infer that instances of prepausal [ŋ] do not arise because of an unfaithful mapping of word-final /n/ to [ŋ], but rather because of a faithful mapping of word-final /ŋ/ to [ŋ]. Thus, the input to the phrasal phonology is restructured to reflect this reinterpretation of the facts (see Figure 3): speakers construct a grammar in which all word-final nasals exit the word-level phonology specified for [DORSAL] place.

This has two critical consequences. Firstly, the word-level grammar is modified such that any nasal that occurs in domain-final position is a target for neutralisation to [ŋ]. The older rule of domain-final neutralisation to [n] — which still operates at all derivational levels in the conservative, alveolarising dialects (see Ramsammy 2012b for further discussion) — now applies only in the smallest domain in velarising dialects, i.e. the stem level. Both the word-level and phrase-level grammars, by contrast, enforce the application of the innovative neutralisation pattern. Secondly, as the velarisation rule migrates upwards to the word level, a pattern of paradigmatic opacity emerges: as in example (16)e, velarisation appears to overapply at the phrase level in word-final prevocalic contexts because of the local assignment of a [DORSAL] place feature to word-final nasals at the word level.

This state of affairs characterises many dialects of Velarising Spanish synchronically: word-level velarisation creates a surface contrast between place-neutralised nasals that occur in domain-final position at the word level and those that do not. This is what we observe, for example, by comparing (16)d and (16)e. Stems like ⟦$_{\text{Stm}}$pan⟧ are subject to (static) neutralisation to [CORONAL] at the stem level: no nasal other than [n] may occur stem-finally in any dialect of Velarising Spanish. At the word level, however, domain-final nasals are targets for (dynamic) neutralisation to [ŋ]. Thus, citation forms like [paŋ] display the effects of velarisation, whereas forms like [panaθo] — in which /n/ does not occur in domain-final position at the word level — do not. Accordingly, the stem level grammar continues to enforce the historical pattern of neutralisation to [n] crucially because restructuring of the word-level input, as illustrated in §2.1.4, has not yet occurred in Velarising Spanish.

4.1.3 Domain narrowing II and lexicalisation: WL ⇒ SL ⇒ Lexicon

Although velarisation is strictly confined to the lower strata in Spanish, an interesting case of extension of the word-level velarisation rule can be observed in Galician. Consider the following data (from Colina & Díaz Campos 2006; see also Carballo Calero 1976: 144–145).

(17) Nasal velarisation in function words: Velarising Spanish vs Galician

	Velarising Spanish	*Galician*	*Gloss*
a.	[uŋ]~[una]	[uŋ]~[uŋa]	‘ART.INDEF.M/F’
b.	[alguŋ]~[alguna]	[alxuŋ]~[alxuŋa]	‘some, any’ (M/F)
c.	[niŋguŋ]~[niŋguna]	[niŋguŋ]~[niŋguŋa]	‘no, none’ (M/F)
d.	[de#uŋ]~[de#una]	[duŋ]~[duŋa]	‘of a’ (M/F)

Here we see that velarisation has come to apply outside of word-final position in Galician: nasals in word-medial prevocalic position in this class of function words display the effects of neutralisation to [DORSAL]. As Colina & Díaz Campos (2006) observe, this process affects only function words: word-medial nasals in non-functional vocabulary do not undergo velarisation. With regard to the life cycle, we may therefore infer that, at some point in the history of Galician, a split in the grammar took place such that function words became targets for an advanced velarisation process. This development is illustrated in (18) below.

(18) Evolution of velarisation in Galician functional vocubulary

	Non-functional vocabulary	*Functional vocabulary*
	SL: neutralisation to [COR] domain-finally	SL: neutralisation to [COR] domain-finally
	WL: neutralisation to [DOR] domain-finally	WL: neutralisation to [DOR] domain-finally
		⇓
Phase 1:	*No input restructuring*	*Input restructuring at WL* ⇓
	No domain narrowing	*Domain narrowing II* ⇓
	SL: neutralisation to [COR] domain-finally	SL: neutralisation to [DOR] domain-finally
	WL: neutralisation to [DOR] domain-finally	WL: neutralisation to [DOR] domain-finally
		⇓
Phase 2:	*No input restructuring*	*Input restructuring at SL* ⇓
	No lexicalisation	*Lexicalisation* ⇓
	No lexical restructuring	Lexical storage of forms with /ŋ/

In the stage preceding the expansion of velarisation, the Galician grammar is identical to that of synchronic Velarising Spanish: velarisation applies domain-finally at the word-level, whereas the stem-level grammar enforces the older pattern of domain-final neutralisation to [CORONAL]. In the first phase of innovation, domain-final neutralisation to [DORSAL] climbs up from the word level to the stem level; however, it targets only functional vocabulary like that listed in (17). Thus, input restructuring at the word level (see §2.1.4) causes masculine words like /algun/ to undergo velarisation directly in the stem-stratum; but since the presuffixal nasal is not domain-final at the stem level in feminine words like /algun-a/, velarisation does not obtain. Nevertheless, in a second phase of innovation, stem-final velarisation extends analogically from the masculine functional items to the feminine words. This development also occurs through input restructuring, this time at the stem-level. Thus, forms with /ŋ/ become lexicalised.

As shown in (19), functional vocabulary in which the /ŋ/ is underlying are therefore exempt from stem-level neutralisation to [n] in synchronic Galician. Consequently, we observe a pattern of surface contrast different from that of Velarising Spanish in which (i) feminine functional items display a word-medial prevocalic [ŋ] (e.g. (19)c/g [alxu**ŋ**a]); (ii) non-functional items like (19)f [ka**n**iɲo] display the effects of stem-final presuffixal place neutralisation to [n]; and (iii) citation forms like [pa**ŋ**] exhibit the application of word-final coda nasal velarisation.

(19) Synchronic Galician

	a.	b.	c.
UR:	/man/	/alguŋ/	/alguŋ-a/
SL neutralisation:	⟦$_{\mathrm{Stm}}$man⟧ ↓ [man]	⟦$_{\mathrm{Stm}}$alguŋ⟧ ↓ [alxuŋ]	⟦$_{\mathrm{Stm}}$alguŋ-a⟧ ↓ [alxuŋa]

	d.	e.	f.	g.
WL neutralisation:	⟦$_{\mathrm{Wrd}}$man⟧ ↓ [maŋ]	⟦$_{\mathrm{Wrd}}$man-iɲ-a⟧ ↓ [maniɲa]	⟦$_{\mathrm{Wrd}}$alxuŋ⟧ ↓ [alxuŋ]	⟦$_{\mathrm{Wrd}}$alxuŋa⟧ ↓ [alxuŋa]
	‘hand’	‘hand.DIM’	‘some, any (M)’	‘some, any (F)’

4.1.4 Rule generalisation

Unlike the advanced velarisation process that operates in Galician, some Caribbean varieties of Spanish provide evidence of expansion of the velarisation rule that does not involve diachronic domain narrowing beyond the word level. Specifically, whereas detailed instrumental investigation reveals that word-final velarisation is confined to prepausal and prevocalic contexts in dialects like Peninsular Velarising Spanish (Ramsammy 2012a) and Cuban Spanish (Kochetov & Colantoni 2011), other dialects are reported to display a more advanced velarisation process that also targets word-final preconsonantal nasal codas. Here, we shall focus on data reported for the Caracas dialect of Venezuelan Spanish (henceforth, Caraqueño) in D'Introno & Sosa (1988).

	/-N#C$_{[\text{COR}]}$-/	/-N#C$_{[\text{LAB}]}$-/	/-N#C$_{[\text{DOR}]}$-/
Velarisation (full dorso-velar closure)	42.2%	51.5%	95.9%
Velarisation (partial dorso-velar closure)	26.9%	21.1%	1.2%
Debuccalisation	17.6%	19.8%	1.7%
Assimilation	11.6%	6.3%	
Other realisations	1.7%	1.3%	1.2%

Table 1: Word-final preconsonantal nasal realisations in Caraqueño.

These data reveal that there is synchronic variation between three phrasal neutralisation processes: (i) velarisation, by which preconsonantal coda nasals place-neutralise to [DORSAL] (hence, [ŋC]); (ii) debuccalisation, by which preconsonantal nasals surface underspecified for place-of-articulation features (hence, [NC]); and (iii) assimilation, by which preconsonantal nasals are specified for place by feature spread (e.g. [mp, n̪t̪, ŋk]). This pattern of variation is not random; on the contrary, the variable application of these neutralisation strategies respects a markedness scale for place-of-articulation.

(20) *[ŋ]/___ C$_{[\text{COR}]}$ $\gg$ *[ŋ]/___ C$_{[\text{LAB}]}$ $\gg$ *[ŋ]/___ C$_{[\text{DOR}]}$

What is critical to note here is that this scale is functionally-motivated. As an inevitable consequence of the human articulatory anatomy, production of [ŋ] preceding coronal obstruents requires high-levels of muscular precision: specifically, the tongue-dorsum raising and retraction gesture must be very carefully timed relative to the tongue-tip raising gesture (see Browman & Goldstein 1992, Hall 2010). By contrast, gestural coordination of [ŋ] before a labial sound is less demanding since the two occlusion gestures require manipulation of two distinct articulatory organs; and homorganic [ŋC$_{[\text{DOR}]}$] clusters are least demanding with respect to articulatory coordination given that they have a monogestural implementation.

Although the data confirm that velarisation is synchronically variable in Caraqueño, a diachronic analysis involving rule generalisation is most plausible for explaining the synchronic asymmetries that D'Introno & Sosa observe. Velarisation occurs almost invariably in the phonetically most favourable environments, i.e. in pre-dorsal contexts. It applies somewhat less frequently in the phonetically less favourable pre-labial contexts; and in the pre-coronal contexts in which velarisation is least favoured from an articulatory point of view, we observe the lowest rate of application of the rule. This suggests a trajectory of change in which the word-final velarisation rule has gradually expanded from its original prevocalic/prepausal conditioning environment to the preconsonantal contexts, first targeting nasals in the phonetically most favourable environment and then generalising further to target nasals in less favourable environments.

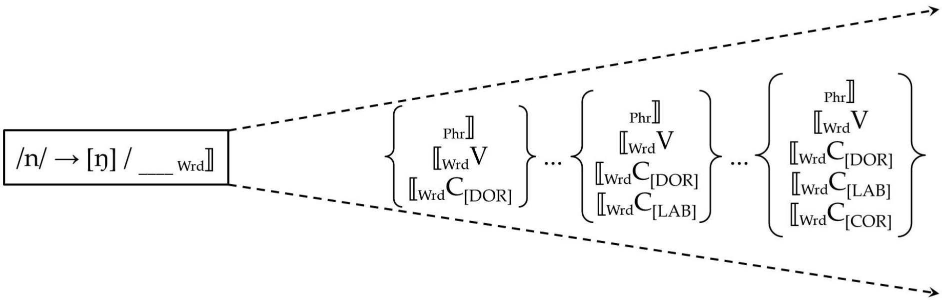

Figure 8: Generalisation of word-final nasal velarisation in Caraqueño.

This is therefore a clear case of what Schuchardt (1885: 22) refers to as *internal expansion* of a sound law by phonetic analogy: an innovative phonological process expands diachronically by rule generalisation, but rule generalisation itself is constrained by phonetic pressures. Crucially, the variable use of velarisation in Caraqueño is dependent on articulatory factors; but assuming a scenario of ongoing rule generalisation, the rate of application of velarisation is also proportional to the historical "age" of the contextual extension of the velarisation rule.

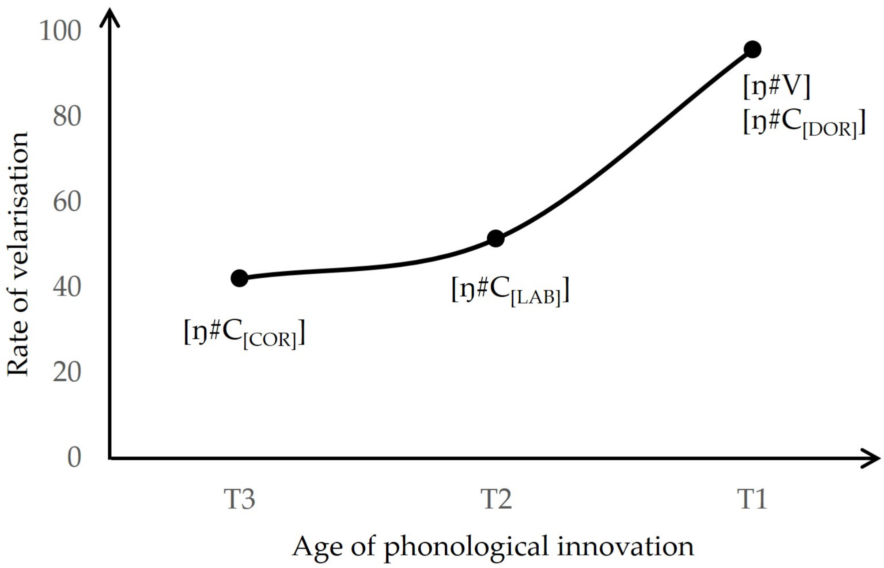

Figure 9: Stabilisation phases of nasal velarisation.

Here we see that velarisation in prevocalic and predorsal contexts is least synchronically variable because phonologisation and stabilisation of the velarisation rule occurred early (i.e. at time point 1). Likewise, velarisation of word-final nasals before labial or coronal obstruents is more variable synchronically given that phonologisation and stabilisation of these extensions of the velarisation rule is more recent: i.e. occurring in later phases of innovation. One possible reason for this is that the high rate of velarisation in prevocalic and predorsal contexts puts pressure on other word-final nasals to conform to the same neutralisation strategy. Thus, unless the process is reversed or altered under the influence of some other innovation, we predict that the trajectory of rule generalisation will ultimately cause Caraqueño to become a dialect of Spanish in which all word-final nasals obligatorily velarise to [ŋ] across phonotactic contexts.

5 Conclusion

The life cycle encompasses three core insights about phonological change. Firstly, it captures the fact that sound change happens in orderly stages. Innovations begin as epiphenomenal phonetic effects that undergo successive reinterpretations: a gradient phonetic process first becomes a categorical rule, and the categorical rule becomes increasingly integrated with morphosyntax as it ages. This observation leads to the second core insight of the life cycle: namely, that synchronic grammars of all languages are shaped both by sound changes that have previously completed their life cycle, and also by younger, ongoing changes. Thirdly, sound changes rarely occur in isolation: rather, they typically occur in numerous genetically related varieties across a dialect continuum. Crucially, the rate at which the sound change progresses differs from dialect to dialect. What we therefore observe as a synchronic microtypology of dialectal patterns of variation reflects different stages of advancement in the life cycle of phonological processes.

The life-cycle model presented here has grown out of decades of research on sound change: the core claims of the model draw upon hypotheses that have been formulated and reformulated throughout the history of phonology. Thus, in providing the analyst with a highly restrictive framework that makes empirically-verifiable predictions about synchronic and diachronic dialectal variation, the life cycle is indispensable as a modern theory of phonological change.

Notes

[1]See, for example, data on the High German consonant shift presented in Schrijver (2011: §§2–5, pp. 218–238)

[2]See, for example, Zsiga (1994), Holst & Nolan (1995), Ellis & Hardcastle (2002), Kochetov & Pouplier (2008), Ramsammy (2012a: chs. 4–5).

[3]See, for example, Hyman (1976), Ohala (1993), Blevins (2004: ch. 5); cf. Hansson 2008: 13ff..

[4]It may, however, display sensitivity to prosodic structure: see Bermúdez-Otero (2011: §4).

[5]It is important here to draw a distinction between the restructuring process that causes reanalysis of inputs to each level of the phonology and phases of change with cause restructuring of lexical forms. Crucially, domain narrowing does not involve any changes to lexical structures: changes to lexical representations occur only in the final phase of the life cycle, namely by lexicalisation (see §2.1.5 below).

[6]The distinction between lexicalisation and morphologisation is a fine-grained one, and diagnosing cases of one or the other development often depends upon specific programmatic assumptions. For lack of space, I shall not discuss this issue here (see Bermúdez-Otero & Trousdale 2012, Anderson 1988: 329ff.).

[7]For example, see Roberts (2012) on the life cycle of Latin rhotacism.

[8]Phonological changes that do not conform to the principles of unidirectionality and modularity may

arise under certain circumstances, for example when the change is externally-induced (as in situations of language contact between adults).

[9]i.e. /mati-a/ → /matca/ → [maθca].

[10]i.e. at the stage reconstructed as Proto Cypriot Greek II. This stage may also characterise the synchronic grammar of Athenian Greek. Whereas the output to glide hardening is different from Cypriot Greek (recall that the Athenian dialect has either [Ç̥ç] or [Ç̬ʝ]), phrasal hardening does also occur: e.g. σπίτι απέναντι /spiti#apenadi/ → [spitçapenadi] 'house opposite'. It is nevertheless not clear from existing descriptions whether this phenomenon is best considered the result of the application of a categorical phrasal rule, or whether it may instead be a gradient phonetic effect.

[11]These examples are taken from Robinson (1976).

[12]The St. Galler Rheintal dialect is representative of this stage: Robinson (1976: 151) notes that this variety exhibits /o/-lowering before /r/, but not before other coronals.

[13]Vennemann, following Schuchardt, at times refers to this process as "phonetic analogy". To avoid potential confusion, I shall use the term *rule generalisation* exclusively.

[14]For example, see Robe (1960), Terrell (1975), Jiménez Sabater (1975), Hammond (1979), Núñez-Cedeño (1980), López Morales (1983), Lipski (1986), D'Introno & Sosa (1988), Hernández (2011). Furthermore, note that this phenomenon is not restricted to Ibero-Romance. Durand (1988) reports the occurrence of word-final nasal velarisation in Midi French, as does Flynn (under revision) for Canadian French. Likewise, nasal velarisation is also found in a number of Italian dialects (see Hajek 1997 and references therein).

[15]However, see Shosted (2006) on Brazilian Portuguese.

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