Pathways of phonological change

An expanded version of section 2 of

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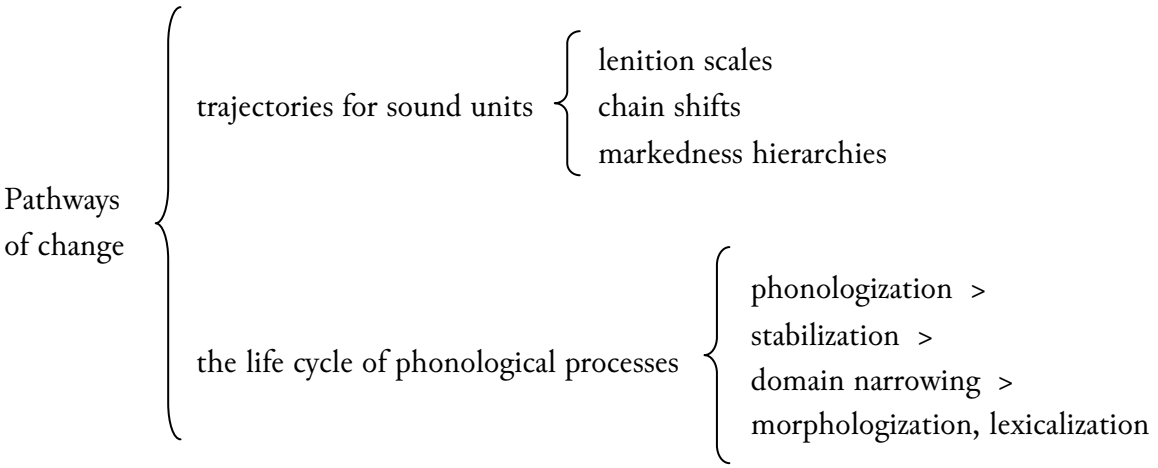
[...]

2 The life cycle of phonological processes

2.0 Introduction

This section of the chapter deals with recurrent pathways of change in phonetics and phonology. In this area, one may initially distinguish between two types of diachronic trajectory according to whether one focuses on the long-term historical evolution of sound units (e.g. segments) or of sound patterns (i.e. "rules" or "processes" broadly conceived):

(1)



The first type of diachronic pathway includes "lenition scales" and "chain shifts", respectively addressed in this cluster in the chapters by Honeybone and Dinkin. Both terms designate sets of phonetic changes in which a sound or group of sounds appears to evolve in a recognizable direction. Thus, according to Vennemann's famous definition (Hyman 1975: 165; see Honeybone 2008: §2.1.2), lenition scales are recurrent sequences of stages traversed by segments on their way to zero: see Lass (1984: 178) and Hock (1991: 83) for well-known

diagrammatic illustrations. Understood in this way, lenition scales provide a suggestive phonological counterpart to "syntactic cycles" in the sense of van Gelderen (2009: 2); the latter are discussed in §3.1 below and in the chapter by Wallage. Similarly, chain shifts are sets of changes characterized by the fact that one phoneme moves towards the region in phonetic space previously assigned to another. More generally, the idea that linguistic sounds travel historically in recognizable directions lies at the heart of phonological theories positing preference laws (Vennemann 1988) or markedness hierarchies (e.g. Optimality Theory, henceforth OT: Prince and Smolensky 1993). Markedness hierarchies crucially inform the understanding of the phonological development of New Englishes presented in the chapter by Sharma and Wiltshire.

In this chapter, however, we shall be predominantly concerned with the direction of change in the long-term evolution of phonological processes. Most linguistic sound patterns first arise through events of "phonologization" (Hyman 1976), whereby an articulatory, acoustic, or auditory phenomenon beyond human cognitive control gives birth to a new language-specific pattern of gradient phonetic implementation. As they evolve, however, these new phonetic patterns tend to become increasingly detached from their grounding in the physics and physiology of speech. First, sensitivity to continuous phonetic dimensions is replaced by reference to discrete phonological features ("stabilization"; Bermúdez-Otero 2007: 504-06, after Hayes and Steriade 2004: §5.6). Later, categorical phonological rules, which initially apply across the board, acquire morphosyntactic conditions, notably through the narrowing of their "cyclic domains" (Bermúdez-Otero 2006: 504, 2011: 2024-25), and may go on to develop lexical exceptions. Eventually, phonological rules may become altogether "morphologized" (Anderson 1988: 329ff) or "lexicalized". This diachronic pathway has come to be known as "the life cycle of phonological processes" (Bermúdez-Otero 2007: 503-04, 2011: 2024-25, and references therein). It is largely unidirectional, and it bridges the whole span between the realm of physical law (acoustics) and the realm of *l'arbitraire du signe* (the lexicon):

(2) $\begin{matrix}\text{physics}\\ \text{physiology}\end{matrix}$ > phonetics > phonology > $\begin{matrix}\text{morphology}\\ \text{lexicon}\end{matrix}$

Seen in this way, the life cycle of phonological processes bears a striking resemblance to Givón's (1979: 209) vision of the arrow of grammaticalization:

(3) discourse > syntax > morphology ...

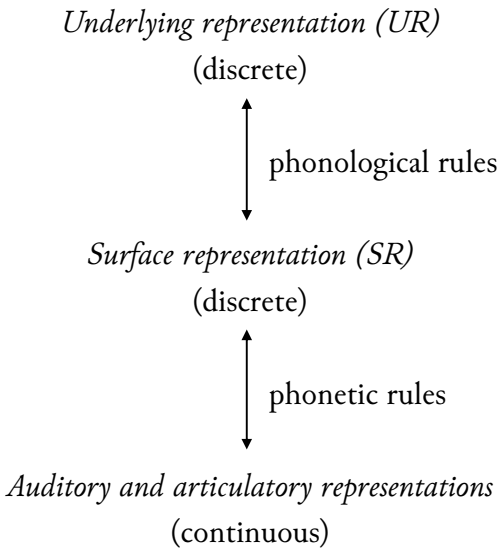
Our exploration of the life cycle of phonological processes will proceed as follows. We begin by illustrating the phenomena of phonologization, stabilization, and domain narrowing with examples from English. Section 2.1 uses evidence from phonetic variation across present-day English speakers to reconstruct the diachronic trajectory of a process of external sandhi targeting the coronal gesture of the nasal consonant in /n#k/ clusters: Ellis and Hardcastle's (2002) fine-grained articulatory data reveal that some speakers exhibit no gestural reduction in

this environment, others have developed a phonetic process gradiently reducing the magnitude of the tongue-tip movement (phonologization), and yet others have acquired a variable phonological rule that categorically deletes the CORONAL feature of /n/ (stabilization). In §2.2 we go on to chart the historical evolution of the phonological process deleting /g/ in coda position after a homorganic nasal: a comparison of reports by the eighteenth-century orthoepist James Elphinston with the distribution of [ŋg] in Received Pronunciation (RP) indicates that the effect of so-called "analogical change" upon this rule was to confine its application to progressively narrower cyclic domains, thereby causing it to climb from the phrase level (PL) to the word level (WL) and thence into the stem level (SL): see Bermúdez-Otero (2006: 504, 2011: 2024-25).

Having thus demonstrated the main features of the life cycle of phonological processes, we next turn to show how knowledge of its existence can help us to rethink long-standing problems in English linguistics, both diachronic and synchronic. In present-day English, word-final prevocalic consonants exhibit both onset-like and coda-like properties. This fact has long raised problems for the theory of the syllable, leading to the postulation of devices like ambisyllabicity (Kahn 1976), and it also makes it difficult to join up Minkova's (2003: ch. 4) authoritative account of phrasal syllabification in Old and Middle English with the observations of the present. In §2.3, however, we show that all the pieces of the puzzle fall into place if one assumes the following: present-day English retains the variable phrase-level rule of resyllabification into onsets that Minkova showed to be already at work in Middle English, but word-final prevocalic consonants nonetheless pick up coda-like features at the word level prior to resyllabification because, in the course of their life cycle, several processes of lenition targeting codas have had their cyclic domain of application narrowed down to the grammatical word.

The section concludes with a look at the vexed problems of unidirectionality and gradience. We stated above that the life cycle of phonological processes is largely unidirectional; but, as is notoriously the case for grammaticalization, there appear to be exceptions. Section 2.4, however, draws on Labov's work on *æ*-tensing (notably Labov 2007) to show that, at least in some cases, changes in the 'wrong' direction—such as the widening of cyclic domains—involve a crucial intermediate step of propagation through contact between adult speakers. This finding supports the intuition, shared by most participants in the debate on grammaticalization, that the issue of unidirectionality in diachronic pathways is intimately bound up with the question of the relative causal roles that language acquisition by children and language use by adults play in linguistic innovation. Finally, in §2.5 we address the problems raised by sound patterns that appear to combine phonetic gradience with morphological or lexical sensitivity: an example is discussed at length in the chapter by Hay and Clendon. At first blush, such patterns seem incompatible with the classical modular separation of phonology and phonetics (Bermúdez-Otero 2007: 501ff, forthcoming: §4; Boersma 2009a: 57, 58):

(4)



At least in some cases, however, the difficulty disappears once one realizes that an extremely common outcome of developments in the life cycle of phonological processes is "rule scattering", i.e. the splitting of one rule into two: a copy that remains *in situ*, and an innovative counterpart introduced into a higher component of the grammar (Bermúdez-Otero 2007: 506, 2010). This result again supports the parallelism between grammaticalization and the life cycle of phonological processes, for rule scattering in the latter produces similar effects to "layering" (Hopper 1991: 22) in the former.

2.1 Phonologization and stabilization: external /n#k/ sandhi in present-day English

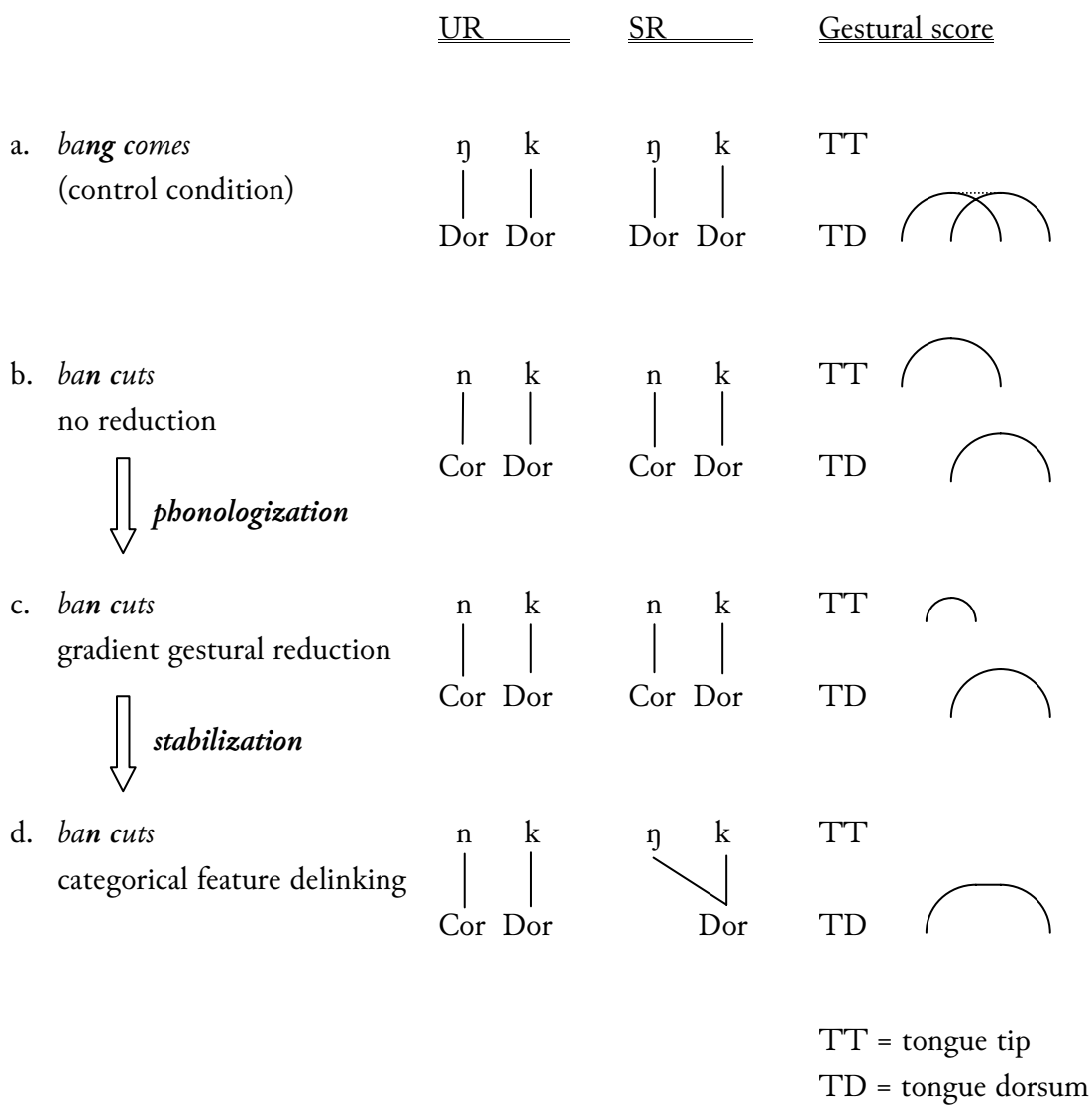
In a grammar set up in accordance with the classical modular architecture shown in (4) above, innovations in different modules manifest themselves as different types of historical changes (Kiparsky 1988, 1995; see Bermúdez-Otero 2007: 503). Notably, innovations in the phonetic implementation component produce "neogrammarian sound changes": see Labov (2010: ch. 13) for examples from present-day American English. Such changes are phonetically gradual but lexically regular, and, whilst they may display exquisite sensitivity to prosody, they do not directly refer to morphosyntactic structure; though see §2.5 below for "rule scattering" and for the 'secondary' effects (Pierrehumbert 2002: 129, 134) of factors such as token frequency, neighbourhood density, and contextual predictability. In this chapter we use the term "phonologization" specifically to refer to neogrammarian sound changes taking place when a physical or physiological phenomenon impinging on speech gives rise to a new phonetic rule. In phonologization, therefore, a mechanism beyond human cognitive control (and, in that sense, extragrammatical) somehow causally contributes to the emergence of a new language-specific (and *a fortiori* cognitively controlled and grammar-internal) generalization over continuous phonetic dimensions.

There is a widespread consensus that this causal relationship is mediated by speech perception. Notably, Ohala (e.g. 1981, 1989) has famously proposed that phonologization occurs when a property of the speech signal created by a mechanical effect is misinterpreted by the listener as being controlled by the speaker's grammar. However, Ohala rejects the modular separation of phonetics and phonology, and so his own implementation of the idea fails to account for the lexical regularity of neogrammarian sound change. This problem does not arise in perception-driven models of phonologization that preserve modularity. Drawing upon Boersma's (2009b, 2009a) modular architecture, for example, Hamann (2009) suggests that phonologization affects the grammatical constraints, called "cue constraints", that regulate the mapping between phonological categories in surface representations and the values of continuous auditory parameters in auditory representations. Thus, in Hamann's model, neogrammarian sound change involves the reweighting of perceptual cues across generations. As well as explaining the regularity of neogrammarian change, this proposal has the advantage of predicting the "structure-preserving bias" in phonologization, whereby a mechanical effect upon a phonetic dimension (e.g. duration, F_0) has a greater chance of becoming phonologized in a language that already uses the same phonetic dimension for cueing a phonological category (e.g. length, tone): see Kiparsky (1995: 656), Bermúdez-Otero and Hogg (2003: 98). In Boersma and Hamann's model, this bias emerges because, in such a language, the cue constraints forbidding the association of particular values of the phonetic attribute with the phonological category are already ranked low.

The classical modular architecture (4) entails a distinction between "phonologization" as defined above and "stabilization", which designates the diachronic process whereby a gradient phonetic rule is reinterpreted as a generalization over discrete categories in the phonological surface representation. This difference emerges clearly in the findings of Ellis and Hardcastle's (2002) articulatory study of external /n#k/ sandhi (as in *ba**n** cuts*) in several idiolects of present-day English. Ellis and Hardcastle's data enable us to reconstruct the historical evolution of a process of reduction of the tongue-tip gesture for the underlying /n/, presumably grounded in the relatively poor acoustic cueing of nasal place in preconsonantal position (see Steriade 1999 for similar phenomena affecting laryngeal properties). Different idiolects show this process caught at three successive stages in its life cycle: before the onset of reduction (5b), after phonologization (5c), and after stabilization (5d). The most conservative speakers consistently attain midsagittal linguoalveolar closure in the realization of the nasal (5b). Relatively innovative speakers produce residual coronal gestures in which the tongue tip rises without achieving midsagittal contact: these speakers have acquired a gradient phonetic rule of gestural reduction (5c), arising from the phonologization of the acoustic effects mentioned above. A third set of even more advanced speakers produce tokens of *ba**n** cuts* without any tongue-tip raising at all for the nasal. Those individuals for whom this is the only articulatory realization might conceivably be analysed as having the gradient process of gestural reduction in (5c) applying at ceiling level. However, Ellis and Hardcastle identified a subset of speakers who displayed variation between two discrete choices: full midsagittal linguoalveolar closure as in (5b), or

complete absence of tongue-tip raising. This bimodal pattern cannot be described by means of a continuous process of gestural reduction; rather, it reflects the variable but categorical application of a rule of autosegmental delinking and spreading in the phonology (5d). This categorical rule is the stabilized counterpart of the gradient process of gesture reduction in (5c).

(5)



Interestingly, Ellis and Hardcastle (2002: 394) refrained from drawing the conclusion that we reach here, pointing out that, in some individuals, tokens of underlying /n/ realized with no tongue-tip raising remained phonetically different from realizations of underlying /ŋ/ in the same environment: more specifically, the former had significantly shorter durations. However, this observation is compatible with—and indeed corroborates—the categorical autosegmental analysis. First, the output of delinking and spreading is a place-linked structure, as shown in the SR for (5d), which remains different from the fake geminate in the control condition (5a). Secondly, the durational difference points in the right direction: the bigestural

structure (5a) has greater duration than the monogestural one (5d). Indeed, Holst and Nolan (1995: 32) found very strong durational compression in instances of categorical /s#ʃ/→[ʃ·] sandhi.

Determining whether or not a sound pattern has become categorical normally requires careful statistical analysis of high-quality phonetic data from individual speakers. Indeed, in cases that may involve hidden residual gestures, nothing short of ultrasound or electromagnetic articulography will do: this becomes apparent not only in Ellis and Hardcastle's (2002) investigation of /n#k/ sandhi, but also in Lawson, Stuart-Smith, and Scobbie's (2008) study of ongoing derhoticization in Glasgow. When the necessary phonetic data are available, however, bimodal distributions of the sort found in speakers who vary between (5b) and (5d) but avoid (5c) provide conclusive evidence that stabilization has indeed taken place. In this connection, bimodality has been shown to play a crucial role in the development of phonological categories in infants: Maye, Werker, and Gerken (2002) showed that infants familiarized with a continuum of speech sounds learn to discriminate tokens from the endpoints of the continuum if the latter is bimodally distributed, but not if it is unimodal (see further Maye, Weiss, and Alsin 2008, and McMurray, Aslin, and Toscano 2009).

The bimodality criterion does have some limitations. In principle, for example, absence of bimodality does not necessarily entail absence of categoricity, since a mixture of two densities creates a bimodal distribution only under certain conditions (Schilling et al. 2002). The problem is further compounded by the fact that stabilization often results in "rule scattering": a new categorical rule enters the phonology, but a version of the old gradient process remains active in the phonetic implementation module (see §2.5 below). Despite its limitations, however, the bimodality criterion yields important conclusions. For example, it enables one to settle the long-running debate whether American English /t,d/-flapping is a categorical rule of the phrase-level phonology (e.g. Kaisse and Shaw 1985: 4ff) or a phonetic process gradiently shortening the hold phase of alveolar plosives (e.g. de Jong 1998 and references therein). In a recent acoustic study by Herd, Jongman, and Sereno (2010: 508), the variable application of flapping was found to give rise to a clearly bimodal distribution on the duration continuum, with each speaker's plosive and flapped allophones forming distinct—and indeed nonoverlapping—token clusters. This confirms that the flapping rule has indeed reached the stabilization stage in its life cycle. As we saw in the case of /n#k/ sandhi, this conclusion is perfectly compatible with the observation that contrasts such as *utter* vs *udder* are incompletely neutralized (Bermúdez-Otero 2004: §14-§22, 2010: §11).

While it is thus often feasible to decide whether or not a sound pattern has become categorical, the cognitive mechanisms involved in stabilization are far less well understood. Boersma (forthcoming: §10.2.7) reviews a range of possible approaches to the emergence of categories in the surface phonological representation. These include models of the "perceptual magnet effect" (Kuhl 1991) in which a nonuniform distribution of tokens in acoustic space induces a corresponding warping of perceptual space, with the emergence of "attractors" (e.g.

Guenther and Gjaja 1996). This approach accords well with the findings of Maye, Werker, and Gerken (2002) mentioned above. However, Boersma observes that, at present, all these models have difficulty explaining how category labels become available to symbolic computation in the phonology.

2.2 The narrowing of cyclic domains: James Elphinston's /ŋg/

After a sound pattern has become stabilized as a generalization over discrete categories in the surface phonological representation, it can go on to develop sensitivity to morphosyntactic structure (as opposed to purely prosodic conditioning). In traditional historical linguistics, the relevant changes fall under the rubric of "analogy". In a large proportion of cases, "analogy" has the effect of progressively narrowing down the morphosyntactic domain over which a phonological process applies (Dressler 1985: 149); concomitantly, the process ceases to be surface-true and becomes increasingly opaque. The history of Late Modern English provides several examples. A particularly clear one was highlighted by Garrett and Blevins (2009: 528), and subsequently taken up by Bermúdez-Otero (2006: 504, 2011: 2024-25): it concerns the diachronic evolution of the rule of postnasal /g/-deletion found in varieties such as RP.

In its purely phonological aspect, the generalization is that [g] cannot occur in the coda if immediately preceded by [ŋ]. Accordingly, any token of underlying /ŋg/ is expected to surface faithfully in environments where an onset position is available to the plosive; otherwise, deletion will apply. The testimony of the orthoepist James Elphinston (1765) reveals that in the eighteenth century there were dialects where this generalization held true across the board (Müller 1914: 215-16): in particular, word-final /ŋg/ clusters were able to escape /g/-deletion through the syllabification of the plosive in the onset before a vowel or liquid in the following word.

(6)

sin[g] aloud	sprin[g] eternal
prolon[g] it	lon[g] repose
stron[g] and mighty	youn[g] Leander

As noted by Garrett and Blevins (2009: 528), Elphinston's report indicates that the conditions that favoured resyllabification included absence of a strong phrase boundary ('immediate connexion and dependance') and absence of stress on the following syllable ('feebleness'). Crucially, however, Elphinston describes the rescue of postnasal /g/ through phrase-level resyllabification (6) as limited to the speech used 'upon solemn occasions', i.e. to formal registers. Before a vowel or liquid in the same word (7), in contrast, the plosive was systematically retained even in informal speech.

(7)

han[g]-er	han[g]-ing
sin[g]-er	sin[g]-ing
	prolon[g]-ing

The orderly variation displayed by Elphinston's dialect reflects phonological change in progress: his formal register is diachronically conservative; his informal register, in contrast, has taken a step towards present-day RP, applying postnasal deletion to word-final /g/ regardless of context.

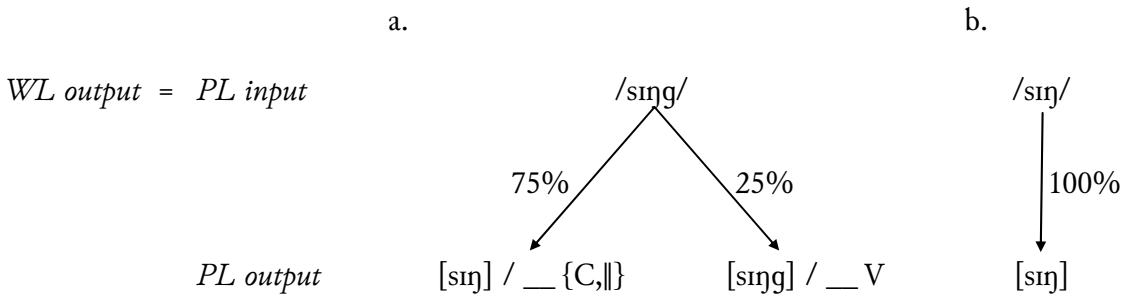
In stratal-cyclic architectures such as those of Lexical Phonology or Stratal OT, the change in progress in Elphinston's dialect would be described as narrowing down the morphosyntactic domain of application of /g/-deletion, which concomitantly climbs up from a lower stratum (the phrase level) to a higher stratum (the word level). Before the change, postnasal /g/-deletion applies over phrase-level domains, and so is sensitive to the effect of the phrasal context upon the syllabification of word-final /g/. On completion of the change, the application of /g/-deletion becomes confined to the grammatical word: information about the phrasal context ceases to be available, word-final /g/ is treated as a coda even when followed by a vowel in the next word, and consequently /g/-deletion becomes opaque on the surface (it "overapplies").

(8)

	phrase-level /g/-deletion (conservative)	**word-level /g/-deletion (innovative)**
⟦PL ⟦WL sin/**g**/-er⟧⟧	[g]	[g]
⟦PL ⟦WL sin/**g**/⟧⟦WL aloud⟧⟧	[g]	[∅]
⟦PL ⟦WL sin/**g**/⟧⟧	[∅]	[∅]

This transition from phrase-level to word-level application was probably driven by input restructuring (Bermúdez-Otero 2011: 2024, and references therein). In the conservative grammar (9a), the word *sing* was represented as /sɪŋg/ in the input to the phrase-level phonology; surface tokens lacking [g] in preconsonantal and prepausal environments were derived by means of an unfaithful phrase-level mapping. Such tokens, however, occurred approximately three times more frequently than faithful prevocalic ones (Bybee 1998: 73). Learners who took them at face value replaced /sɪŋg/ with /sɪŋ/ in the phrase-level input (9b). The eventual effect was to impose a phonotactic ban on coda [g] after [ŋ] in the word-level output, and so the rule of postnasal /g/-deletion climbed up from the phrase to the word level.

(9)



Later, the entire development repeated itself in the input to the word level (i.e. the output of the stem level), replacing Elphinston's *si*[ŋg]-*er* and *si*[ŋg]-*ing* (7) with present-day *si*[ŋ]-*er* and *si*[ŋ]-*ing*. Significantly, current patterns of inter- and intra-dialectal variation in /l/-darkening (Hayes 2000: 98) suggest an identical diachronic trajectory consisting of successive rounds of domain narrowing: see Bermúdez-Otero (2011: 2043) and Turton (2011).

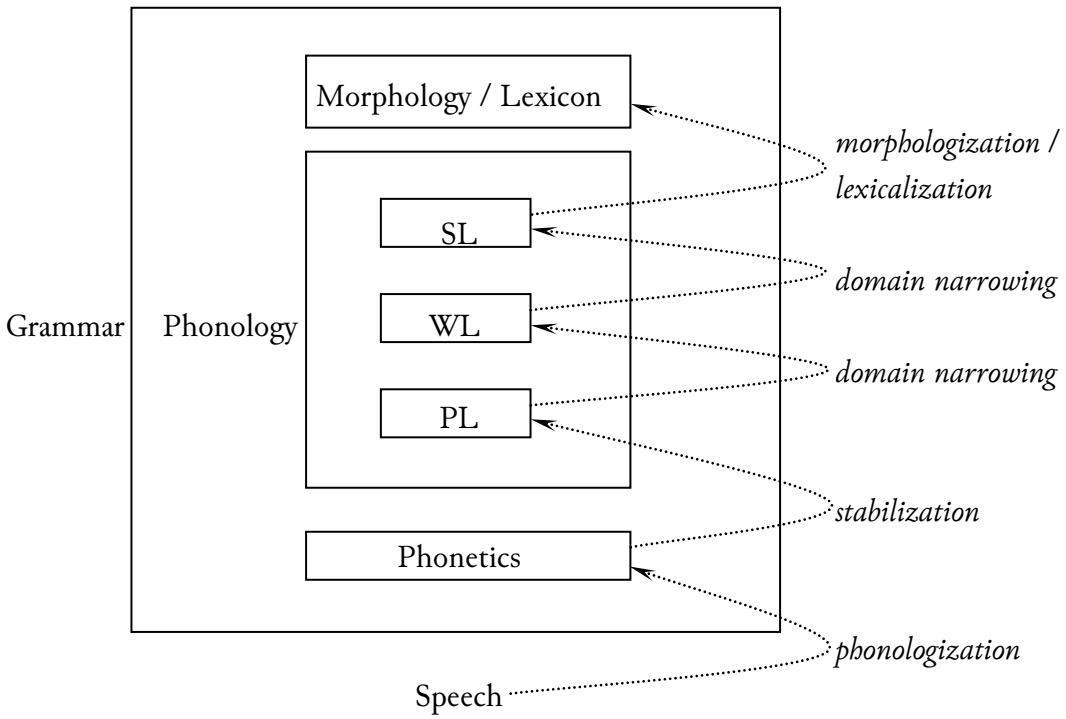
As phonological processes reach the stem level, the effect of morphological and lexical factors becomes increasingly apparent. Postnasal /g/-deletion, for example, has already developed a number of interesting irregularities. The high-frequency adjectives *long*, *strong*, and *young* possess lexically listed synthetic comparative and superlative forms that unexpectedly retain [g]; the gradation suffixes *-er* and *-est* normally attach at the word level, and so the regular pattern is the one exhibited by [g]-less forms like *wro*[ŋ]-*er* and *winni*[ŋ]-*est* (Bermúdez-Otero forthcoming: §4.2.3). Conversely, exceptions to the prohibition of [ŋ] in morpheme-internal onset position have arisen from various sources, including the univerbation of former phrases and compounds: e.g. *Nottingham* ['nɒ.tɪ.**ŋ**əm] (< *Snotinga hām*), *dinghy* ['dɪ.**ŋ**ɪ], *Menzies* ['mɪ.**ŋ**ɪs] *Campbell*. Relatedly, the absence of postnasal [g] in codas is now cyclically transferred to novel semantically transparent derivatives, even with stress-attracting suffixes: e.g. *Peki*[ŋ] → *Peki*[ŋ]-*ése* 'Peking dialect' (cf. *Peki*[n]-*ése* 'dog breed'), *swin*[ŋ] → *swi*[ŋ]-*ómeter* (see Wells 1990: *sub vocibus*). Bermúdez-Otero (2008, forthcoming: §3.3) accounts for this pattern of irregularity (specially the link between cyclic misapplication at the stem level and exceptions in monomorphemic items) by means of the hypothesis that stem-level expressions are listed nonanalytically, i.e. as whole forms (Jackendoff 1975).

Eventually, a phonological process may be replaced by a purely morphological generalization (Anderson 1988: 329ff) or disappear altogether, leaving a mere residue of lexical idiosyncrasies behind. Thus, Old English *i*-umlaut, which once must have been a gradient process of vowel-to-vowel coarticulation (e.g. Magen 1997), exists now only as the unproductive pattern of alternation found in *foot-feet, tooth-teeth, food-feed,* etc.

2.3 The life cycle of phonological processes and Minkova's riddle of phrasal syllabification

The life cycle of phonological processes, then, works like an escalator, continually lifting sound patterns from lower to higher components of the grammar:

(10)



The prevalence of change along this pathway predicts some important tendencies. In general, older processes will tend to apply at higher levels than younger ones. As a special case, if a phonological rule applies variably at more than one level, then higher strata should exhibit equal or smaller application rates than lower strata, for it is in the lower strata that the process will have been active the longest. An instance of this scenario may be found in the effect of morphosyntactic structure upon rates of /l/-darkening in some dialects of American English: see Turton's (2011) stratal analysis of Hayes's (2000) data; cf. Guy (1991). Similarly, if the grammar contains two separate phonological processes corresponding to successive steps in a single lenition scale (§2.0), and if the two processes have different cyclic domains, then the older rule, representing a milder form of lenition, may be expected to apply in narrower cyclic domains than the younger rule, representing a more aggressive form of lenition. This last prediction, in particular, casts new light on a classic problem in English phonology: the syllabic affiliation of word-final prevocalic consonants.

Thanks to Minkova (2003: ch. 4), we now have a solid understanding of phrasal syllabification in Old and Middle English. Minkova shows that, like present-day German, Old English used [ʔ]-epenthesis to repair stressed onsetless syllables. Since Old English had root-initial stress, the epenthetic glottal stop removed most opportunities for the resyllabification of word-final consonants before underlyingly vowel-initial content words:

(11) Ēadmund æþeling (*Brun* 3a)
UR /æːɑ̯dmund æθeliŋg/
SR [ˈʔæːɑ̯d.mund.ˈʔæ.ðe.liŋg], cf. *[ˈæːɑ̯d.mun.ˈdæ.ðe.liŋg]
'prince Edmund'

Four main pieces of evidence support Minkova's account. First, Old English metre allowed underlyingly vowel-initial stressed syllables to alliterate with each other regardless of vowel quality. This suggests that the glottal stop sufficed to satisfy the identity requirement imposed by alliteration. The glottal stop's allophonic status need not have prevented it from playing a crucial role in verse, especially if epenthesis took place at the stem or word level.

(12) **[ʔ]**Æþelstān cyning **[ʔ]eo**rla dryhten (*Brun* 1)
'King Æthelstan, lord of noblemen'

Secondly, a word-final unstressed open syllable was able to fill a weak metrical position in Old English verse not only when followed by a consonant or a caesura, but also when preceding a stressed vowel in the same half-line; in the latter case, [ʔ]-insertion prevented the two vowels from coalescing (13a). Observe, in contrast, the crucial application of synaloepha in the Spanish hendecasyllable in (13b).

(13) a. ´ × ´ ×
lan.g**e** [ʔ]**ā**h.te (*Beo* 31b)
'long reigned'

b. Era del año l**a e**stación florida (Góngora, *Soledades*, I, 1)
[ˈe.ɾa.ðe.ˈla.ɲo.l**aę**s.ta.ˈθjon.flo.ˈɾi.ða]
'It was the flowery season of the year'

Thirdly, Old English prefix-final vowels are always retained before stem-initial stressed vowels: in (14) we see an example in which this absence of contraction is essential for metrical well-formedness.

(14) ´ × ´ × (*Beo* 1885)
oft ġe.[ʔ]æh.ted
'often praised'

Significantly, contraction was confined to negative *ne* with prosodically weak verbs (e.g *nis* 'is not') and to *be* with prosodically weak adverbs (e.g. *binnan* 'within'). Fourthly, it appears that Anglo-Saxon scribes sometimes used the letter <h> to notate the epenthetic glottal stop: e.g.

(15) <Ða se **h**ælmihtiga> (*GuthB* 950b)
'Then the Almighty'

Minkova argues convincingly that this "inorganic <h->" did not arise from sociolinguistic hypercorrection for /h/-loss: /h/-loss only became active later; the insertion of unetymological <h-> was not accompanied by omission of etymological <h->; and inorganic <h-> occurred more frequently in verse manuscripts (where prosodification was crucial) than in prose.

During the Middle English period, however, [ʔ]-epenthesis became optional, triggering a concomitant surge in the resyllabification of word-final prevocalic consonants. Minkova identifies several symptoms of this change, of which we shall highlight four. First, the overall incidence of vowel alliteration in alliterative verse (12) dropped dramatically, from 15.5% in *Beowulf* to a mere 2.1% in *Wynnere and Wastoure*; just as significantly, the proportion of cases involving vowels of the same quality increased, suggesting that [ʔ] was no longer available to satisfy identity requirements in verse. Secondly, word- and prefix-final vowels became targets for elision and contraction, and these phenomena were often crucial to well-formedness in syllable-counting metres:

(16) a. W S W S W S W S
þatt Godess Sun**(e) A**llmahhtiȝ Godd (*Orm* 11042)
'that God's Son Almighty God'

b. W S W S W S W
þin blettsinng **tu**nnderrganngenn (*Orm* 10661)
'to receive your blessing'

Thirdly, Middle English alliterative metres occasionally allowed a word-final consonant resyllabified into the onset of a stressed syllable to carry the alliteration ("Stab der Liaison"):

(17) Vmquile he **n**oys as a **n**owte ‖ as a**n**‿ox quen he lawes (*Wars Alex.* (Ashm) 4744)
'At times he moans like a bull, like an ox when it lows'

Turville-Petre (1989: 200) observes that, in this example, 'The scribe writes *a nox*, to indicate the alliteration'. Fourthly, Middle English saw a large increase of "false junctures", in which resyllabified word-final consonants are misparsed as word-initial: e.g.

(18) a**n** eke name > a **n**eke name
an extra name a nickname

The evolution of phrasal syllabification during Old and Middle English thus appears fairly straightforward: in Old English, word-final consonants followed by underlyingly vowel-initial words behaved as codas because the glottal stop blocked resyllabification; in Middle English, the decline of [ʔ]-epenthesis enabled such consonants to be resyllabified as onsets. Ironically, the main problem arises when one tries to follow up Minkova's narrative into the Modern period, for in present-day English word-final prevocalic consonants display both onset-like and coda-like properties.

The lateral approximant /l/ provides a clear example; see Bermúdez-Otero (2011: §7) and Hay and Clendon's chapter in this volume for different takes on the somewhat more complex case of /ɹ/. First, word-final prevocalic /l/ behaves like a coda in many present-day dialects in that it undergoes darkening, which we here define as the phonological process whereby the segment's DORSAL feature replaces the CORONAL node as the designated primary articulator, causing the tongue-dorsum gesture to be phased before the tongue-tip gesture in articulation (Sproat and Fujimura 1993). Darkening affects /l/ in canonical coda positions, but does not apply to canonical onsets. At the same time, however, many varieties of English display a categorical process whereby /l/ is realized with midsagittal coronal closure before vowels, but without linguoalveolar contact before consonants or pause; we retain the traditional designation of "/l/-vocalization" for this process, without prejudice to the question whether the relevant phonological feature is [consonantal], [continuant], or some other. Crucially, word-final prevocalic /l/ resists vocalization in many—though not all—accents (Scobbie and Wrench 2003), and in this respect patterns like an onset. Word-final prevocalic /l/ thus behaves neither like a canonical onset nor like a canonical coda: the dilemma is summarized in (19).

(19)

Position	Example	Realization		
/...V#__V.../	*see **L**ynn*	[l]	linguoalveolar contact	dorsal lag
/...V__#V.../	*seal in*	[ɬ]	linguoalveolar contact	dorsal lead
/...V__#C.../	*seal bins*	[ɬ̪]	no linguoalveolar contact	dorsal lead

One might conceivably respond to this situation by asserting that word-final prevocalic /l/ is ambisyllabic (Kahn 1976), and that word-final prevocalic consonants have acquired a coda attachment in Modern English by analogy with their correspondents in citation forms, while retaining the onset attachment introduced by the Middle English rule of phrasal resyllabification. However, this solution is unsatisfactory for two reasons. First, the theory of ambisyllabicity merely provides us with an additional representational category beyond onsets and codas, but makes no predictions about this category. It does not tell us in what respects the alleged ambisyllabics should resemble onsets or codas, or indeed whether they should display peculiarities all of their own: for example, should they exhibit inalterability like geminates, since they are claimed to belong in two syllables simultaneously? More decisively,

ambisyllabicity leads to analytical paradoxes: e.g. there are English dialects in which the pattern of ambisyllabification required to account for the allophony of /l/ makes incorrect predictions for /t/, and vice versa (Bermúdez-Otero 2011: 2038-39).

When we consider the facts in the light of the life cycle of phonological processes, however, our difficulties vanish. The key lies in the observation that darkening and vocalization constitute successive steps in a single lenition scale for liquids:

(20) l >darkening ɬ >vocalization ɫ̩ (>deletion ∅)

The rule of darkening is therefore historically older (i.e. it reached the stabilization stage earlier) than the rule of vocalization. Accordingly, if the two processes have different cyclic domains, we predict darkening to apply at a higher level than vocalization, since darkening got on the escalator in (10) well before vocalization did. This is precisely what we do find: darkening applies at the word level; vocalization, at the phrase level.

(21)

	*see **L**ynn*	*seal in*	*seal bins*
	⟦PL ⟦WL siː⟧⟦WL lɪn⟧⟧	⟦PL ⟦WL siːl⟧⟦WL ɪn⟧⟧	⟦PL ⟦WL siːl⟧⟦WL bɪnz⟧⟧
WL (coda darkening)	.lɪn.	.siːɬ.	.siːɬ.
PL (coda vocalization)	.siː.lɪn.	.siː.ɬɪn.	.siːɫ̩.bɪnz.

Thus, the phrase-level process of prevocalic resyllabification that entered the grammar in Middle English has never gone away; but, between Middle English and the present day, relatively old coda lenition rules like /l/-darkening have undergone domain narrowing in line with the life cycle of phonological processes.

Incidentally, this account easily accommodates several observations deemed problematic by Scobbie and Pouplier (2010). First, /l/-vocalization is a relatively young process, and so it can still be observed in the early stages of its life cycle in some dialects, much as in the case of /n#k/ sandhi in (5). The most conservative varieties (e.g. speakers S5 and E2 in Scobbie and Pouplier 2010) lack vocalization altogether. In contrast, the most advanced speakers (e.g. S1, S2, S3, and S4) have word-level vocalization, and so produce [ɫ̩] even in word-final prevocalic position. Between these extremes, however, Scobbie and Pouplier found not one but two intermediate systems. Speakers with categorical phrase-level vocalization, as per (21), produce word-final /l/ with linguoalveolar contact variably before vowels, and vocalize it before all consonants, including /h/ (e.g. S1 and S3). In contrast, other speakers (e.g. E5 and E3) preserve linguoalveolar contact both before vowels and before /h/. The latter group can plausibly be understood as reflecting a stage of /l/-vocalization before stabilization, in which the rule does not refer to categorical properties of suprasegmental representation at SR, but to phasing relations between oral gestures in Articulatory Form: at this stage, /h/ is transparent to vocalization because it does not contribute oral gestures.

In sum, the diachronic evolution and synchronic behaviour of English word-final prevocalic consonants can be fully understood only against the background of the life cycle of phonological processes. It should be as inconceivable for phonetic, phonological, and morphological research to proceed in ignorance of this life cycle as it is for research into morphology, syntax, semantics, and pragmatics to ignore the facts of grammaticalization.

2.4 A note on unidirectionality: child-driven vs adult-driven phonological innovation

We have described the life cycle of phonological processes as largely unidirectional. Exceptions to this statement do indeed seem extremely rare, but the literature furnishes some plausible counterexamples. For instance, the English dialect of New Orleans exhibits a phonological process of *æ*-tensing whose origins are to be sought in a stem-level rule of the New York vernacular (Labov 2007: 364-69). Crucially, it appears that, at some point in the evolution of the New Orleans process, certain speakers internalized a word-level generalization instead of the original stem-level rule: in New York, *æ* undergoes tensing before coda nasals, but a stem-final nasal immediately followed by a vowel belonging to a word-level suffix counts as a coda because tensing applies in stem-level domains, where word-level suffixes are not visible; in New Orleans, in contrast, *æ* becomes tense even before onset nasals, presumably because a generation of New Orleans speakers interpreted opaque tensing before stem-final prevocalic nasals as the transparent outcome of a word-level rule (Labov 2007: 369).

(22)

		New York	*New Orleans*
(Cardinal) Manning	⟦WL ⟦SL Manning⟧⟧	[æ]	[æː]
mann-ing (the pumps)	⟦WL ⟦SL man⟧ ing⟧	[æː]	[æː]

The descent of the New Orleans rule from the stem to the word level violates the unidirectionality of the life cycle of phonological processes. Nonetheless, Labov demonstrates that the propagation of *æ*-tensing from New York to New Orleans was mediated by linguistic contact between adults. Accordingly, responsibility for the reanalysis of opaque forms like *m*[æː]*nn-ing* can plausibly be imputed to adult innovators. This account accords well with the generalization that, although change remains possible throughout the lifespan (Harrington 2006, Sankoff and Blondeau 2007), deep or large-scale structural innovations are rare after adolescence (Kerswill 1996, Nahkola and Saanilahti 2004). Dinkin's chapter in this volume pursues the same idea in his account of the life cycle of vowel shifts.

2.5 A note on gradience: rule scattering

So far, we have explained the life cycle of phonological processes in terms of the modular architecture introduced in (4) and elaborated in (10). This architecture predicts that generalizations over continuous phonetic dimensions must apply across the board, and that

processes confined to particular cyclic domains must be categorical. In consequence, the modular architecture faces an empirical challenge from reports of sound patterns that appear to be at once phonetically gradient and morphologically sensitive (Kawahara 2011: §2.3.3).

English /l/-darkening is a case in point: the derivation shown in (21) requires darkening to apply at the word level, but Sproat and Fujimura (1993) claimed that darkening is a gradient articulatory adjustment delaying the tongue-tip gesture in proportion to the duration of the rhyme. The difficulty disappears, however, if the relevant grammars contain not one but **two** cognate processes of /l/-darkening, as suggested by both Hayes (2000: 93) and Bermúdez-Otero (2007: note 6). The first process applies in the phonology, where it introduces a categorical distinction between light [l] (with CORONAL as its designated primary articulator) and dark [ɫ] (with DORSAL as its designated primary articulator): see §2.3 above. It is this categorical phonological process that displays sensitivity to morphosyntactic domains. In turn, the second process applies in the phonetics, where it gradiently adjusts the relative phasing of the tongue-tip and tongue-dorsum gestures in realizations of dark [ɫ] according to the duration of the rhyme. This two-step derivation is strikingly vindicated by the results of the phonetic study conducted by Yuan and Liberman (2009). Yuan and Liberman defined a continuous measure of darkness, the '*D* score', such that the vast majority of /l/ tokens in canonical onset position (e.g. ***l**ike, **pl**ease*) have negative *D* scores and the vast majority of /l/ tokens in canonical coda position (e.g. *fu**ll**, fe**lt***) have positive *D* scores: thus, the larger the *D* score is, the darker the /l/. Yuan and Liberman found that the *D* score of coda /l/ grows as the duration of the rhyme increases, just as predicted by Sproat and Fujimura. Contrary to Sproat and Fujimura's claims, however, Yuan and Liberman observed that coda /l/ is always dark (i.e. always has a positive *D* score), even when it occurs in a very short rhyme. Moreover, canonical onset /l/ is always light (always has a negative *D* score) and, crucially, duration has absolutely no effect on its *D* score. Thus, Yuan and Liberman's findings indicate that English has a categorical distinction between light [l] and dark [ɫ], overlaid with gradient duration-driven adjustments of gestural phasing in the realization of dark [ɫ]. Indeed, some of Sproat and Fujimura's (1993) own raw data point in this direction: visual inspection of their Figure 3 (page 303) suggests that the realizations of /l/ by speaker CS are bimodally distributed and form two clusters, one comprising tokens with coronal lead, the other comprising tokens with coronal lag (see §2.1 again for the relevance of bimodality).

Considered from a diachronic viewpoint, this result is far from surprising. There are good reasons to believe that phonological systems of this sort, where a categorical phonological rule coexists in the same grammar with a cognate gradient phonetic process, arise naturally in the life cycle of phonological processes by "rule scattering": the stabilization of a gradient phonetic pattern often leaves the old process *in situ* even as a new distribution of discrete categories emerges at SR (Bermúdez-Otero 2007: 506; 2010). Zsiga's (1995) study of pre-yod palatalization provides a clear example. The grammar of present-day English turns out to contain two cognate palatalization rules: a fully neutralizing process confined to stem-level domains (e.g. *confe*[ʃ]*-ion*), and a gradient nonneutralizing process of coarticulation applying

across the board (e.g. *press you* [pɹɛʃjuː]). The phenomenon of "layering" in grammaticalization (Hopper 1991: 22) offers a highly suggestive parallel.

Whilst rule scattering effective disposes of many putative instances of morphologically sensitive phonetics (see Bermúdez-Otero 2010; cf. Kawahara 2011: §2.3.3), controversy still surrounds the ways in which factors such as token frequency, neighbourhood density, and contextual predictability affect fine phonetic detail. The proponents of exemplar theory regard classical grammatical architectures as falsified by these effects: see for example Hay and Clendon's chapter in this volume. However, there are alternative accounts of these phenomena that preserve modularity by various means, including speaker-internal mechanisms like cascading activation (Rapp and Goldrick 2000, Goldrick 2006, Goldrick and Blumstein 2006, Baese-Berk and Goldrick 2008) and listener-oriented mechanisms like hypo- and hyper-articulation (Fowler 1988, Lindblom 1990).

[...]

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