What keeps a historical phonologist up at night?
Part II: Structuralization

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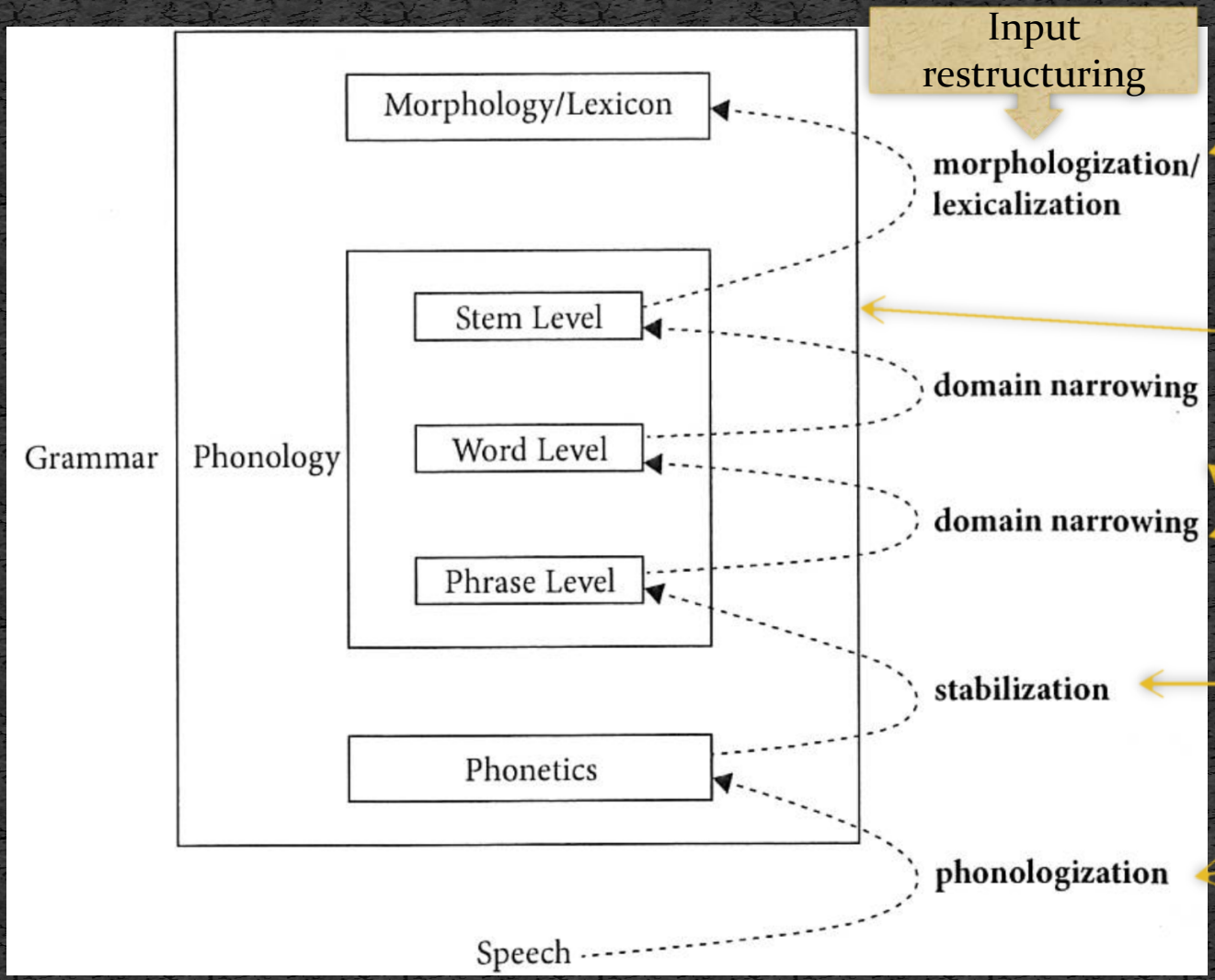
Structuralization

- A phonologized sound change becomes sensitive to grammatical structure
  - Morphosyntactic structure: the Life Cycle
    - Recognized since Baudouin de Courtenay (1895)
  - Phonological classes: rule generalization
  - Prosodic structure: syllable, foot, PWd, ϕ, ι,
- Life cycle of phonological processes
  - Modular feedforward model: Stratal OT (Berm-O 2006)

Life cycle of a phonological process

Bermúdez-Otero & Trousdale (2012: 700)



Idiosyncratic lexical residue or morphological operation

Exceptions due to nonanalytic listing of stem-level outputs

Sensitivity to morphosyntactic structure

Categorical counterpart of phonetic rule

New phonetic rule
= regular, gradient
= Neogrammarian

Where does it come from?

- Modules may be innate (e.g. Fodor 1985) or emerge during child's cognitive development (e.g. Karmiloff-Smith 1994)
- 'Elements… may emerge during acquisition from the interaction of factors such as the schedule of the child's morphosyntactic development, lexical listing, and morphological blocking' (Berm-O 2015)
- More work required to ascertain mechanisms/possibility of emergence

Amphichronic Phonology

- Explicit relationship between synchrony and diachrony
- Life cycle model is restrictive and predictive
  - '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' (Bermúdez-Otero & Trousdale 2012)

Stage	Realization of underlying /ŋg/				Level reached by the rule	Period or variety
	elongate	*prolong-er*	*prolong it*	*prolong* ǁ		
0	ŋg	ŋg	ŋg	ŋg	—	Early Modern English
1	ŋg	ŋg	ŋg	ŋ	phrase level	Elphinston (formal)
2	ŋg	ŋg	ŋ	ŋ	word level	Elphinston (casual)
3	ŋg	ŋ	ŋ	ŋ	stem level	present-day RP, GenAm

Modular feedforward model (mfm)

- Predictive in several domains, e.g. Three types of change:
  - Phon gradual, lex abrupt = change in phonetic rules
  - Phon abrupt, lex abrupt = change in phonological rules
  - Phon abrupt, lex gradual = change in lexical representations
- All three attested:
  - Gradient, regular 'Neogrammarian' change (Labov 2010: /u:/-fronting; Fruehwald 2012: /aɪ/-raising, pace Bybee 2001, Phillips 2015)
    - Ohalan mechanisms cannot predict this: just lexical forms
    - Pure exemplar theory cannot predict this: word-specific clouds
  - Across-the-board categorical phenomena: Sardinian phrase-level external sandhi (Ladd & Scobbie 2003)
  - Lexical diffusion (Wang 1969; Chen & Wang 1973): categorical variants spreads through lexicon

Rule aging

- Correlation between relative ages of rules and their positions in the grammar
  - Older rules apply in higher strata
- E.g. Lenition trajectories
  - Older: mild reductions; newer: more severe ones
  - Opposite logically impossible (path to Ø)
- Mild reductions in higher strata
  - Stem-level coda /ɹ/ → [ɻ̩] (linking [r]: *for a*)
  - Word-level l-darkening (*seal in*)
- Drastic reductions in lower strata
  - Eng. phrase-level coda r-deletion, l-vocalization

Dialectal variation (Ramsammy 2015)
Space and time

- Sound changes frequently occur across a dialect continuum, but can be at different rates
- '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'
- Spanish coda nasal velarization
  - Word-level: Peninsular Velarizing Spanish
    - [paŋ], [panaθo]
  - > stem-level > lexicalized : Galician functional vocabulary
    - masc. [alxuŋ], fem. [alxuŋa] 'some, any'
    - cf. PVS [alguŋ] vs. [alguna]

Stratal OT and the Life Cycle: Questions from historical phonology

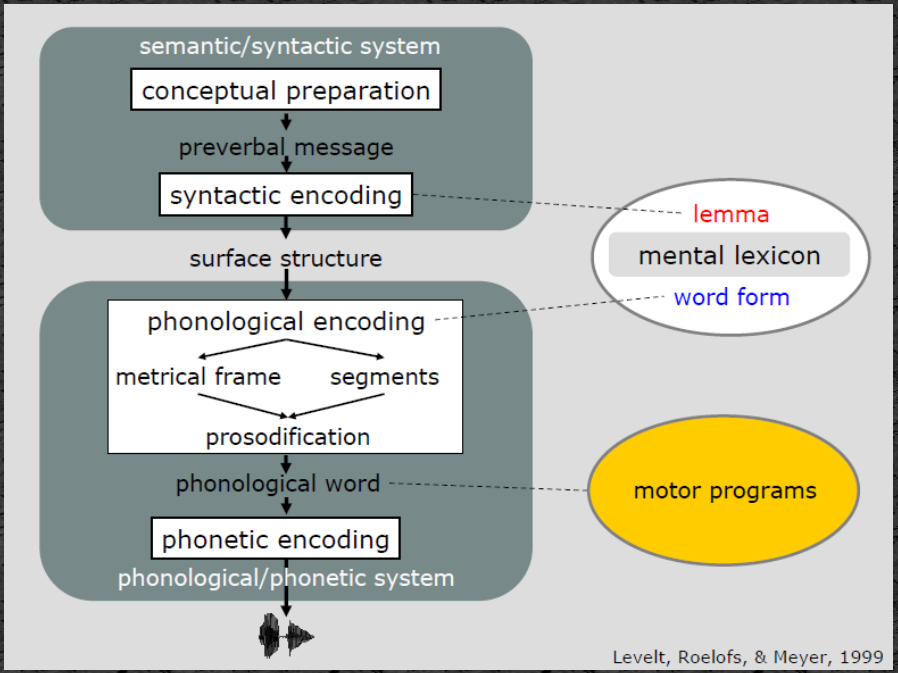
- What is a 'phonetic rule'? Mainly yesterday's question
- When does phonetics become phonology? Stabilization
- What are the cognitive mechanisms favouring domain narrowing and not vice versa? Domain broadening
- How do we account for phonetics apparently sensitive to morphology/lexicon? Rule scattering
- How do generalization and prosodification of rules fit in? Phonetic and analogical origins
- Are 'mystical, pan-generational forces' needed to sustain the life cycle? (Hale et al. 2015)
- Others:
  - Can lexically diffusing changes reflect lexically varied computation rather than storage? Which items first and why?
  - What are the full range of predictions of nonanalytic listing of stem-level outputs?

What is a phonetic rule?

- Stratal OT (e.g. Berm-O 2006) has explicitly formulated storage (UR, stem-level listing) and computation (SL, WL, PL)
- No explicit, formal account of phonetic implementation: mapping phonological categories onto continuous phonetic parameters. Need to import…
- Hamann (2009) and Boersma (2009) do just that, but with the focus on the listener using cue constraints
  - Neogrammarian sound change involves the reweighting of perceptual cues across generations: targets shift
  - Supported by computational simulations
  - Predicts observed structure-preserving bias in phonologization

Exemplar theory (see Sóskuthy 2011)

- Or is 'phonetic rule' computed from exemplar memory structured by category-based clouds?
  - Hybrid exemplar theory (Pierrehumbert 2002)
- So we do store phonetic detail, but it only becomes available very late in speech production process?
- Cf. Levelt et al. (1999): 'mental syllabary' of motor programs
- Predictions of different formulations to be ascertained



When does phonetics become phonology? Recognizing stabilization

- 'Determining whether or not a sound pattern has become categorical normally requires careful statistical analysis of high-quality phonetic data' (Bermúdez-Otero & Trousdale 2012)
- E.g. Bimodality criterion in articulatory data, insensitivity to speech rate or any quantitative properties of the environment
  - e.g. Japanese palatalisation in /ti/ even in hyperspeech
  - Ellis & Hardcastle (2002) on English /n#k/
  - Strycharczuk (2012) on Quito Spanish
- Limitations
  - Absence of bimodality does not entail absence of categoricity
  - Rule-scattering = gradient rule remains alongside new rule
  - Extreme caution with 'statistically significantly different = categorical = phonological': behaviour is phonology's domain

Domain broadening?

- Cypriot Greek (Kaisse 1993)
  - 1 Older rule: [±continuant] dissimilation
    - /ek-tim-o/ → [extimo] 'I esteem'
  - 2 Newer rule: glide-hardening j → c / C__
    - Provides input to rule 1: /spiti-a/ → [spiθca]
- Dissimilation broadening from SL/WL to PL while hardening narrows PL > SL/WL?
- No, both are now SL/WL and interact at a single level, not interstratally (Ramsammy 2015)
- OT models single-level interaction well without rule order
  - Incorrect: synchronic rule order matches diachronic incorporation (McMahon 2000: 9)

Domain broadening is rare, but possible

- Adult borrowing (Labov 2007: 369)
  - From: NYC stem-level short-æ tensing
  - To: New Orleans word-level short-æ tensing
- Mis-internalization of opaque forms: SL as WL (Bermúdez-Otero & Trousdale 2012)

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

  - 'Unidirectionality has been found to break down in circumstances that favour higher rates of replication error than intergenerational transmission within a speech community' (Berm-O 2015)
- Why can't infant/adult from same dialect mis-internalize?
- Why so rare ('at most an occasional retrograde step')?

Why so rare?

- dada dad-a dad a dad dad > PL dada dad-a dad a dat dat
  - 2 out of 3 word-final /d/ devoiced… so generalized:
- > WL dada dad-a dat a dat dat
  - 3 out of 4 stem-final /d/ devoiced… so generalized:
- > SL dada dat-a dat a dat dat
  - Every instance of /dad/ now [dat]: lexicalizes as /dat/

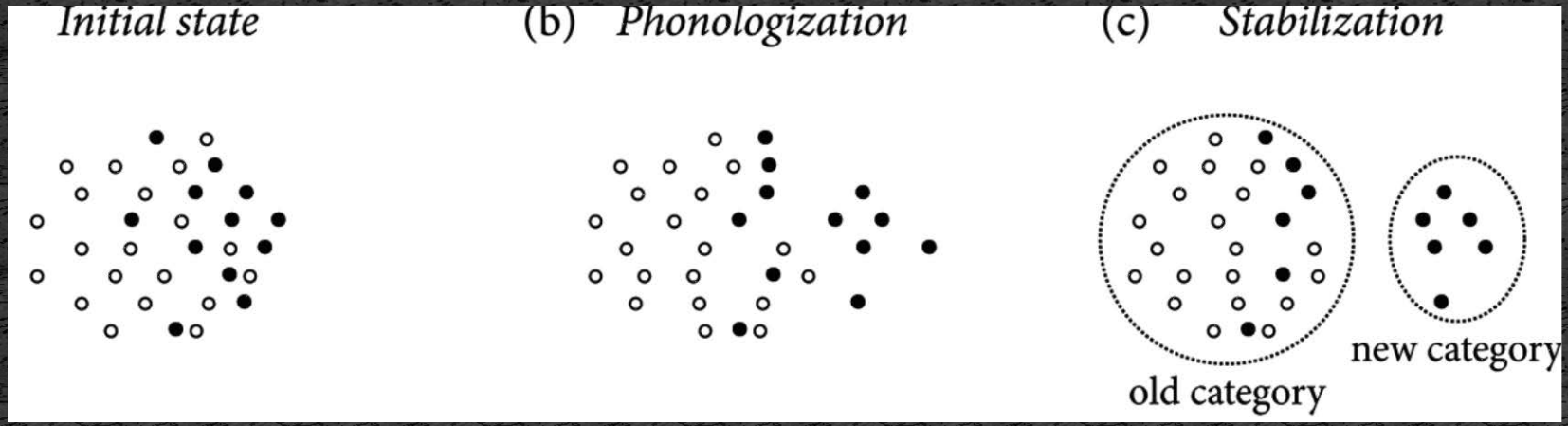
- SL dada dat-a dat a dat dat
  - 4 out of 5 non-word-initial /d/ devoiced… generalize?
- > WL data dat-a dat a dat dat
  - 5 out of 9 non-phrase initial /d/ devoiced…??! (token frequency)
- > PL data tat-a tat a tat tat??
- Crucially, environment has expanded from coda /d/ to any non-initial /d/: rule generalization necessary for domain broadening?

Morphologically-sensitive phonetics?

- Modularity: phonetically gradient change must be free of morphological and lexical conditioning (no interface)
- Morphological structure can appear to affect gradient phonetic rules (Kawahara 2011: §2.3.3)
- Eng. l-darkening (Sproat & Fujimura 1993; Boersma and Hayes 2001)
  - light > gai-ly > Hayley > hail-y > mail it > bell
- BUT modular stratal account explains illusion of a morphology-phonetics interface AND size of morphological effects
  - Categorical l-darkening rules at SL, WL, and PL: more levels, more likely to be darkened (Turton 2012)
  - Gradient, duration-driven phonetic rule (the longer the darker)
- Account based on 'rule scattering': diachronic domain narrowing of a rule, with a version remaining in situ

Rule scattering

- Rules created by stabilization coexist with phonetic rules from which they emerge
  - E.g. stem-level categorical palatalization (*confession*) and gradient phonetic palatalization (*press you*)
- Predicted to be the norm, e.g. vowel tokens in a backing environment
- See Berm-O's 2015 account of Philadelphia æ-tensing at (1) stem-level and (2) phonetic implementation, sensitive to similar factors
  - A few other instances of rule-scattering across languages cited therein



Challenges

- Rule scattering cannot explain all instances of morphologically-sensitive phonetics
- E.g. Dutch *-te*/*-de* past tense phonetically gradient allomorphy (Sebregts and Strycharczuk 2012)
  - Similarity-based analogy, i.e. neighbourhood density
  - Mismatch in neighbourhood → phonetic blending
- Most common alternative: cascading/spreading activation, i.e. partial activation of multiple lexical or phonological representations (Goldrick & Blumstein 2006)
- If required, can such mechanisms also explain e.g. l-darkening, etc. instead of rule scattering?

Lexically-sensitive phonetics

- Major challenges which appear to falsify modularity
  - Token frequency
  - Neighbourhood density
  - Contextual predictability
- Need to keep lexicon phonetics-free?
- Duck theory?... recall options re: 'phonetic rule'...
- Exemplar theory: storage of fine phonetic detail?
  - Can word-specific phonetics via categories be accessed at a late stage in speech production?

Rule generalization = 'phonetic analogy' (Schuchardt 1885)

- Change often begins in specific environment with phonetically favourable conditions
- Progressively spreads to more general contexts
- Rules get further from phonetic origins with age
- Like life cycle, dialect continuum can reflect rule age
  - OHG (af)frication: V__(north) > C__ > #__(south) (Berm-O 2015)
- 'The causes of rule generalization are imperfectly understood' (Berm-O 2015)
  - Top-down formal biases favour generality (Hayes 1999; Pater & Moreton 2012)

Rule generalization types

- (1) 'Phonetic': conditions more favourable in older than newer context(s), but present in both
  - Gradual phonologization of an effect predicted to be environment by environment
  - Caraqueño final nasal velarization rates according to phonetic favourability: __ Dor > __Lab > __Cor (Ramsammy 2015)
- (2) 'Analogical': rule spread by phonological similarity, without phonetic influence, e.g. __r > __Cor (Swiss German?)
- Analogical generalization targets least frequent forms if diffused, e.g. Latin onset /kl/ > /kVl/ epenthesis (Sen 2015: ch5)
  - Result of 2 analogies, ultimately spreading from /bl/-epenthesis
  - Most frequent forms resistant to change (*hercle, perīculum*)
  - Contrast /pl/-epenthesis which shows phonetic conditioning

Rule generalization and rule scattering

- Illusion of 'rule generalization + domain broadening' is in fact 'rule generalization + rule scattering'
  - Older rule : higher stratum : specific phonological conditions
  - Newer rule : lower stratum : more general conditions
  - I.e. Elsewhere Condition simply falls out from the model
- Swiss German interaction of umlaut and o-lowering (Robinson 1976; Berm-O 2015, Ramsammy 2015)
  - Older: pre-r lowering at stem-level
  - Umlaut at word-level
  - Newer: scattered general pre-COR lowering with dialect continuum reflecting diachronic progression: WL in Schaffhausen [xœrbli, trøtli], SL in Kesswil [xœrbli, trœtli]

Rule scattering types according to generalization types?

- (1) Phonetically natural, i.e. new gradient phonetic rule
- (2) Generalized by analogy, i.e. new categorical rule
- Rule scattering in (1) has independent motivation
- Why should (2) start as phrase-level rule?
  - Word-level rule of final devoicing of stops might be generalized to all obstruents without phrase-level devoicing of fricatives (arguably not phonetic in origin)?
- WL stop-devoicing: dad a daz a dad daz → dat a daz a dat daz
  - > WL obstruent-devoicing: dat a das a dat das
- Or if scattered: > PL fricative-devoicing: dat a daz a dat a das
  - But by what logic is it PL?
- Is rule scattering in (2) stipulative?
  - Account for facts neatly and fits life cycle framework…

Sensitivity to prosodic structure

- Some coda effects came about through prosodic non-prominence of coda (direct influence)
  - E.g. beginnings in articulatory reduction
- Many came about due to absence of release or masking by following C (indirect influence)
  - Latin assimilations stayed that way (Sen 2011; 2015: ch6)
- __{C, #} >]σ = linear sequence > prosodic structure
- Should we see a difference in the way these types behave (e.g. when lexically diffused)?

Prosodic hierarchy

- Syllable < Foot < Prosodic Word < Phonological Phrase < Intonational Phrase
- How should rules progress? What is the learner's logic?
- σ > Ft
  - Eng. l-darkening and r-deletion: syllable coda (conservative dialects) > non-foot-initial (innovative) (Berm-O 2011)
  - Set of weak positions in the syllable is a proper subset of the set of weak positions in the foot (Berm-O 2015)
- ('da.da)('dad) > ('da.da)('dar) > ('da.ra)('dar)
- Like domain narrowing, higher frequency of d > r than d-retained needed in non-Ft-initial position
  - I.e. lots of codas, but reinforces original pattern?

Up or down?

- If stabilization is of a phonetic effect, couldn't prosodic sensitivity also go from big to small
  - E.g. phrase-final lengthening effects > word-final?
- Some rules are more 'general' if they apply to smaller prosodic units, and some if they apply to larger, so either plausible
- Contrast σ > Ft with:
- IP-final effect (pre-pausal) generalized to:
  - PP: $_{IP}$[dada dad dad dar] > $_{PP}$[dada dar] $_{PP}$[dad dar]
  - > PWd: $_{PWd}$ [dada] $_{PWd}$[dar] $_{PWd}$[dar] $_{PWd}$[dar]
- Frequency-assisted? Need lots of non-branching units for IP/PP-final position to coincide with PP/PWd-final
- Or simply an instance of top-down bias favouring generality?

Dual morphosyntactic conditioning

- Morphosyntactic structure can condition prosodic structure (e.g. alignment constraints)
- Difficult to distinguish between two kinds of morphosyntactic conditioning in phonology (Berm-O & Luís 2009, Berm-O 2011)
  - Procedural: cyclic domains
  - Representational: prosodic structure
- Either/both can change diachronically, e.g. Latin iambic shortening (Sen 2015b)
  - Advances, but incorrect predictions in Mester (1994), Prince & Smolensky ((1993)2004), Jacobs (2003)
  - Notably, phrasal iambic shortening disregarded

Latin iambic shortening: a real feature of early spoken Latin

- PrWd iambic shortening: LH → (ĹL)
  - *homo:* → *(hó.mo)* 'human'
    potest → *(pó.tĕst)* 'can'
- 'Word-initial' iambic shortening: LH… → (ĹL)…
  - *vere:ba:mini:* → *(ve.re).(bá:).mi.ni:* 'you (pl.) were afraid'
    volupta:tem → *(vo.lŭp).(tá:).tem* 'desire (acc.)'
- Cretic shortening: HLH → (Ĥ)(LL)
  - *di:cito:* → *(dí:)(ci.to)* 'say (fut. impve)'
    di:xerunt → *(dí:k).(se.rŭnt)* 'they said'
- Cross-word iambic shortening: L#H… → (L#L…)
  - *sed ostendere* → *(se.dŏs).(ten).(de.re)* 'but to show'
  - *hic est* → *(hi.cĕst)* 'this is'

Phrase-level shortening

- Due to pressure towards exhaustive parsing
- Remaining faithful to stresses assigned at word level
  - MAX-FootHead (Berm-O & McMahon 2006: 399)
- But some word-level stresses destressed to achieve binary feet
  - Cross-word iambic shortening demonstrates that FTBIN » MAX-FTHD at phrase level
- Word-level ranking
  - NONF, H/R » FTBIN, CLASH, *(HL), MAX-μ » WSP » PARSE-σ
  - *(lé)go:, (dí:)cito:, (vòlup)(tá:)tem, (ét) ab(dú:)cere*
  - *a(mí:)cam, fi(dè:)li(tá:)tem*
- Phrase-level ranking
  - FTBIN » MAX-FTHD, *(HL) » PARSE-σ, WSP » NONF, CLASH, MAX-μ, H/R, SWP
  - *(légo), (dí:)(cito), (vòlŭp)(tá:)(tem), (étăb)(dú:)(cere)*
  - *a(mí:)(cam), fi(dè:)li(tá:)(tem)*

Diachrony: Life Cycle (see Fortson 2008: 177)

- Early Latin verse (e.g. Plautus): phrase-level
- Early 'popular' verse inscriptions: word-level
  - Limited to single words of iambic shape, not polysyllables or word groups
- Later republican/imperial verse: word-level with further restrictions
  - Only shortening of long V, not closed syllable
- Imperial: lexicalised
  - Shortened forms continued as standard in classical Latin: *bene* 'well', *modo* 'only', *ego* 'I', *sibi* 'him (dat.)'

Phonological phrases

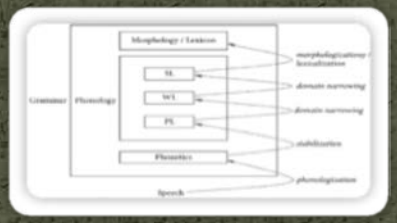
- Shortening also sensitive to prosodic structure
- Shortening within phonological phrases (ϕ), which were not heads of their intonational phrases (ι) in feet which did not bear the main stress (non-heads) of the phonological phrase
- Phonological phrases formed in an isomorphic fashion to lexical phrasal projections, encompassing NPs, VPs, and APs (e.g. Selkirk 2011: Match(XP, ϕ)
  - Purely phonological markedness constraints may result in non-isomorphism

ϕ-internal analysis explains philological literature's findings that:

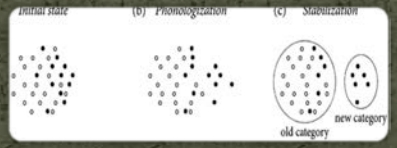
- 'Close syntactic connection' between two words in cross-word iambic shortening: (e.g. Questa 1973: 496-7, Soubiran 1988: 247)
  ϕ-internal
- Shortening never when L was followed by a 'full word boundary', e.g. end of a clause: (e.g. Devine & Stephens 1980: 149)
  ϕ-internal
- Shortening never when H was followed by 'full word boundary':
  not in head (final by default) ϕ of ι
- Shortening never occurred in focused elements:
  not in head (focused) ϕ of ι

Domains and units

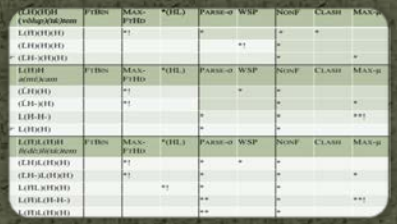
- Cyclic domain narrowing
- Prosodic domain shrinking
  - Earlier version refers to Intonational Phrase
  - Later version refers to syllable structure (V: but not VC)
- Aside from the separate trajectories of prosody and the cycle, are there any more closely bound interactions?
- Requires further investigation…



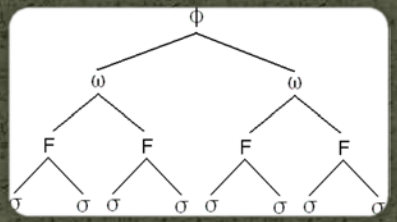
The life cycle model is the main way in which synchronic structure can help explain diachronic phonology



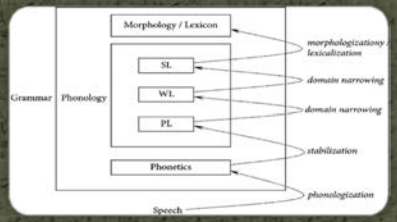
Domain broadening might occur, but rule scattering can account for many effects, including some morphologically-sensitive phonetics



Rules can be generalized and scattered or just generalized in the same domain, depending on type of generalization



Changes can be prosodified and go through the prosodic hierarchy (up or down); morphosyntactic conditioning may come about this way



The life cycle is everywhere!

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