

Morphologically conditioned phonetics? Not proven.

Ricardo Bermúdez-Otero (*University of Manchester*)

INTRODUCTION

The fundamental philosophical questions like the continuous versus the discrete or the limits of knowledge are **never** definitively solved.

Gregory Chaitin, *Metamaths*, 2.

§1 In classical modular feedforward architectures of grammar (Pierrehumbert 2002, Bermúdez-Otero 2007), there is no direct communication between morphology and phonetics; morphology can affect the application of gradient processes of phonetic implementation only indirectly, through categorical properties of the surface phonological representation.

§2 So-called English /t,d/-deletion appears to challenge the classical architecture (Myers 1995,¹ Coetzee and Pater 2011):

- *morphological sensitivity* (e.g. Labov et al. 1968; Guy 1980, 1994)

/t,d/ are deleted more often when affiliated to a stem *mist*
than when affiliated to a regular inflectional suffix *miss-ed*

- *phonetic gradience* (Browman and Goldstein 1989, 1990)

in at least some instances, the tongue-tip gesture of the allegedly deleted /t,d/ is not removed, but merely hidden by adjacent overlapping gestures (and also possibly reduced).

§3 The rate of complete (categorical) vs incomplete (gradient) /t,d/-deletion is currently unknown.

In any case, the classical architecture can describe the facts in §2 by means of a two-step derivation (cf. Scobbie 1995):

- (1) *phonology*: variable, categorical, morphologically sensitive featural or prosodic change
- (2) *phonetics*: variable, gradient, morphologically insensitive gestural adjustment.

§4 Two-step derivations along the lines of §3 should not be regarded as contrived; they are the natural and expected result of the highly prevalent diachronic process of rule scattering.

RULE SCATTERING (after Robinson 1976):

Diachronic change often introduces a new avatar of an existing pattern into a higher component of the grammar by reanalysis, while the old avatar remains *in situ*.

¹ **Note added on 17 Dec 2010.** Some two weeks after this paper was presented at OnLI II, it was brought to my attention that J. Myers had reached very similar conclusions about English /t,d/-deletion in an entirely independent study, reported in Myers (1995). I have added references to Myers's manuscript, highlighted in red, at relevant points in this handout.

MORPHOLOGY AND PHONETICS IN THE CLASSICAL ARCHITECTURE

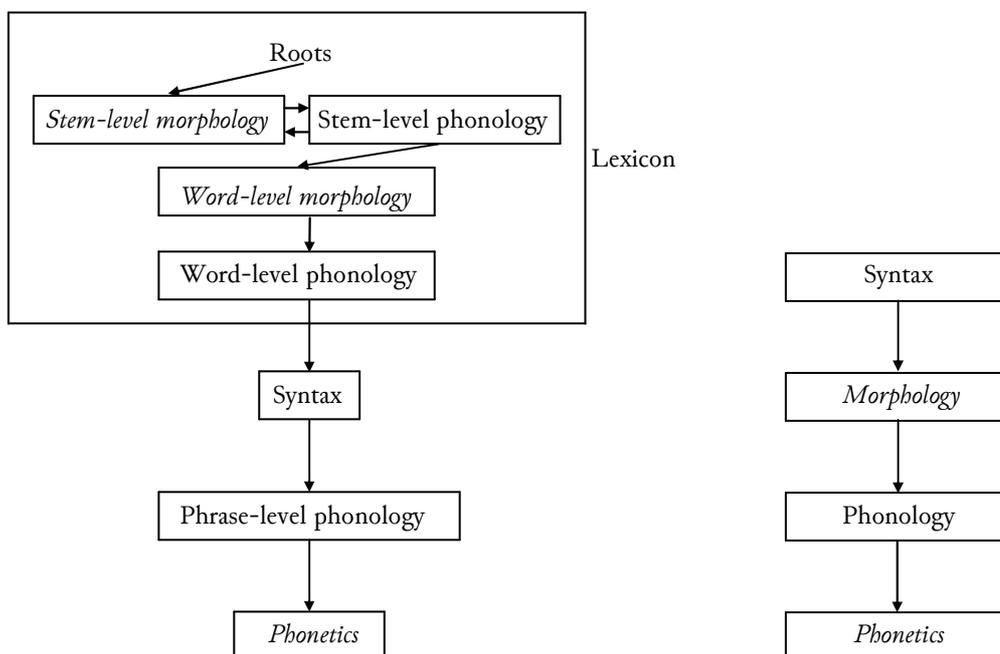
No morphological conditioning in phonetics

§5 In classical architectures, there cannot be direct communication between morphology and phonetics

because morphology and phonetics do not share an interface;
the (categorical) phonology always mediates between the two.

§6 (a) *Late 1980s interactionist architecture*
 (Kiparsky 1985, Booij and Rubach 1987)

(b) *Late 1980s noninteractionist architecture*
 (Halle and Vergnaud 1987, Odden 1993)



§7 A long-standing principle (see Scheer 2010):

- Kruszewski (1881 [1995]: 27):
 ‘the combinatory process [=coarticulation] cannot be impeded by “analogy”.’
- Structuralism (e.g. Z. S. Harris 1951, ch. 8):
 morphosyntax controls the distribution of juncture phonemes;
 allophony rules refer to juncture phonemes, not to morphosyntax.
- *SPE* (Chomsky and Halle 1968): a variant of §6(b).
- Bidirectional Phonology and Phonetics (Boersma 2009):
 parallel, rather than feedforward, architecture;
 but, still, no constraints directly evaluating the relationship between Morphemes and
 Auditory Form or Articulatory Form.

Empirical challenges

§8 Allegations of direct morphological conditioning of gradient phonetic processes (see also Kawahara 2011: §2.3.3):

<u>phenomenon</u>	<u>reference</u>	<u>this paper</u>
• English /t,d/-deletion	Myers (1995) , Coetzee and Pater (2011)	§22ff
• English /l/-darkening	Sproat and Fujimura (1993)	†
• The Withgott Effect	Steriade (2000)	§9-§13
• Korean gestural timing	Cho (2001)	§18-§21
• Dutch final devoicing	Ernestus and Baayen (2006, 2007)	
• Dutch <i>-igheid</i>	Pluymaekers et al. (2010)	

† I assume that the approach to /t,d/-deletion defended in this paper is also appropriate for /l/-darkening: see Hayes (2000: 93), Bermúdez-Otero (2007: note 6), but specially Bermúdez-Otero (2013: §2.4).

Prosodic solutions (I): the Withgott Effect

§9 The Withgott effect (Withgott 1982):

cápi[r]al ⇒ *càpi[r]alístic*
míli[t^h]àry ⇒ *míli[t^h]arístic*

The effect is subject to variation (Riehl 2003).

§10 Steriade's (2000) claims:

- Flapping is a gradient phonetic process (shortening of stop closure); cf. §11 below.
- The Withgott effect requires analogical transfer (via output-output correspondence) of gradient phonetic properties; cf. §12 below.

§11 In fact, flapping is a variable but categorical phrase-level process creating discrete stop vs flap allophones:

- Stop and flap allophones are distinguished by several interacting acoustic cues (Riehl 2003).
- Stop and flap allophones create a bimodal distribution in duration (Herd et al. 2010: 508).
- /t/-flaps and /d/-flaps are phonetically indistinguishable: e.g. same mean duration (Zue and Laferriere 1979: 1043-44, Kwong and Stevens 1999: 3, Herd et al. 2010: 511, Braver 2010).

The underlying /t/-/d/ contrast is reflected only in the preceding vowel, notably in its duration. This effect is entirely expected since prefortis clipping (vowel shortening before voiceless obstruents) can be independently shown to apply at the stem level and so to precede phrase-level flapping (Bermúdez-Otero 2004: §14-§22).

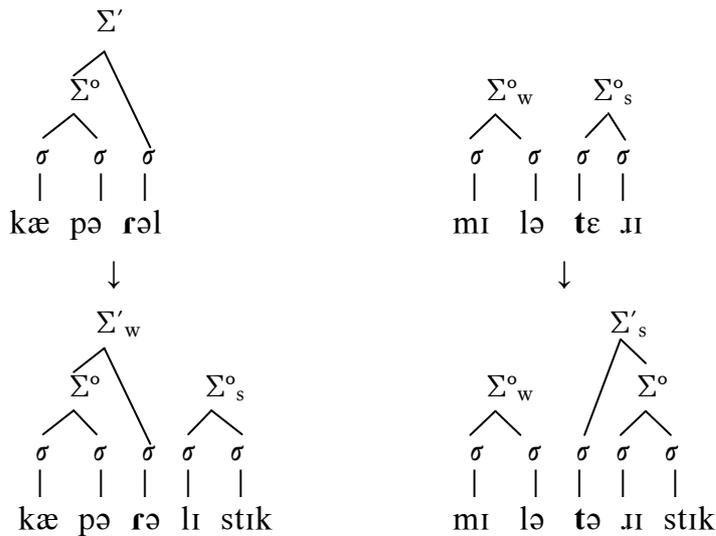
§12 In fact, morphological structure affects flapping not directly, but indirectly via prosody:

foot structure is built cyclically

and an intervocalic /t/ resists flapping if it is initial in some foot-projection at the word level.

See Kiparsky (1998), Jensen (2000: 208-11), Davis (2005), Bermúdez-Otero and McMahon (2006: 403-04).

§13



Prosodic solutions (II): durational effects of suffixation

§14 Sugahara and Turk (2009) on durational effects of word-level suffixation in Scottish English:

phonetic realization of the string /ɛ:z/ $\left\{ \begin{array}{l} \Rightarrow \text{shorter duration in } \textit{raisin} \quad [\text{ɛ:zɪ}] \\ \Rightarrow \text{longer duration in } \textit{rais-ing} \quad [\text{ɛ:zɪŋ}] \end{array} \right.$

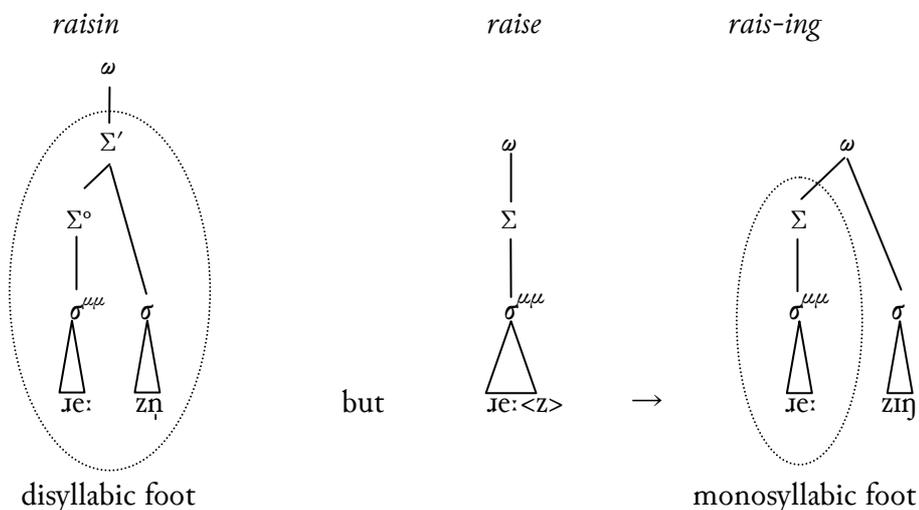
The effect is relatively small:

- it was not detected at all in Sproat and Fujimura (1993)
- not statistically significant at ‘normal’ speech rates (Sugahara and Turk 2009: 496)
- 6.6% difference (mean of 23ms) at ‘slow’ speech rates (Sugahara and Turk 2009: 496)
- 9.6% difference (mean of 42ms) at ‘extra-slow’ speech rates (Sugahara and Turk 2009: 499).

§15 A prosodic solution (Bermúdez-Otero 2011: §4):

- stem level (stress-affecting affixation) \Rightarrow exhaustive footing
- word level (stress-neutral affixation) \Rightarrow stray syllables attached directly to ω

§16



§17 Sugahara and Turkel propose the prosodification [_ω [_ω ɛ:z] ɪŋ] for *rais-ing*, but this incorrectly predicts that the stem will behave durationally like the first member of a compound (*pace* Sugahara and Turkel 2009: 488; cf. Sproat 1993: 178).

Processing solutions? A speculative suggestion

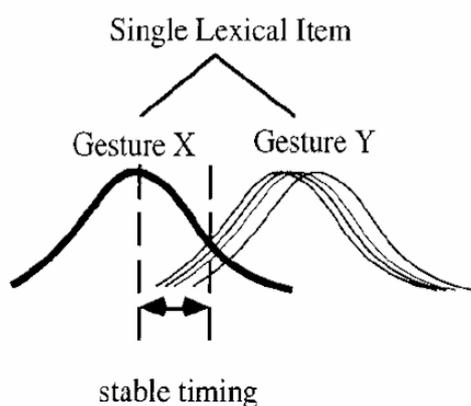
§18 Cho (2001) on gestural timing in Korean:

- tautomorphic segments ⇒ low variability in gestural timing /napi/ ‘butterfly’
- heteromorphic segments ⇒ high variability in gestural timing /nap-i/ ‘lead-NOM’

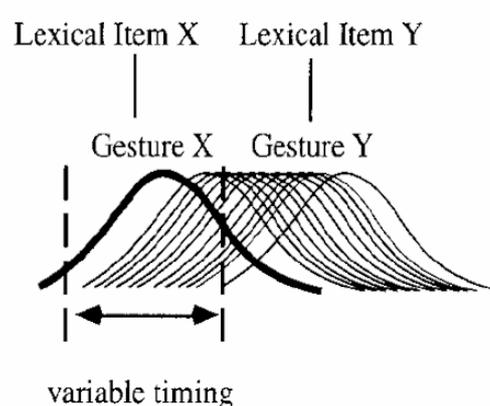
I assume that Cho is right in treating Korean nominal inflections as belonging in the same morphological and prosodic word as the stem: cf. Yoon (2005) for a phrasal-affix analysis, but see Bermúdez-Otero and Payne (2011).

§19

a
within a morpheme or a lexical item



b
across different morphemes or lexical items



(Cho 2001: 131, Figure 1)

!! In this case, the effect of morpheme boundaries is symmetrical: both more extreme overlap and more extreme nonoverlap; cf. §14.

§20 Cho’s analysis:

‘[...T]he phonological structure of a lexical entry forms a “constellation” of gestures, a stable organization among gestures whose timing is specified in the lexicon’ (p. 153, my emphasis).

Cf. Articulatory Phonology (Browman and Goldstein 1989, 1990); see also Bradley (2007).

§21 A speculative suggestion: cascading activation.

Processing models with cascading activation allow competing representations at processing stage *s* to pass on activation to subsequent processing stages even before selection is complete at stage *s*.

- In such models, competing morphs can pass on activation downwards to phonological representations and thence to articulatory planning even before morph selection is complete.
 - If that happens, we expect higher amounts of articulatory ‘jitter’ near points of morph selection (morphological boundaries) than inside morphs.
 - In this scenario, articulatory jitter is an artifact of processing:
 - phonological representations *can* be more or less activated in processing,
 - but phonological representations *do not* contain fine-grained detail about gestural timing.
- (See Rapp and Goldrick 2000, Goldrick 2006, Goldrick and Blumstein 2006, Baese-Berk and Goldrick 2008).

A TWO-STAGE DERIVATION OF ENGLISH *t/d*-DELETION

Morphological sensitivity

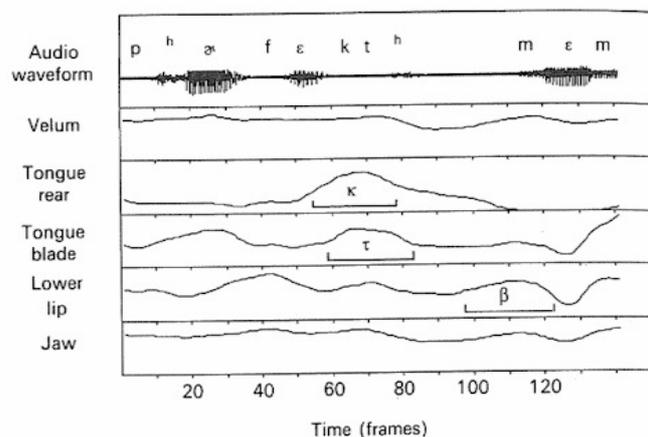
§22	Morphological affiliation	Examples	Surface forms	% deleted (Guy 1991a: 5)
	stem	<i>mist, pact</i>	[mɪs(t), pæk(t)]	38.1
	regular inflectional suffix	<i>miss-ed, pack-ed</i>		16.0

This correlation between the morphological affiliation of the stop and deletion rate has been replicated in various dialects (e.g. Guy 1994: 140), but at least two studies have warned of possible confounding variables: the preceding consonant (Tagliamonte and Temple 2005: 295-96) and lexical frequency (Guy et al. 2008).

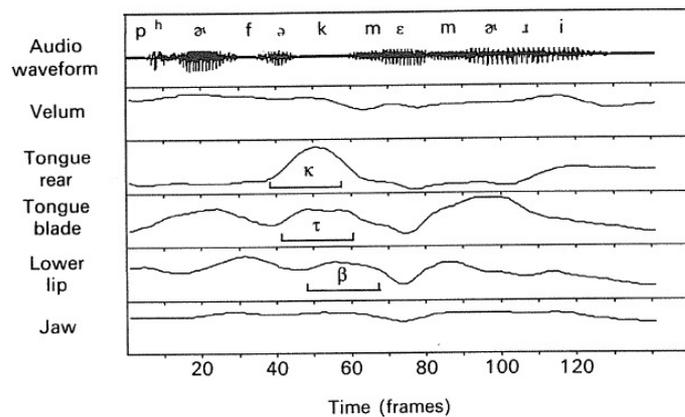
- §23 Irregular weak verbs (e.g. *lef-t, tol-d*) display an intermediate average rate of deletion in corpora: e.g. 33.9% in Guy (1991a: 5). This does not reflect a third type of morphological structure (*pace* Guy 1991a,b), but is rather an effect of age grading (Guy and Boyd 1990, Guy 2010: 255):
- *lef-t, tol-d* behave like *mist, pact* for younger speakers
 - *lef-t, tol-d* behave like *miss-ed, pack-ed* for older speakers.

Phonetic gradience

- §24 Audibly released /t/ in *perfect memory* (Browman and Goldstein 1990: 364, figure 19.13(a))



§25 Inaudible /t/ with hidden tongue-blade gesture (τ) in *perfect memory* (Browman and Goldstein 1990: 364, figure 19.13(b))



§26 • How many of the instances of /t,d/-deletion reported in the sociolinguistic literature are actually incomplete, like §25?

We just don't know.

• Can we assume that /t,d/-deletion is always incomplete (see e.g. Temple 2009)?

No! Lichtman (2010) examined the Wisconsin Microbeam Database and conducted an additional electromagnetic articulography study, and found that all speakers produced at least some instances of deleted /t/ without residual linguoalveolar gestures.

• Cf. the following cautionary tale:

Early reports of gradient coarticulation in assimilatory external sandhi led to the belief that categorical feature delinking and spreading did not operate across word-boundaries

(e.g. Barry 1985, Wright and Kerswill 1989, Nolan 1992, Hardcastle 1995, Zsiga 1995);

but this belief has proved false: categorical assimilatory external sandhi does exist

(e.g. Nolan et al. 1996, Ellis and Hardcastle 2002, Kochetov and Pouplier 2008: 414).

Two-step derivations

§27 Assume the worst-case scenario: morphologically-sensitive incomplete /t,d/-deletion is prevalent.

Can this be accommodated within the classical architecture?

Yes, by means of two step-derivations:

(1) *phonology*: variable, categorical, morphologically sensitive featural or prosodic change

(2) *phonetics*: variable, gradient, morphologically insensitive gestural adjustment.

See Myers (1995) for a similar view.

§28 *Scobbie's Caveat* (after Scobbie 1995):

If, as commonly assumed, phonological processes need not be neutralizing (i.e. need not be 'structure-preserving' in the sense of Kiparsky 1985),
 then evidence of gradience is not evidence of absence of a categorical effect.

§29 Key question:

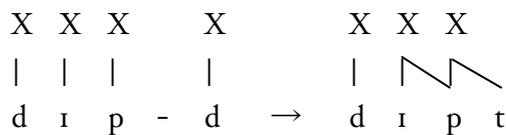
Is there an independently motivated way of categorically representing /t,d/-reduction in the phonology?

§30 • Option 1: represent the absence of audible release

e.g. in Element Theory, delete the h° element (noise component)
 (e.g. J. Harris and Lindsey 1995)

• Option 2: represent concurrent articulation

e.g. tuck the underlying /t,d/ under the timing slot of the preceding consonant

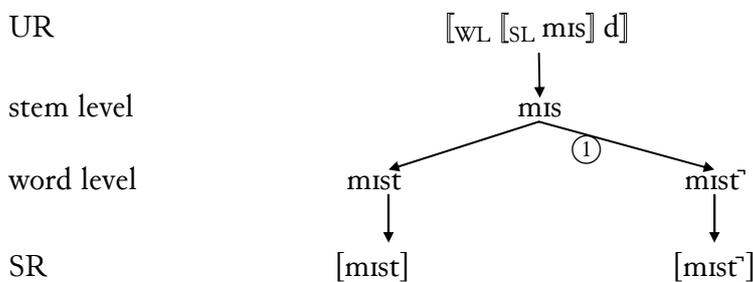


This autosegmental chart iconically represents

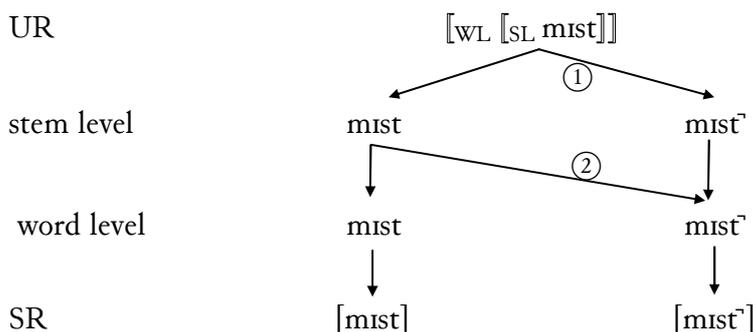
- prefortis clipping (reduced duration of /ɪ/ before longer fortis /p/)
- overlap of /p/ and /d/.

Deriving the effect of morphology on frequency cyclically (Guy 1991a, 1991b)

§31 One round of variable reduction in *miss-ed* ⇒ low reduction rate



§32 Two rounds of variable reduction in *mist* ⇒ high reduction rate



§33 Pace Guy (1991a, 1991b), I do not assume that the rate of reduction must be the same in every cycle.

On the contrary:

- In their normal diachronic life cycle (Bermúdez-Otero 2007: 503-5, 2013; Bermúdez-Otero and Trousdale 2012: §2), phonological processes enter the grammar from below and climb up to progressively higher levels.
- This predicts the possibility that a process may display higher rates of application at lower levels, where it has been active the longest (e.g. Turton 2012 on /l/-darkening).

TWO-STAGE DERIVATIONS ARE NATURAL: DIACHRONIC RULE-SCATTERING

A doctrine is not judged at all until it is judged in its best form.

John Stuart Mill, 'Sedgwick's *Discourse*', quoted in John Rawls, 'Some remarks about my teaching'

Diachronic rule-scattering gives rise to two-step derivations

§34 A perfectly ordinary stage of affairs:

two cognate rules, one gradient, one categorical, representing different stages in the diachronic life cycle of the same sound pattern, coexist within the same grammar.

- Examples:
- Philadelphia æ-tensing (Labov 1994) §36-§37 below
 - Pre-yod /s/-palatalization (Zsiga 1995) §38-§40 below
 - The Scottish Vowel Length Rule (McMahon 1991, 2000) Myers (1995: §1)

§35 Why is this stage of affairs common? Presumably because of the mechanics of *stabilization* (i.e. of the diachronic process of reanalysis whereby tokens of a gradient rule of phonetic implementation are reinterpreted as involving a categorical distinction):

the reanalysed tokens give rise to a new categorical rule, whilst the nonreanalysed tokens preserve the gradient rule *in situ* (see Bermúdez-Otero 2013: example (7) and surrounding discussion).

☞ Just a special case of rule scattering: see §4.

Philadelphia æ-tensing

§36 *A categorical default stem-level rule...*

- categorical opposition between lax [æ] and tense [æ:]
- the phonetic realizations of [æ] and [æ:] occupy largely nonoverlapping regions in auditory space (Labov 1989: 8-10)
- default pattern: æ is normally tense before coda /m, n, f, θ, s/ (Labov 1994: 430)
- counterbled by resyllabification before word-level suffixes:
e.g. *m[æ:]n*, *m[æ]nner*, *m[æ:]nn-ing* (Labov 1994; 430-31)
- outright lexical exceptions: [æ:] in *mad*, *bad*, *glad*; but [æ] in *sad*, *fad*, *lad*
[æ] in strong verbs like *began*, *ran*, *swam*

§37 *...overlaid with a gradient phonetic process*

the precise formant values of the acoustic realization of [æ:] are exquisitely sensitive to the phonetic environment

	<u>effect on height</u>
following nasal	158
preceding nasal	99
preceding obstruent plus /l/	-210
two following syllables	-410
etc.	(coefficients in Labov 1994: 466)

Pre-yod /s/-palatalization

§38 *A neutralizing stem-level morphophonological process...*

confe/s+/j/on → *confe[j]on* [j] realized with same pattern of linguopalatal consonant as underlying /j/

§39 *...coexisting with gradient gestural overlap across word-boundaries*

pre/s/ # /j/ou → *pre[s̠j]ou* [s̠j] arises from the superposition of the patterns of linguopalatal contact for /s/ and /j/

§40 But the same diachronic origin! cf. Chaucer's *confe/si.u:n/*.

METHODOLOGICAL CONSIDERATIONS

The insufficiency of conceptual arguments

§41 *Implications of the evidence for rule-scattering (§34–§40)*

☞ Criteria of elegance or simplicity (e.g. Ockham’s Razor) do not suffice to dismiss the two-step solution to the problem that English *t/d*-deletion raises for classical architectures.

Two-step derivations may look synchronically complex, but they are diachronically natural.

Of course, the evidence from rule scattering does not *prove* that two-step derivations are right for English *t/d*-deletion.

§42 *Conceptual arguments against direct communication between morphology and phonetics*

Grotesquely nonclassical behaviours become conceivable:

- e.g.
- ‘Mark dual number by adding /-no/ and increasing gestural overlap by 20%.’
 - ‘Form eventive nominalizations by adding /-ti/ and lengthening VOT by 30%.’

Of course, usage-based models need not predict such aberrant behaviour:

e.g. Bybee’s line (2001: 54):

Speakers are driven by efficiency requirements to constantly reuse a finite set of highly practised neuromotor programmes in speech. Presumably, this prevents morphological categories from drifting apart in phonetic space.

However, in the absence of equations or computer simulations, isn’t this just a promissory note?

“This family of theories [sc. exemplar-based theories—RBO] holds that the lexicon consists of a massive number of stored phonetic (or auditory) events, with or without category labels. Those subtheories that touch on category creation can do so because they include no category labels, but those subtheories that make interesting linguistic generalizations [...] do require the presence of category labels.” (Boersma 2012: §10.2.7)

Empirical problems

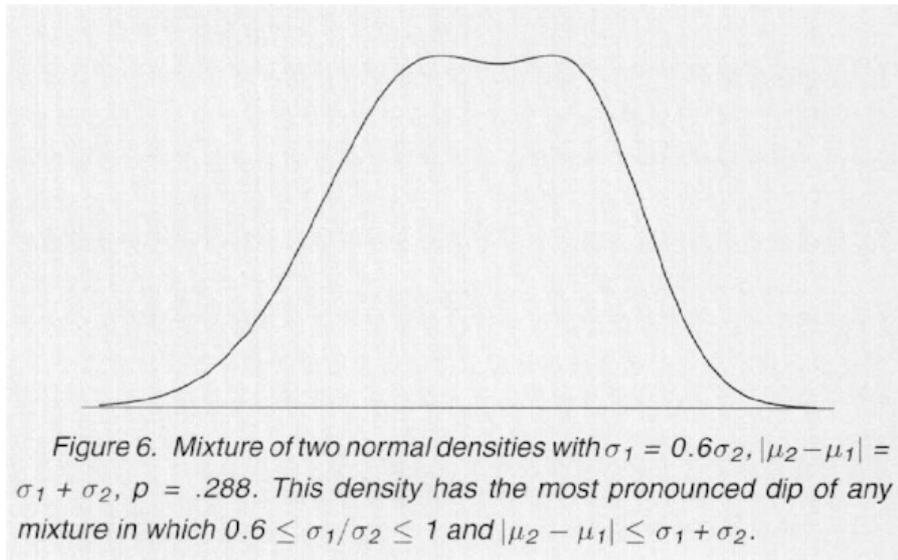
§43 *Limitations of the data currently available*

- sociolinguistic studies: impressionistic coding
no way of controlling for the presence of hidden gestures
- articulatory studies: few speakers
few tokens
lack of control of relevant morphological and phonological factors

§44 *Analytical challenges*

A bimodal distributions on some phonetic dimension is usually treated as the clearest indication of a categorical distinction (e.g. §11 above):

Problem: suppose that the realizations of two categories create two normal densities on some phonetic dimension;
the mixture of these two densities may be unimodal or very weakly bimodal under a wide range of conditions.



(Schilling et al. 2002: 225, figure 6)

See Myers (1995) for discussion with particular reference to the problem of *t/d*-deletion.

REFERENCES

- Baese-Berk, Melissa and Matthew Goldrick (2008). 'Mechanisms of interaction in speech production', *Language and Cognitive Processes* 24 (4): 527-54.
- Barry, Martin C. (1985). 'A palatographic study of connected speech processes', *Cambridge Papers in Phonetics and Experimental Linguistics* 4: 1-16.
- Bermúdez-Otero, Ricardo (2004). 'Raising and Flapping in Canadian English: grammar and acquisition'. Paper given at CASTL Colloquium, University of Tromsø, Tromsø, 2 November 2004. Available at www.bermudez-otero.com/tromsoe.pdf.
- (2007). 'Diachronic phonology', in Paul de Lacy (ed.), *The Cambridge handbook of phonology*. Cambridge: Cambridge University Press, 497-517.
- (2011). 'Cyclicality', in Marc van Oostendorp, Colin J. Ewen, Elizabeth Hume, and Keren Rice (eds), *The Blackwell companion to phonology* (vol. 4: *Phonological interfaces*). Malden, MA: Wiley-Blackwell, 2019-48.

- (2013). ‘Amphichronic explanation and the life cycle of phonological processes’, in Patrick Honeybone and Joseph C. Salmons (eds), *The Oxford handbook of historical phonology*. Oxford: Oxford University Press. Available at <http://ling.auf.net/lingbuzz/001679>.
- Bermúdez-Otero, Ricardo and April McMahon (2006). ‘English phonology and morphology’, in Bas Aarts and April McMahon (eds), *The handbook of English linguistics*. Oxford: Blackwell, 382-410.
- Bermúdez-Otero, Ricardo and John Payne (2011). ‘There are no special clitics’, in Alexandra Galani, Glyn Hicks, and George Tsoulas (eds), *Morphology and its interfaces*. Amsterdam: John Benjamins, 57-96.
- Bermúdez-Otero, Ricardo and Graeme Trousdale (2012). ‘Cycles and continua: on unidirectionality and gradualness in language change’, in Terttu Nevalainen and Elizabeth Closs Traugott (eds), *The Oxford handbook of the history of English*. New York: Oxford University Press, 691-720.
- Boersma, Paul (2009). ‘A programme for bidirectional phonology and phonetics and their acquisition and evolution’. Ms. Amsterdam: Institute of Phonetic Sciences, University of Amsterdam. Available at <http://www.fon.hum.uva.nl/paul/papers/BiPhon19.pdf>. Revised version of a LOT Summer School handout, June 2006.
- (2012). ‘Modeling phonological category learning’, in Abigail C. Cohn, Cécile Fougeron, and Marie K. Huffman (eds), *The Oxford handbook of laboratory phonology*. Oxford: Oxford University Press, 207-18.
- Booij, Geert and Jerzy Rubach (1987). ‘Postcyclic versus postlexical rules in Lexical Phonology’, *Linguistic Inquiry* 18 (1): 1-44.
- Bradley, Travis G. (2007). ‘Morphological derived-environment effects in gestural coordination: A case study of Norwegian clusters’, *Lingua* 117 (6): 950-85.
- Braver, Aaron (2010). ‘Is there incomplete neutralization in American English flapping?’ Paper given at 18th Manchester Phonology Meeting, Manchester, 21 May 2010.
- Browman, Catherine P. and Louis Goldstein (1989). ‘Articulatory gestures as phonological units’, *Phonology* 6: 201-51.
- (1990). ‘Tiers in articulatory phonology, with some implications for casual speech’, in John Kingston and Mary E. Beckman (eds), *Papers in laboratory phonology I: between the grammar and physics of speech*. Cambridge: Cambridge University Press, 341-76.
- Bybee, Joan (2001). *Phonology and language use*. Cambridge: Cambridge University Press.
- Cho, Taehong (2001). ‘Effects of morpheme boundaries on intergestural timing: evidence from Korean’, *Phonetica* 58: 129-62.
- Chomsky, Noam and Morris Halle (1968). *The sound pattern of English*. New York: Harper & Row.
- Coetzee, Andries W. and Joe Pater (2011). ‘The place of variation in phonological theory’, in John A. Goldsmith, Jason Riggle, and Alan Yu (eds), *The handbook of phonological theory* (2nd edn). Oxford: Blackwell, 401-34.
- Davis, Stuart (2005). ‘Capitalistic v. militaristic: the paradigm uniformity effect reconsidered’, in Laura Downing, T. Alan Hall, and Renate Raffelsiefen (eds), *Paradigms in phonological theory*. Oxford: Oxford University Press, 106-21.
- Ellis, Lucy and William J. Hardcastle (2002). ‘Categorical and gradient properties of assimilation in alveolar to velar sequences: evidence from EPG and EMA data’, *Journal of Phonetics* 30 (3): 373-96.
- Ernestus, Mirjam and R. Harald Baayen (2006). ‘The functionality of incomplete neutralization in Dutch: the case of past-tense formation’, in Louis Goldstein, D. H. Whalen, and Catherine T. Best (eds), *Laboratory phonology 8* (Phonology and Phonetics 4-2). Berlin: Walter de Gruyter, 27-49.

- (2007). ‘Intraparadigmatic effects on the perception of voice’, in Jeroen van de Weijer and Erik Jan van der Torre (eds), *Voicing in Dutch: (de)voicing—phonology, phonetics, and psycholinguistics*. Amsterdam: John Benjamins, 153–74.
- Goldrick, Matthew (2006). ‘Limited interaction in speech production: chronometric, speech error, and neuropsychological evidence’, *Language and Cognitive Processes* 21 (7-8): 817-55.
- Goldrick, Matthew and Sheila E. Blumstein (2006). ‘Cascading activation from phonological planning to articulatory processes: Evidence from tongue twisters’, *Language and Cognitive Processes* 21 (6): 649 - 83.
- Guy, Gregory R. (1980). ‘Variation in the group and the individual: the case of final stop deletion’, in William Labov (ed.), *Locating language in time and space*. New York, NY: Academic Press, 1-36.
- (1991a). ‘Explanation in variable phonology: an exponential model of morphological constraints’, *Language Variation and Change* 3 (1): 1-22.
- (1991b). ‘Contextual conditioning in variable lexical phonology’, *Language Variation and Change* 3 (2): 223-39.
- (1994). ‘The phonology of variation’, in Katharine Beals et al. (eds), *CLS 30-2: Parasession on variation in linguistic theory*. Chicago: Chicago Linguistic Society, 133-49.
- (2010). ‘Sociolinguistics and formal linguistics’, in Ruth Wodak, Barbara Johnstone, and Paul Kerswill (eds), *The SAGE handbook of sociolinguistics*. London: SAGE, 249-64.
- Guy, Gregory R. and Sally Boyd (1990). ‘The development of a morphological class’, *Language Variation and Change* 2: 1-18.
- Guy, Gregory R., Jennifer Hay, and Abby Walker (2008). ‘Phonological, lexical, and frequency factors in coronal stop deletion in early New Zealand English’. Paper given at Laboratory Phonology 11, Wellington, New Zealand, 30 June 2008. Abstract available at <http://www.victoria.ac.nz/labphon11/LP11%20abstracts/Guy,%20Hay%20&%20Walker.pdf>.
- Halle, Morris and Jean-Roger Vergnaud (1987). ‘Stress and the cycle’, *Linguistic Inquiry* 18: 45-84.
- Hardcastle, William J. (1995). ‘Assimilations of alveolar stops and nasals in connected speech’, in Jack Windsor Lewis (ed.), *Studies in general and English phonetics: essays in honour of Professor J. D. O’Connor*. London: Routledge, 49–67.
- Harris, John and Geoff Lindsey (1995). ‘The elements of phonological representation’, in Jacques Durand and Francis Katamba (eds), *Frontiers of phonology: atoms, structures, derivations*. Harlow, Essex: Longman, 34-79.
- Harris, Zellig S. (1951). *Methods in structural linguistics*. Chicago: The University of Chicago Press.
- Hayes, Bruce (2000). ‘Gradient well-formedness in Optimality Theory’, in Joost Dekkers, Frank van der Leeuw, and Jeroen van de Weijer (eds), *Optimality Theory: phonology, syntax, and acquisition*. Oxford: Oxford University Press, 88-120.
- Herd, Wendy, Allard Jongman, and Joan Sereno (2010). ‘An acoustic and perceptual analysis of /t/ and /d/ flaps in American English’, *Journal of Phonetics* 38 (4): 504-16.
- Jensen, John T. (2000). ‘Against ambisyllabicity’, *Phonology* 17: 187-235.
- Kawahara, Shigeto (2011). ‘Experimental approaches in theoretical phonology’, in Marc van Oostendorp, Colin J. Ewen, Elizabeth Hume, and Keren Rice (eds), *The Blackwell companion to phonology* (vol. 4: *Phonological interfaces*). Malden, MA: Wiley-Blackwell.
- Kiparsky, Paul (1985). ‘Some consequences of Lexical Phonology’, *Phonology Yearbook* 2: 85-138.
- (1998). ‘Paradigm effects and opacity’. Ms. Stanford, CA: Stanford University.
- Kochetov, Alexei and Marianne Pouplier (2008). ‘Phonetic variability and grammatical knowledge: an articulatory study of Korean place assimilation’, *Phonology* 25 (3): 399-431.

- Kruszewski, Mikołaj (1995). 'On sound alternation (translated from the German by Robert Austerlitz)', *Writings in general linguistics* (edited by Konrad Koerner: Amsterdam Classics in Linguistics 11). Amsterdam: John Benjamins. First published (1881), *Ueber die Lautabwechslung*, Kazan: Universitätsbuchdruckerei.
- Kwong, Katherine and Kenneth N. Stevens (1999). 'On the voiced-voiceless distinction for *writer/rider*', *Speech Communication Group Working Papers (Research Laboratory of Electronics at MIT)* 11: 1-20.
- Labov, William (1989). 'Exact description of the speech community: short *a* in Philadelphia', in Ralph W. Fasold and Deborah Schiffrin (eds), *Language change and variation*. Amsterdam: John Benjamins, 1-57.
- (1994). *Principles of linguistic change: internal factors*. Oxford: Blackwell.
- Labov, William, Paul Cohen, Clarence Robins, and John Lewis (1968). *A study of the nonstandard English of Negro and Puerto Rican speakers of New York City* (Cooperative Research Report, no. 3288). Washington, DC: U.S. Office of Education.
- Lichtman, Karen (2010). 'Testing Articulatory Phonology: variation in gestures for coda /t/'. Paper given at the Illinois Language and Linguistic Society Conference 2 (ILLS2), University of Illinois at Urbana-Champaign, 29 May 2010.
- McMahon, April M. S. (1991). 'Lexical phonology and sound change: the case of the Scottish vowel length rule', *Journal of Linguistics* 27: 29-53.
- (2000). *Lexical phonology and the history of English*. Cambridge: Cambridge University Press.
- Myers, James (1995). 'The categorical and gradient phonology of variable *t*-deletion in English'. Paper given at the International Workshop on Language Variation and Linguistic Theory, University of Nijmegen, September 1995. Available at <http://www.ccunix.ccu.edu.tw/%7Elnproc/t-deletion-manuscript.pdf> (accessed on 16 December 2010).
- Nolan, Francis (1992). 'The descriptive role of segments: evidence from assimilation', in Gerard R. Docherty and D. Robert Ladd (eds), *Papers in laboratory phonology II: gesture, segment, prosody*. Cambridge: Cambridge University Press, 261-80.
- Nolan, Francis, Tara Holst, and Barbara Kühnert (1996). 'Modelling [s] to [ʃ] accommodation in English', *Journal of Phonetics* 24 (1): 113-37.
- Odden, David (1993). 'Interaction between modules in Lexical Phonology', in Sharon Hargus and Ellen M. Kaisse (eds), *Studies in Lexical Phonology* (Phonetics and Phonology 4). San Diego: Academic Press, 111-44.
- Pierrehumbert, Janet (2002). 'Word-specific phonetics', in Carlos Gussenhoven and Natasha Warner (eds), *Laboratory Phonology 7*. Berlin: Mouton de Gruyter, 101-39.
- Pluymaekers, Mark, Mirjam Ernestus, R. Harald Baayen, and Geert Booij (2010). 'Morphological effects on fine phonetic detail: the case of Dutch *-igheid*', in Cécile Fougeron, Barbara Kühnert, Mariapaola D'Imperio, and Nathalie Vallée (eds), *Laboratory phonology 10* (Phonology and Phonetics 4-4). Berlin: De Gruyter.
- Rapp, Brenda and Matthew Goldrick (2000). 'Discreteness and interactivity in spoken word production', *Psychological Review* 107 (3): 460-99.
- Riehl, Anastasia K. (2003). 'American English flapping: perceptual and acoustic evidence against paradigm uniformity with phonetic features', *Working Papers of the Cornell Phonetics Laboratory* 15 (271-337).
- Robinson, Orrin Warner (1976). 'A "scattered" rule in Swiss German', *Language* 52 (1): 148-62.
- Scheer, Tobias (2010). *A guide to morphosyntax-phonology interface theories: how extra-phonological information is treated in phonology since Trubetzkoy's Grenzsignale*. Berlin: Mouton de Gruyter.
- Schilling, Mark F., Ann E. Watkins, and William Watkins (2002). 'Is human height bimodal?' *The American Statistician* 56 (3): 223-29.

- Scobbie, James M. (1995). 'What do we do when phonology is powerful enough to imitate phonetics? Comments on Zsiga', in Bruce Connell and Amalia Arvaniti (eds), *Phonology and phonetic evidence: papers in laboratory phonology IV*. Cambridge: Cambridge University Press, 303-14.
- Sproat, Richard (1993). 'Looking into words', in Sharon Hargus and Ellen M. Kaisse (eds), *Studies in Lexical Phonology* (Phonetics and Phonology 4). San Diego: Academic Press, 173-95.
- Sproat, Richard and Osamu Fujimura (1993). 'Allophonic variation in English /l/ and its implications for phonetic implementation', *Journal of Phonetics* 21: 291-311.
- Steriade, Donca (2000). 'Paradigm uniformity and the phonetics-phonology boundary', in Michael B. Broe and Janet B. Pierrehumbert (eds), *Papers in laboratory phonology V: acquisition and the lexicon*. Cambridge: Cambridge University Press, 313-34.
- Sugahara, Mariko and Alice Turk (2009). 'Durational correlates of English sublexical constituent structure', *Phonology* 26 (3): 477-524.
- Tagliamonte, Sali and Rosalind A. M. Temple (2005). 'New perspectives on an ol' variable: (t,d) in British English', *Language Variation and Change* 17: 281-302.
- Temple, Rosalind A. M. (2009). '(t,d): the variable status of a variable rule', in 'Ōiwi Parker Jones and Elinor Payne (eds), *Papers in phonetics and computational linguistics* (Oxford University Working Papers in Linguistics, Philology, and Phonetics 12). Oxford: Faculty of Linguistics, Philology, and Phonetics, 145-70. Available at <http://www.ling-phil.ox.ac.uk/files/uploads/OWP2009.pdf>.
- Turton, Danielle (2012). 'The darkening of English /l/: a Stochastic Stratal OT analysis'. Ms.: University of Manchester. Available at <http://ling.auf.net/lingbuzz/001524>.
- Withgott, Mary Margaret (1982). *Segmental evidence for phonological constituents*. Doctoral dissertation, University of Texas, Austin.
- Wright, Susan and Paul Kerswill (1989). 'Electropalatography in the analysis of connected speech processes', *Clinical Linguistics and Phonetics* 3 (1): 49-57.
- Yoon, James Hye Suk (2005). 'Non-morphological determination of nominal particle ordering in Korean', in Lorie Heggie and Fernando Ordóñez (eds), *Clitic and affix combinations: theoretical perspectives* (Linguistik aktuell 74). Amsterdam: John Benjamins, 239-82.
- Zsiga, Elizabeth C. (1995). 'An acoustic and electropalatographic study of lexical and postlexical palatalization in American English', in Bruce Connell and Amalia Arvaniti (eds), *Phonology and phonetic evidence: papers in laboratory phonology IV*. Cambridge: Cambridge University Press, 282-302.
- Zue, Victor W. and Martha Laferriere (1979). 'Acoustic study of medial /t,d/ in American English', *Journal of the Acoustical Society of America* 66 (4): 1039-50.

CONTACT DETAILS

Ricardo Bermúdez-Otero
Linguistics and English Language
University of Manchester
Oxford Road
Manchester M13 9PL
United Kingdom

r.bermudez-otero@manchester.ac.uk
www.bermudez-otero.com