

24.964

Phonetic Realization

Phonetic Detail and the ‘Too Many Solutions’ Problem

Phonetic detail in phonology

- We have examined theories which give phonetic detail a role in phonology (distribution of contrasts, stress, etc).
- These theories make predictions about phonetic-phonological typology.
 - E.g. CVN will only be a better licenser of contour tones than CVVO if its sonorous rhyme duration is greater.
- Predictions concerning phonetic detail are difficult to test due to lack of data.
 - Coarser ‘phonological’ predictions are easier to test, e.g. long Vs are better licensers of contour tones than short Vs (other things being equal).

Phonetic detail in phonology

- Today: examine cases in which formulation of an analysis in terms of standard phonological representations vs. phonetically detailed representations results in different phonological predictions.
- Case study: Dispreference for Nasal-Voiceless obstruent clusters.
 - Analysis in terms of *NT: *[+nasal][-son, -voi] predicts too many solutions.
 - Over-prediction can be avoided by an analysis in terms of a more precise statement of the problem posed by NT sequences.

*NT

- Pater (1995), Hayes (1995, 1999) demonstrate a cross-linguistic dispreference for nasal-voiceless obstruent sequences.

– *[+nasal][-son, -voi]

- Main effect: post-nasal voicing. E.g. Wembawemba (Hercus 1986)

taka	‘to hit’	*taga
milpa	‘to twist’	*milba
jandin	‘me’	*jantin
panbar	‘shovel’	*panpar

– *[+nasal][-son, -voi] >> Ident(voi)

*NT

- In principle *NT can be satisfied in many ways:
 - [-voice] → [+voice] nt → nd
 - [+nasal] → [-nasal] nt → tt
 - [-son] → [+son] (must change [voice] also)
 - t → ∅ nt → n
 - n → ∅ nt → t
 - ∅ → V nt → nət
- Many of these are attested, but not all (‘too many solutions’) (Pater 1995)
 - epenthesis is unattested.

*NT solutions

- Deletion/merger of voiceless obstruent, e.g. Indonesian

	<u>simple form</u>	<u>prefixed form</u>	
a.	ambil	məŋambil	‘take’
b.	isi	məŋisi	‘fill up’
c.	pilih	məmilih	‘to choose, vote’
d.	tulis	mənulis	‘to write’
e.	kasih	məŋasih	‘to give’

- Denasalization - Mandar

/məŋ-ɗundu/	mandundu	‘to drink’
/məŋ-tunu/	mattunu	‘to burn’

- Nasal deletion, e.g. Venda?

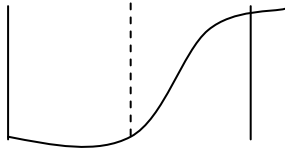
Restricting solutions with the P-map

- All solutions are predicted to be possible if faithfulness constraints can be freely ranked with respect to *NT and each other.
- Steriade (2001) proposes that there are universally fixed rankings among faithfulness constraints
 - correspondence constraints penalizing perceptually larger changes are ranked higher.
- Plausibly $nt - n\text{ət} \triangleright nt - nd$
 - $\text{DepV/N}_T \gg \text{Ident(voi)/N}_$
- Less clear that $nt - n\text{ət} \triangleright nt - t, nt - n$

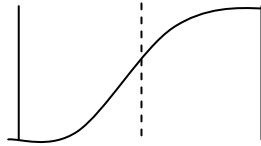
The phonetic basis for *NT

- NT sequences are problematic because velum lowering associated with the nasal is liable to persist into the voiceless stop, and lowered velum vents air pressure, making rapid cessation of voicing more difficult.
 - Hayes & Stivers (1995) also posit a role for velar movement after closure.
- So *NT could be decomposed into several more general constraints:
 - *Rapid Velum Movement
 - *[+voice][-voice, partial nasalization]
 - duration constraints.
- An NT cluster can be brought into line with these constraints by denasalization, elimination of [+voi][-voi] transition, or lengthening of the cluster.

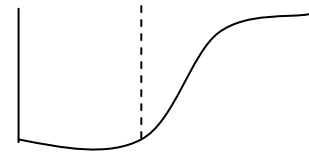
The phonetic basis for *NT effects



partial nasalization



early velum raising



cluster lengthening

- Phonetically detailed representations/constraints allow for solutions at the level of phonetic detail.
 - Constraints in terms of features/segments can only be satisfied by feature changes or segment insertion/ deletion.
- Some indications of cluster lengthening in English: total closure duration of [mp] > [mb] (Hayes & Stiver 1995).
- V epenthesis only satisfies the constraints above to the extent that it adds duration for the velum raising movement.
- Universally dispreferred to cluster lengthening. Why?

The phonetic basis for *NT effects

- Epenthesis universally dispreferred to cluster lengthening.
Why?
 - P-map? nt - nət ➤ nt - nt'
 - not clear that cluster lengthening is generally a violation of faithfulness. Details of duration are presumably governed by markedness constraints, especially in the absence of length contrasts.
 - DepV/N_T must outrank relevant duration constraint or [nət] must violate the constraint (brevity?).
- Similar considerations should apply to other constraints favoring slower articulatory movements.

Interactions between coronal place and vowel backness

- Another case in which typology provides evidence for phonetic detail in phonology rather than a ‘phonologized’ constraint.
 - Not an instance of the ‘too many solutions’ problem.
- Anterior coronals (dentals, alveolars) and palato-alveolars can condition fronting of adjacent vowels (Clements 1991, Hume 1992, Flemming 2003).
 - E.g. Cantonese - only front vowels between dentals.
 - Allophonic effect in English.

(a)	kyt̚ 'decide' hø 'boots'		kut̚ 'bracket' ho 'river'
(b)	t̚yt̚ 'to take off' t̚øn̚ 'a shield'	*t̚ut̚ *t̚on̚	t̚ɔk 'bald head' t̚ok 'to carry (on shoulders)'
(c)	jyt̚ 'moon' jøt̚ 'weak'	*jut̚ *jot̚	

Coronal place and vowel backness

- Vowel backness can also affect coronal place. E.g. Walmatjari (Hudson & Richards 1969):
 - Contrasts apical alveolar and retroflex consonants.
 - Contrast neutralized in word-initial position (cf. Steriade 2001).
 - Neutralized apicals are alveolar following [i] but retroflex following [a, u].
- Association between anterior/palato-alveolar coronals and front vowels, and between retroflexes and back vowels.

(a)	jɪŋgi landa pari nʊŋudʒaɹi	'poke!' 'boy, bleeding'
(b)	ja.ru ɭanda maŋa ɮarpaɹa	'wound it!' 'hold the girl!'

Image by MIT OpenCourseWare.

Coronal place and vowel backness

Placement of the tongue tip and blade to form a coronal constriction is easiest if the tongue body moves cooperatively.

- Anterior coronals (dentals and alveolars) require the tongue tip/blade to be near the teeth, most easily achieved if the tongue body is fronted (Öhman 1966:167, Stevens 1999:355).
- Non-anterior laminals (palato-alveolars) – it is difficult to form a laminal constriction behind the alveolar ridge without the front of the tongue body being close to the hard palate, i.e. fronted.
- Non-anterior apicals (retroflexes) it is easiest to curl the tongue tip back towards the palate if the tongue body is back, allowing the front of the tongue to be lowered.

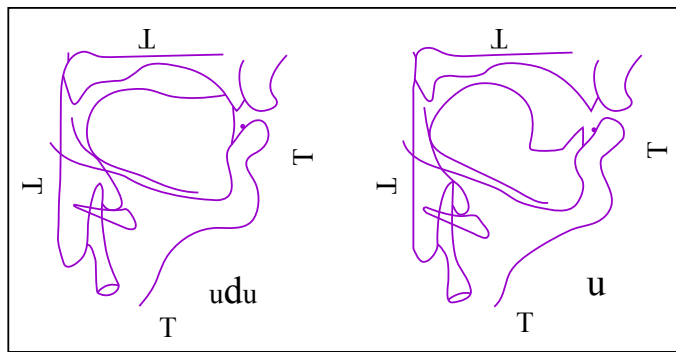


Image by MIT OpenCourseWare. Adapted from Öhman, S. Coarticulation in VCV utterances: Spectrographic measurements, 1966.

Coronal place and vowel backness

- Interactions between coronal place and vowel backness involve tongue body assimilation (Flemming 2003).
 - E.g. Agree(back)
- The relationship between tongue body position and coronal place are regulated by effort constraints outlined above.
 - Anterior→Front: [+anterior] → [-back]
 - Palato-alveolar→Front: [-anterior, laminal] → [-back]
 - Retroflex→Back: [-anterior, apical] → [+back]

<u>t</u> <u>u</u> <u>t</u>	ANT → FR	AGREE[bk] ₂	IDENT[ant]	IDENT[bk] _v
(a) <u>t</u> ^w <u>u</u> ^w <u>t</u>	*!*			
(b) <u>t</u> ⁱ <u>u</u> ⁱ <u>t</u>		*!		
(c) <u>t</u> ^w <u>u</u> ⁱ <u>t</u>	*!			
→ (d) <u>t</u> ⁱ <u>y</u> ⁱ <u>t</u>				*
(e) <u>t</u> ^w <u>u</u> ^w <u>t</u>			*!*	

Coronal place and vowel backness

- Vowel backness affects coronal place:

(a)	ut	AGREE[bk]	RETRO → BK CLO	ANT → FR	IDENT[ant]
(i)	u ⁱ t	*!			
(ii)	u ^w t			*!	
→ (iii)	u ^w t				*

(b)	it	AGREE[bk]	RETRO → BK CLO	ANT → FR	IDENT[ant]
→ (i)	i ⁱ t				*
(ii)	i ⁱ t		*!		
(iii)	i ^w t	*!			

Image by MIT OpenCourseWare. Adapted from Flemming, Edward. "The Relationship Between Coronal Place and Vowel Backness (pre-publication version)." *Phonology* 20 (2003): 335-373.

Coronal place and vowel backness

- Analyzing coronal-backness interactions in terms of a relatively direct implementation of their phonetic basis implies representing tongue body position during all coronals.
 - Also must distinguish front tongue body position typical of anterior coronals from palatalization.
- Alternative: constraints like *[cor, +ant][+back].
 - Avoids representing tongue body position
 - Less direct relationship between phonetic explanation and constraint - cf. *NT.
- Incorrectly predicts that velarized coronals could condition fronting - in fact they only condition vowel backing (e.g. Marshallese, Arabic).
 - typology distinguishes the analyses.

‘Too many solutions’ - final devoicing

- Steriade’s original example of ‘too many solutions’: final devoicing:
 - Assuming a constraint against final voiced obstruents.
 - Violating input /tab/ could be brought into line in many ways: deletion [ta], nasalization [tam], epenthesis [tabə], etc.
 - In fact only one solution is attested: devoicing [tap].
- Steriade (2001) provides an analysis in terms of the P-map - devoicing is the perceptually minimal repair.
- Outline an alternative approach:
 - Final devoicing is actually motivated by lack of sufficient cues to voicing in final position (Steriade 1997).
 - Propose that problems of perceptual indistinctness are only solved by neutralization of the indistinct contrast (here voicing).
 - Generalizes to a class of ‘too many solutions’ problems involving perceptual difficulty.

‘Too many solutions’ - final devoicing

- Problem lies with final obstruent voicing contrasts: tab vs. tap
 - Lack of VOT cues in pre-pausal environment.
 - distinctiveness constraint, e.g. Mindist = VOT:1
- Contrasts like [tab-tam], [tab-tab´] do not suffer from comparable distinctiveness problems.
- So in a sense the unattested ‘repairs’ like /tab/->[tam] do not address the real problem.
 - non-neutralizing epenthesis does look like a viable repair.
- Proposal: if an insufficiently distinct contrast is repaired, it is always achieved by neutralizing the indistinct contrast.
- Implementation in terms of the Dispersion Theory model in Flemming (2006).

‘Too many solutions’

- An inventory of basic contrasts is derived from the interaction of segment-internal effort constraints and distinctiveness constraints.
 - segments are specified in phonetic detail - targets.
- Input forms are constructed from sequences of segments drawn from the basic inventory.
- Phonetic realization component supplies the (hypothetical) phonetic realization for input sequences
 - interaction of timing, effort, and correspondence constraints
 - inventory supplies targets.
 - epenthesis applies here.
- Minimum distance constraints evaluate contrasts with realizations of neighboring inputs to ensure that they are adequately distinct.
 - insufficiently distinct contrasts are neutralized.

'Too many solutions'

- Inventory

targets:

	d	t	T
VOT	0	1	-
voice	1	0	-

- Realization

(i)

	/ad/	DEPV	MAX(reltrans)	IDENT[VOT]	IDENT(voice)
(a)	→ ad		*		
(b)	adə	*!			
(c)	at		*		*

(i)

	/at/	DEPV	MAX(reltrans)	IDENT[VOT]	IDENT(voice)
(a)	→ at		*		
(b)	atə	*!			
(c)	ad		*		*!

Image by MIT OpenCourseWare.

- Evaluation of surface contrasts

	/ad ₁ , at ₂ /	MINDIST = VOT:1	*MERGE
(a)	/ad ₁ , at ₂ / ad at	*!	
(b)	→ /aT _{1,2} / at		*

Image by MIT OpenCourseWare.

Too many solutions - place assimilation

- Constraints against heterorganic clusters, e.g. Agree(place), could be satisfied by assimilation or epenthesis.
- In fact epenthesis does not seem to be an alternative to epenthesis.
- How do we know? If epenthesis applies, then assimilation does not.
- Asymmetry between the typologies of place assimilation and epenthesis.

Too many solutions - place assimilation

- In VC_1C_2V , C_1 may assimilate in place to C_2 (neutralizing place contrasts in C_1 position).
- Implicational universal: if stops in C_1 are targets of assimilation, then so are nasals (Jun 1995, Mohanon 1993).
- Malayalam (Mohanon and Mohanon 1984)
 - Nasals undergo assimilation:
/peŋ-kutti/ peŋkutti ‘girl (female child)’ cf. peŋŋə ‘female’
/miin-tʃaŋta/ miintʃaŋta ‘fish market’ cf. miin ‘fish’
 - Stops do not undergo assimilation:
uʈkarʃam ‘progress’ sapʈam ‘eight’
- Korean (Jun 1995) – stops and nasals undergo assimilation:
/mit-ko/ [mikko] ‘believe and’
/ip-ko/ [ikko] ‘wear and’
/cinan-pam/ [cinampam] ‘last night’
/nam-kik/ [naŋkik] ‘the South Pole’

Too many solutions - place assimilation

- If epenthesis were an alternative repair to assimilation then we would expect to find a parallel typology of epenthesis
- E.g. epenthesis that breaks up nasal-stop cluster but not stop-stop clusters
 - /anba/ → [anəba] but: /atpa/ → [atpa]
- This pattern is unattested. Theories of environments of epenthesis imply that nasal-stop clusters are actually disfavored locations for epenthesis (Fleischhacker 2002, Rose 2000).
- Hypothesis: epenthesis is primarily motivated by faithfulness to transition specifications (Max Trans, Max Rel Trans) in Realization.
 - not specific to nasals.
- If epenthesis does not apply in realization, indistinct place contrasts can only be neutralized in Evaluation of Surface Contrasts (assimilation).
 - There is no Agree(place) constraint in Realization - assimilation results from gesture minimization in the realization of neutralized Cs.
 - So Agree(place) cannot motivate epenthesis.

Ponapean

- Ponapean has been argued to exemplify epenthesis as an alternative to assimilation (McCarthy ??, DeLacy 2002).
- But it seems that epenthesis applies where assimilation cannot, it doesn't apply to prevent assimilation.
 - Nasals undergo place assimilation (some liquids become nasals and assimilate).
 - Epenthesis applies to other clusters.
 - Reverse of the pattern predicted if epenthesis is an alternative to assimilation for marked heterorganic clusters.

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