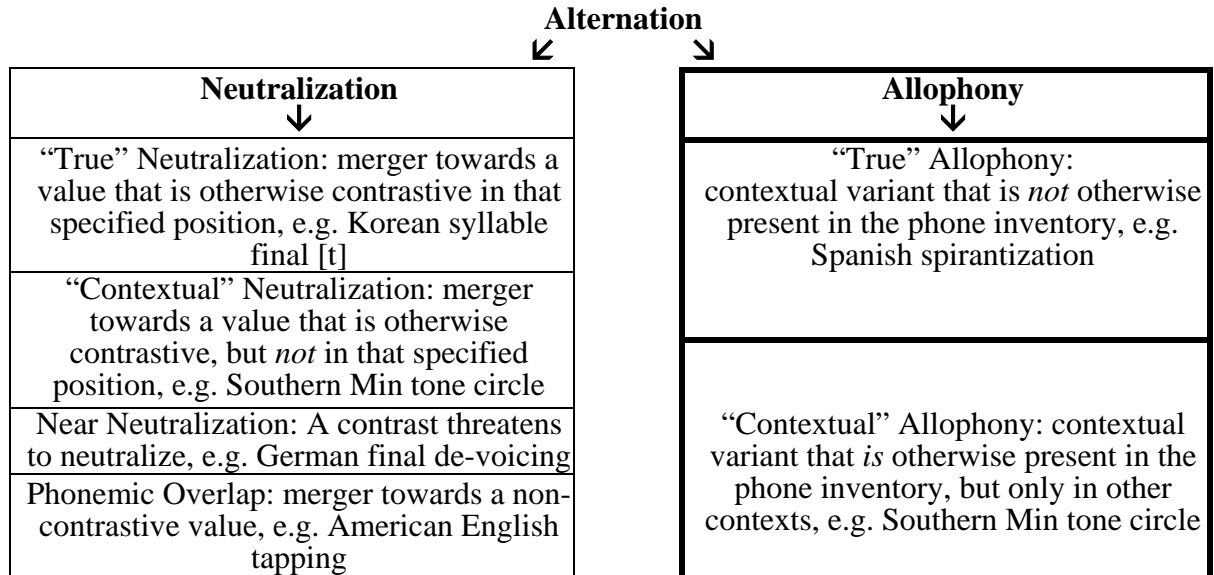


Alveolar stops in American English, and the nature of allophony

1.



2. Question: Are patterns of alternation merely random, or are there generalizations to be found from which predictions might be made regarding when an alternation should be allophonic versus neutralizing?
3. Hypothesis: Allophonic patterns may be a (diachronic) consequence of linguistic function: certain acoustic/auditory cues which convey contrasts are enhanced/modified in contexts where contrasts are otherwise vulnerable to neutralization.
4. A major function of phonology: Achieve effective communication
5. **Contrast maintenance**—an *abstract* functional constraint: “Contrastive values (whatever their origin and whatever their mental status) are maintained” (see also Martinet 1952, Kiparsky 1972, Liljencrantz and Lindblom 1972, Silverman 1997)
6. Hypothesis: Neutralizing patterns may be a (diachronic) consequence of energy constraints: neutralization may take place when insufficient energy is present in the relevant context of the speech signal (from the speaker) for contrasts to be effectively communicated (to the listener) (Jun 1995, Steriade 1995, Silverman 1997).
7. A major constraint on effective communication: Availability of energy
8. **Energy availability**—a *physical* functional constraint: “Energy for the speech signal is limited in its availability” (see also Martinet 1952, Lindblom 1983, Jun 1995, Steriade 1995, Kirchner, in prep.)
- 9.

Allophony may be a consequence of contrast maintenance (given sufficient energy availability) —an <i>abstract</i> functional constraint
Neutralization may be a consequence of insufficient energy availability —a <i>physical</i> functional constraint
Unmarked values are typically natural values; marked values are typically less natural. These distinctions in naturalness/markedness carry over to contextually-conditioned alternations.
There is a necessary interdependence between abstraction and physicality in order to properly account for patterns of alternation

10. English alveolar stop contrasts possess several context-dependent manifestations. “Fortis” refers to the so-called voiceless stop (“/t/”). “Lenis” refers to the so-called voiced stop (“/d/”).

11.

	lenis:			fortis:		
	form:	example:		form:	example:	
(a) word-initially:	t	'tak	dock	t ^h	't ^h ap	top
(b) syllable- and word-finally:	ɾ	'naɪɾ	nod	t ^ɪ	'naɪt ^ɪ	knot
	ɾ	'naɪɾ		ʔ	'naʔ	
(c) intervocalic stressed-syllable-initially:	d	ə'dapt	adopt	t ^h	ə't ^h ap	atop
(d) word-internal unstressed syllable-initially:	ɾ	ɑɪɾ	odder	r	'ɑɪɾ	otter
	r	ɑɪɾ	(neutralized)			
(e) preceding s:	form: t	example: stap ^ɪ ; stop (non-contrastive)				

12. Contrary to standard labeling conventions, it is actually the lenis (“voiced”; [voice]) stop which is unmarked; the fortis stop (“voiceless”; [-voice], or Øvoice) is marked. The patterning of English so-called [-voice] or Øvoice stop is not parallel to the cross-linguistic norm for stops: its presence implies the presence of the “unmarked” norm, i.e., the so-called [voice] stop.

13.

	lenis:			fortis:		
	form:	example:		form:	example:	
(a) word-initially:	t	'tak	dock	t ^h	't ^h ap	top

14. Natural laryngeal setting for word-initial stops is near-zero VOT, as sufficient transglottal pressure drop is not present to naturally implement vocal fold vibration until oral release (Westbury and Keating 1986, pace Rothenburg 1968).

15. Gestural model (Browman and Goldstein 1986, 1989):

Lenis stop:

tongue tip:

up	down
----	------

tongue body:

low

vocal folds:

spread	approximated
--------	--------------

“percept”:

ta

16. If there is a laryngeal contrast among stops, what is its likely manifestation? A laryngeal contrast here may be effected by pushing toward late VOT (aspiration) (e.g. English).

Fortis stop:

tongue tip:

up	down
----	------

tongue body:

low

vocal folds:

spread	approximated
--------	--------------

“percept”:

t^ha

17. Or, a laryngeal contrast here may be effected by pushing toward early VOT (e.g. Spanish, Dutch, Japanese).

Voiced stop:

tongue tip:

up	down
----	------

tongue body:

low

vocal folds:

spread	approximated
--------	--------------

“percept”:

da

18. Or there may be prenasalization (e.g., Chinantec):

Prenasalized stop:

tongue tip:

up	down
----	------

tongue body:

low

velum:

down	up
------	----

vocal folds:

approximated

“percept”:

n da

19. Or there may be implosion (e.g. Vietnamese):

Imploded stop:

tongue tip:

up	down
----	------

tongue body:

low

vocal folds/larynx:

“percept”:

tense/lowered	raised, approximated
---------------	----------------------

ɗɑ

20. These environment-specific manifestations maintain the contrast by accommodating to particular articulatorily natural constraints; by shifting the natural laryngeal posture (for the unmarked pattern) to a somewhat less natural laryngeal posture (for the marked pattern); either extend vocal fold spreading beyond release (aspiration), or extend voicing to precede release (prevoicing, prenasalization, implosion). The observed contrast can be motivated by comparing the natural, unmarked value ([t]) to the unnatural, marked value ([t^h], [d], [n^hd], or [d']).

	(a) word-initially:
Lenis/natural	t
	⇕
Fortis/less natural	t ^h

21. Nothing explanatory emerges by generating the respective values from some hypothesized lexical representations, by *changing* (not temporally shifting) particular hypothesized distinctive feature values that cannot be formally related to one another:

22. Distinctive feature theory: [voice] → ∅voice, ∅voice → [spread]

23.

	lenis:			fortis:		
	form:	example:		form:	example:	
(b) syllable- and word-finally:	ɾ ɾ̥	'nat̚ 'naɾ̥	nod	t̚ ʔt̚ ʔ	'nat̚ 'naʔt̚ 'naʔ	knot

24. Lenis stop:

tongue tip:

down	up
------	----

tongue body:

low

vocal folds:

“percept”:

approximated	spread
--------------	--------

ɑ

ɗ

-or-

tongue tip:	down	up
tongue body:	low	
vocal folds:	approximated	spread
“percept”:	ɒ	t

25. Word-final and syllable-final stops are naturally voiceless. The natural laryngeal posture for syllable-and word-final stops is rather sudden dissipation of vibration, as the sealed oral cavity quickly fills to capacity, resulting in a rapid equalization of subglottal and supraglottal pressure (Westbury and Keating 1986).

26. For the fortis stop, concomitant vowel shortening and/or glottal constriction may be implemented to enhance the contrast.

Fortis stop:

tongue tip:	down	up
tongue body:	low	
vocal folds:	approximated	constricted
“percept”:	ɒ	tʰ

-or-

tongue tip:	down	up
tongue body:	low	
vocal folds:	approximated	constricted
“percept”:	ɒ	ʔt

-or-

The glottal constriction can take the place of the oral occlusion. This configuration mimics the acoustic properties of a voiceless alveolar stop (silence with far less pronounced formant transitions than labials or velars).

tongue tip:	down	
tongue body:	low	
vocal folds:	approximated	constricted
“percept”:	ɒ	ʔ

27. Again, this environment-specific manifestation maintains the contrast by accommodating to particular articulatorily natural constraints. The natural (unmarked) pattern involves

voicelessness, and so the marked value normally involves a moderately less natural laryngeal posture.

	(b) syllable- and word-finally:
Lenis/natural	:t/:d
	⇕
Fortis/less natural	t/?t/?

28. Distinctive feature theory: [voice] → ∅voice, ∅voice → [constricted]

29.

	lenis:			fortis:		
	form:	example:		form:	example:	
(c) intervocalic stressed-syllable-initially:	d	ə'dapt	adapt	t^h	ə't ^h ap	atop

30. An “embarrassment of riches”: Stressed syllables, with their increased energy, duration, and articulatory force (de Jong 1991) allow for maximally distinct values to be readily implemented.

31. Lenis stop:

tongue tip:

down	u	p	down
------	---	---	------

tongue body:

central	low
---------	-----

vocal folds:

“percept”:

approximated

ə

'd a

32. Fortis stop:

tongue tip:

down	u	p	down
------	---	---	------

tongue body:

central	low
---------	-----

vocal folds:

“percept”:

approximated	spread	approximated
--------------	--------	--------------

ə

t^h a

33.

	(c) stressed-syllable-initially:
Lenis/natural	d
	⇕
Fortis/less natural	t ^h

34. Distinctive feature theory: ∅voice → [spread]

35. In sharp contrast, intervocalically before a *stressless* syllable is a poor context for laryngeal contrasts to be maintained (but cf. place features). Voicing is natural intervocalically (Westbury and Keating 1986), as the oral closure is typically short enough so that transglottal flow does not markedly dissipate. Moreover, stresslessness corresponds to a reduction of duration, energy and articulatory force, which establishes a natural environment for (obstruent) stops to turn into (sonorant) taps (cf. English vowel reduction; de Jong 1991).

36.

	lenis:			fortis:		
	form:	example:		form:	example:	
(d) word-internal unstressed syllable-initially:	ɾ r	ɹɑɹɹ ɹɑɹɹ	odder (neutralized)	r	'ɑɹɹ otter	

37. Not surprisingly, in such energy-deprived contexts, the contrast only barely survives (in vowel length); in many dialects, it is lost.

38. Lenis stop:

tongue tip:

down	u	p	down
------	---	---	------

tongue body:

low	central
-----	---------

vocal folds:

approximated

“percept”:

'ɑɹ r ə

39. Fortis stop:

tongue tip:

down	u	p	down
------	---	---	------

tongue body:

low	central
-----	---------

vocal folds:

approximated

“percept”:

'ɑ r ə

40.

	(d) word-internal unstressed syllable initially:
Lenis/natural	(ɹ)r
Fortis/less natural	r

41. Distinctive feature theory: [voice] → [+sonorant], Øvoice → [+sonorant]

42.

	lenis:		fortis:	
	form:	example:	form:	example:
(e) preceding s:	form: t	example: stap ⁷ ; stop (non-contrastive)		

43. Due to the laryngeal articulatory demands of the voiceless fricative (sustained laryngeal spreading), energy availability becomes the overriding factor here.

44. No contrast:

tongue tip:

close	up	down
-------	----	------

tongue body:

low

vocal folds:

spread	approximated
--------	--------------

“percept”:

s **ta**

45.

	(e) preceding s:
(no contrast)	t

46. English allophonic chain shift:

(a) word- initially:		(b) syllable- and word-finally:		(c) intervocalic stressed- syllable- initially:		(d) word-internal unstressed syllable initially:		(e) preceding s:
t (natural)	↔	ɾ:t/ɾ (natural)	↔	d (natural)	↗			
↕		↕		↕		(:)r	↔	t
t ^h (less natural)	↔	t/?t/? (less natural)	↔	t ^h (less natural)	↘			
Contrast maintenance		Contrast maintenance		Contrast maintenance		Creeping energy availability		Energy availability

*	(:)ð/(:)z (less natural)		t (natural)
	↕		↕
	r (natural)	*	t ^h (less natural)

47. In (d), alternation with spirants would provide no functional gain, as ð and z are contrastive in these contexts, e.g. ‘lather’ (cf. ‘ladder’), ‘reason’ (cf. ‘heathen’). Moreover, this contextual manifestation of the contrast would involve the unmarked, or natural lenis stop

being realized in a marked fashion (a spirant), while the marked, unnatural fortis stop would be implemented naturally, as a tap. This sort of contextual markedness reversal is thus correctly predicted unattested.

48. Some other systems:

Corsican (Dinnsen and Eckman 1977); true allophony:

# __:		V __ V:
<u>Voiceless stops:</u> peðe 'foot' tengu 'I have' sak:u 'bag'	↔	<u>Voiced stops:</u> u beðe 'the foot' u dengu 'I have it' u zak:u 'the bag'
↕	↔	↕
<u>Voiced stops:</u> bok:a 'mouth' dente 'tooth' gola 'throat'		<u>Voiced fricatives:</u> a βok:a 'the mouth' u ðente 'the tooth' diyola 'of throat'

49. β, ð, γ *exclusively* alternate with b, d, g; they do not contrast with b, d, g. Spirantization is thus non-neutralizing.

50. Spirantization maintains the contrast, again, by shifting to a less natural (more marked) value: fricatives are marked (and presumably involve more effort to properly implement) in comparison to stops.

51.

Voiceless stops (p,t,k):	Truly allophonic (word-initially only)
Voiced stops (b,d,g):	Contextually allophonic (word-initially, and intervocalically)
Voiced spirants (β, ð, γ):	Truly allophonic (intervocalically only)

52. Southern Min “free” syllable tone circle (Chen 1987); contextual allophony/contextual neutralization:

__ #		~ __ #
24	↔	22
↕		↕
22	↔	21
↕		↕
21	↔	53
↕		↕
53	↔	44
↕		↕
44	↔	22

53. Most sandhi forms are contextually allophonic; non-neutralizing. Only 22 is a (contextually) neutralized value (deriving from both 24 and 44) in the sandhi environment (non-final position).

54. Summary and conclusion:

Allophony may be a consequence of contrast maintenance (given sufficient energy availability) —an <i>abstract</i> functional constraint
Neutralization may be a consequence of insufficient energy availability —a <i>physical</i> functional constraint
Unmarked values are typically natural values; marked values are typically less natural. These distinctions in naturalness/markedness carry over to contextually-conditioned alternations.
There is a necessary interdependence between abstraction and physicality in order to properly account for patterns of alternation

Sources:

- Browman, C.P., and L. Goldstein (1986) "Towards an Articulatory Phonology," *Phonology Yearbook* 3:219-252.
- Browman, C.P., and L. Goldstein (1989) "Articulatory Gestures as Phonological Units," *Phonology* 6:201-251.
- Chen, M. (1987) The syntax of Xiamen tone sandhi, *Phonology Yearbook* 4:109-149.
- De Jong, K. (1991) The oral articulation of English stress accent. Ph.D. dissertation, Ohio state University.
- Dinnsen, D.A., and F.R. Eckman (1977) Some substantive universals in atomic phonology," *Lingua* 45:1-14.
- Flemming, E. (1995) *Auditory Representations in Phonology*. Ph.D. dissertation, University of California at Los Angeles.
- Houlihan, K., and G.K. Iverson (1979) "Functionally constrained phonology," in D.A. Dinnsen, ed., *Current approaches to phonological theory*. Indiana University Press, Bloomington, 50-73.
- Jun, J. (1995) A constraint-based analysis of place assimilation typology. Ph.D. dissertation, University of California at Los Angeles. Also, UCLA dissertations in linguistics Series.
- Kirchner, R. (in prep.) (Untitled dissertation).
- Liljencrants, Johan, and Lindblom, Björn (1972) Numerical Simulation of Vowel Quality Systems: The Role of Perceptual Contrast. *Language* 48.4:839-862.
- Lindblom, Björn, (1983) "Economy of speech gestures," in P. MacNeilage, ed., *The production of speech*. New York, Springer-Verlag, 217-245.
- Martinet, A. (1952) "function, structure, and sound change," *Word* 8.2:1-32.
- Rothenberg, M. (1968) *The Breath-Stream Dynamics of Simple Released-Plosive Production*. Basel : S. Karger.
- Silverman, D. (1997) Tone sandhi in Comaltepec Chinantec. *Language* 73.3:473-492.
- Steriade, D. (1995) "Neutralization and the expression of contrast," Manuscript, UCLA.
- Westbury, J.R. and P.A. Keating (1986) "On the naturalness of stop consonant voicing," *Journal of linguistics* 22:145-166.