

Evolutionary Phonology and Sound Change Typology

Lecture 3 The role of synchrony: structural conditions on sound change

I. A Principle of Paradigmatic Contrast

(1) Some preliminaries

A. *Paradigms.*

In many languages, words are organized into paradigms and these paradigms, along with their internal structure, are concrete components of grammar (Hockett 1954; Robins 1959; Matthews 1972; Blevins & Blevins 2008).

B. *Contrast.*

Paradigms typically consist of words that share certain phonological properties of a common stem, and contrast in others. Due to this, words within the same paradigm will often be in the same ‘phonological neighborhood’ as each other, and may contrast minimally (with respect to a single phonological feature), or not at all (syncretism).

C. *Competition.*

Paradigms often consist of words that share certain categorial properties (all verbs, all past verbs, all past perfect verbs, etc.). Due to this, words within the same paradigm will often be in direct competition with each other in syntagmatic frames. For example, every word in Table 1 can occur in the Yurok sentence [_____ *ku pu:k*].

	SUBSYLLABIC STEM <i>ʔ</i> - ‘take’	SYLLABIC STEM <i>tʃpurk</i> - ‘to take care of’
1SG	ʔo:kʔ	tʃpurkokʔ
2SG	ʔo:ʔm	tʃpurko:ʔm
3SG	ʔoʔm	tʃpurkoʔm
1PL	ʔo:	tʃpurkoh
2PL	ʔo:ʔw	tʃpurkoʔw
3PL	ʔo:ʔ	tʃpurkoʔ

TABLE 1. INDICATIVE UNIPERSONAL PARADIGM: YUROK *oo*-CLASS-(I) VERBS (Blevins 2005c)

(2) Lexical Character Displacement (Blevins & Wedel 2009)

Lexical character displacement occurs when differences among similar words whose syntagmatic distributions overlap are accentuated, while the same differences may be minimized or lost where syntagmatic distributions do not overlap. Lexical character displacement is based on the principle that, to coexist in a stable environment, two competing words must occupy distinct phonetic niches.

Compare the theory of ecological character displacement (Brown and Wilson, 1956; Losos 2000). When two very similar species come into contact and resources are limited, there will be heavy competition. This can result in competitive exclusion (cf. linguistic merger, lexical replacement), or character displacement (cf. lexical character replacement). In the second case, natural selection favors the individuals in each population whose phenotype allows them to use resources not used by the other species. A common result is that populations diverge in phenotype and resource use, reducing competition for resources and permitting coexistence (e.g. Galápagos finches; Weiner 1994).

(3) Principle of Paradigmatic Contrast (cf. Malkiel 1968; Lyovin 1977)

Lexical character displacement (2) will be more common paradigm-internally than elsewhere, since paradigms contain phonologically similar words whose syntagmatic distributions often overlap, giving rise to extreme cases of lexical competition. Lexical character displacement may show itself *paradigm-internally* as:

- (i) Accentuation of minimal phonetic/phonological contrasts.
- (ii) Inhibition of otherwise regular sound changes exactly where sound change results in paradigm-internal homophony, due to this accentuation.
- (iii) Rare phonological contrasts which are the sole markers of paradigm-internal contrasts, due to this accentuation.

II. Sound change in Evolutionary Phonology (Review: Blevins 2004, 2005a, 2006)

(4) A general phonetic typology of sound change as imperfect phonological acquisition
S = speaker, L = listener

- i. CHANGE: The phonetic signal is *misperceived* by the listener due to: acoustic similarities between the utterance and the perceived utterance; biases of the human perceptual system.
- ii. CHANCE: The phonetic signal is accurately perceived by the listener but is intrinsically phonologically ambiguous. The listener associates a phonological form with the utterance which differs from the phonological form in the speaker's grammar.
- iii. CHOICE: Multiple phonetic variants of a single phonological form are accurately perceived by the listener. The listener (a) acquires a proto-type or best exemplar which differs from that of the speaker; and/or (b) associates a phonological form with the set of variants which differs from the phonological form in the speaker's grammar.

(5) Structural Analogy (Blevins 2004:153-55, 246-48, 297-99)

In the course of language acquisition, the existence of a (non-ambiguous) phonological contrast between A and B will result in more instances of sound change involving shifts of ambiguous elements to A or B than if no contrast between A and B existed.

(6) Early phonologization under CHOICE (Blevins 2004:244-46)

(7) Other significant factors influencing *phonetic variation* as source of CHOICE

- i. Anticipated perceptual difficulty for listeners: Speakers produce clearer speech when there is loud background noise (Lane & Tranel 1971); when the addressee cannot see the speaker's face (Anderson et al. 1997); when the addressee is a non-native speaker (Bradlow and Bent 2002) or when the addressee has a hearing impairment (Picheny et al. 1986).
- ii. Style. There are significant acoustic differences between clear and casual speech in French (Duez 1992); English (Moon & Lindblom 1994); and Croatian (Smiljanić & Bradlow 2005).
- iii. Discourse structure. Words are pronounced with greater clarity and duration when they introduce new information into a discourse than when they refer to old/given information (Bolinger 1963; Chafe 1974; Hawkins and Warren 1994)

- iv. Frequency. Words with low usage frequencies are pronounced with greater duration than words with high usage frequencies; words with high usage frequency undergo more reduction than low frequency words (Balota and Chumbley 1985, Whalen 1991, Bybee 2001, Gahl 2008).
- v. Predictability. Words which are highly predictable in sentential contexts are reduced (Lieberman 1963; Fowler & Housum 1987; Jurafsky et al. 2001), and the same may be true for subparts of words (Walsh & Parker 1983, Blevins 2005a; Scarborough 2006).
- vi. Phonological neighborhood density (see below).

III. Evidence for Lexical Character displacement

(8) Phonological neighborhood density effects

Phonological neighbors are words which are phonologically similar to target words. Often they are defined as words which differ only in a single phoneme so that phonological neighbors of English *bead* would include *beet*, *bean*, *bee*, *beads*, etc. By similar definitions, verb forms in each Yurok indicative unipersonal paradigm in Table 1. would all be phonological neighbors.

Words with many phonological neighbors have dense phonological neighborhoods, while those with few neighbors have sparse phonological neighborhoods. Evidence for general lexical character displacement consists of studies showing that dense phonological neighborhoods inhibit lexical recognition (i.e. there is competition), and correlate positively with hyperarticulation (phonetic differences are accentuated), while sparse phonological neighborhoods speed lexical recognition (i.e. there is less competition), and correlate positively with increases in phonetic reduction (phonetic differences are not accentuated). Here I focus on evidence for accentuation of phonetic differences, since it is this differentiation in its most extreme form which, I suggest, can inhibit regular (neutralizing) sound change.

(9) From speech production: phonological neighborhood density effects

- VOT differences for minimal English CVC pairs differing only in C1 voicing is greater in pairs from dense phonological neighborhoods than sparse ones (Goldinger and Summers, 1989). Phonological neighborhood effects on vowel duration and formant frequency have also been found for English words, with greater differences in denser phonological neighborhoods (Munson and Solomon, 2004).
- Low frequency words from dense high frequency neighborhoods ('hard words') show larger vowel spaces (greater vowel dispersion) than high frequency words from sparse, low frequency neighborhoods ('easy words') (Wright 1997, 2003; Stephenson 2004), even in predictable contexts (Scarborough 2006).

(10) From simulations: categories diverge where lexical competition is extreme

- In computer simulations of exemplar-based phonological category evolution, Wedel (2006) suggests that categories will naturally diverge precisely where lexical competition is most extreme. This *non-teleological* explanation for category divergence under lexical competition follows from modeling of the production/perception loop. (Cf. Campbell and Ringen 1981)

When a particular pronunciation strongly activates more than one lexical category it may fail to be identified and not contribute to category maintenance (Luce and Pisoni, 1998), or, it may contribute equally to competitors, and have little effect on category maintenance. The same is not true of highly contrastive variants: these are more likely to be positively identified, and hence, will contribute to single categories more often than less contrastive exemplars. As a consequence, the lexicon evolves to reflect *the more contrastive variants* precisely *where lexical competition* is extreme.

IV. Evidence for Principle of Paradigmatic Contrast

(11) Phonetics, morphology, and sound change: Synthesis, exemplification from Yurok

Phonetics: Pre-Yurok stressed monosyllables show variable lengthening: e.g. */ʰoʰ/ 'take 3pl' with phonetic variants including [ʰoʰ, ʰoʰː, ʰoːʰ, ʰoːʰː].

Morphology: High frequency lengthened variants contribute to category evolution, except where forms compete paradigm-internally, e.g. */ʰoʰm/ 'take 3sg' vs. */ʰoːm/ 'take 2sg'. Here, exemplars like [ʰoːm] may not contribute to either 3sg or 2sg, while 'extreme' pronunciations (e.g. [ʰoʰm] 'take 3sg', [ʰoːːm] 'take 2sg', will allow positive identification, and will contribute to category maintenance.

Sound change: *V > Vː in lexical monosyllables (= monosyllabic vowel lengthening), *except in 3sg subsyllabic oo-class verbs* (3ii).

(12) Classic cases of (3i-ii) in the historical linguistics/sound change literature

a. Classical Greek: *s > Ø / V_V (phonetically *s>h; h > Ø / V_V)

except in certain 'future' and 'aorist' verb forms, where /s/ marks future. In these words, s-loss would result in homophony with present (Bloomfield 1933:362-64; Anttila 1972:98-99; Campbell 1974; Campbell & Ringen 1981; Campbell 1998)

	<u>present</u>	<u>future</u>	
I	trépo:	trépsō:	'I turn/will turn'
		deíkso:	'I will point'
II	stéllo:	steléo: (<*steleso:)	'I send/will send'
	méno:	menéo: (<*menesō:)	'I remain/will remain'
II	lúo:	lú:so:	'I loosen/will loosen'
	poiéo:	poié:so:	'I do/will do'

b. Estonian: *n > Ø / _#

(13) New cases of (3i-ii) involving unstressed vowel syncope

- | | | | | |
|------------------|--------------------------------|-----------|---|----------------------------|
| i. Old Irish | *V > Ø / [C ₀ VC_CV | *dilese | > | dilse 'ownership' |
| ii. Pre-Chamorro | *ə > Ø / [C ₀ VC_CV | *qaləjaw | > | atdaw 'sun' |
| iii. Yupik | *ə > Ø / VC_CV | *aləqa(ɾ) | > | ałqaq 'older sister' (CAY) |

Unstressed vowel syncope is common, and phonetically natural. Within the typology in (4), it is a canonical instance of CHOICE, with significant factors in (7) all appearing to play a role in its progression from variable sound pattern to regular sound change.

a. Tonkawa (Texas, isolate): *V > Ø/ VC_CV

except in certain reduplicated verb forms where syncope (+ degemination) would result in collapse of non-repetitive vs. repetitive or non-plural vs. plural contrast.

Syncope

notxoʔ	< *notoxo-oʔ	'he hoes it'
yakpoʔ	< *yakapa-oʔ	'he hits him'
ketpoʔ	< *ke-topo-oʔ	'he cuts me'
yatasoʔs	< *yatasa-oʔ-s	'I stab him'
yaytasoʔs	< *ya-yatasa-oʔ-s	'I stab him rep.'

Degemination *C_iC_i > C_i

No syncope (+degemination) in historically reduplicated verbs

hewawoʔ	< *he-wa-wa-oʔ	'he is dead'
ham'am'oʔ	< *ha-m'a-m'a-oʔ	'he is burning'
ketotopoʔ	< *ke-to-topo-oʔ	'he cuts me repeatedly' (cf. topo- 'cut')

N.B. Earlier reflections on inhibition of syncope (Hoijer 1946; Blevins 2005b:215-19) were stated in synchronic terms. Here, explanation for the synchronic pattern is attributed to historical developments with the general components shown in (11).

b. Tunisian Arabic: *V > Ø/ [X.C_CV(C)]_{wd} (V unstressed; oblig. w/{i,u})

except in verbs of the form CVC_iC_iVC_i where syncope (+degemination) would result in homophony between CVC_iC_iVC_i and CVC_iC_i stems.

Syncope (+degemination) in nouns, adjectives, & participles

qufti	< *quffiti 'my basket'	cf. quffitna 'our basket'
fumha	< *fummiha 'her mouth'	cf. fummi 'my mouth'
mityaʃʃa	< *mityaʃʃiʃa 'angry, f.'	cf. mityaʃʃiʃ 'angry, m.'

No syncope (+degemination) in verbs

yaʃʃiʃu	< *yaʃʃiʃ-u 'they angered' (cf. yaʃʃ-u 'they cheated')
qarraru	< *qarrar-u 'they decided' (cf. qarr-u 'they admitted')
xaffifu	< *xaffif-u 'they alleviated'

N.B. Earlier reflections on inhibition of syncope (Wise 1983:170; Blevins 2005b:211-14) were stated in synchronic terms. Here, explanation for the synchronic pattern is attributed to historical developments with the general components shown in (11). See Blevins (2005b) for discussion of other Arabic dialects with similar patterns.

c. Dakelh (Carrier/Athabaskan): *ə > Ø/ [C_CV (loss of reduced prefix vowels; Krauss 1969)

except in 1sg and 2nd dual/plural of **ʔ*-valence forms, where syncope would result in homophony between these forms and their transitive **ʔ*-valence counterparts (Gessner and Hansson 2004).

(14) Another new case of (3i-ii): Long vowel shortening (cf. Myers and Hansen 2005, 2007)

Banoni (Southwest Bougainville, Oceanic/Austronesian): V: > V

except "when necessary for disambiguation" (Lincoln 1976:58-59)

/vom/	vom	'turtle'	/tama/	tama	'father'
/vo:m/	vom, (vo:m)	'new'	/tama-V/	tama:	'my father' (*tama)
/vadame/	vadame	'well'	/punu/	punu	'hair'
/da:me/	dame, (da:me)	'good'	/punu-V/	punu:	'my hair' (*punu)
			/kasi/	kasi	'brother'
			/kasi-V/	kasi:	'my brother'

(15) Paradigm-internal locus of rare phonological contrasts (3iii) (cf. Blevins 2004:204-09)

Due to accentuation of phonetic contrasts under paradigmatic competition, one finds rare phonological contrasts which are the *sole* markers of paradigm-internal contrasts. Under less extreme lexical competition, the contrast {would not evolve/be neutralized/is neutralized}.

a. PALANTLA CHINANTEC (Otomanguean) ternary vowel nasalization contrast (Merrifield 1963; Ladefoged 1971; Merrifield & Edmonson 1999)

Contrast: ha^{LM} 'so much' (oral); ha^{LM} 'he opens it wide' (lightly nasalized); hã^{LM} 'foam' (heavily nasalized)

Origin: Lightly nasalized vowels derive from morphologically complex verbs which consisted of a verb root plus the Proto-Chinantec animate marker *-ŋ (Rensch 1989:23-24). Nasal consonant was lost, but contrast between animate and inanimate in nasal vs. oral stems was maintained via nasalization of the second half of the vowel.

Rarity: unique cross-linguistically

Expected sound change: neutralization to simple oral/nasal contrast

b. DINKA (Nilotic) ternary vowel length/quantity contrast. (Andersen 1987, 1990, 2002; Remijsen & Gilley 2008)

Contrast: /i, e, ε, a, ɔ, o, u/, all short, long or overlong, and either non-breathy (or creaky) vs. breathy (except /u, u:, u:./ only breathy). In addition, every vowel has one of three tones: high, low, or falling. Cf. non-breathy: kwel/kwɛ:l 'star sg/pl' ale:l/ale::l 'ironstone sg/pl' (vowel quality grade is systematic. See Anderson 2002:3).

Origin: 3-way quantity/grade distinction arose from vowel loss + compensatory lengthening (Andersen 1990; Kavitskaya 2002; Andersen 2002). Lost vowels were *sole markers* of sg/pl contrast in nouns, and a range of inflectional contrasts in verbs. Paradigmatic contrasts maintained via expansion of vowel quality, length, and tone contrasts.

Rarity: only in Coatlán/San José El Paraíso Mixe (Mixe-Zoquean) (V: < *V:h); Yavapai (Yuman; Thomas 1990); and Estonian (see below).

Expected sound change: neutralization to simple short/long V-length contrast

c. ESTONIAN (Uralic) ternary quantity contrast (Tauli 1954; Eek 1986; Lehiste 1997; Ehala 2003)

Contrast: 3-way quantity contrast in disyllabic sequences of stressed syllable + syllable. If only stressed syllable is given as input, listeners identify Q1, but can't distinguish Q2 from Q3 (Eek & Meister, 1997).

VI. Newly Confirmed Rare Contrasts

A. Four-way register contrasts

REGISTER is a term used in Southeast Asian linguistics referring to a collection of contrastive suprasegmental properties like phonation type, pitch, vowel quality, intensity, and vowel duration. A register language is distinct from a tone language when contrastive phonation type (in contrast to contrastive pitch) is primary. Most register languages, like Middle-Khmer or Wa, contrast only two phonation types. 3-way contrasts are rare, but reported for Jalapa Mazatec (Kirk, Ladefoged & Ladefoged 1993) and Bai (Edmondson & Esling 2006).

Four-way phonation-type contrasts are extremely rare, reported for only a few: Chong (Austroasiatic/Mon-Khmer: Pearic) of Thailand/Cambodia (Di Canio 2009), !X'õ'o (Traill 1985), Bai, and Bor Dinka (Edmondson & Esling 2006). Takhian Thong Chong contains both dynamic (contour) and level registers. There is a modal register, a tense register, a breathy register, and a breathy-tense register.

B. Contrastive voiceless vowels

Blevins (to appear d) reviews the literature on this topic, and concludes that there is at least one clear case of contrastive voiceless vowels in Teso-Turkana languages of the Eastern Nilotic branch of Nilotic.

Kuznetsova (2015) describes the southern varieties of the Lower Luga dialect of Ingrian (a minor Finnic language spoken near St. Petersburg) as having a contrast between final modal and voiceless vowels, pronounced in a whisper, without vibration of the vocal folds. [ku·kko] 'rooster' vs. [ku·kko] 'rooster.ILL.SG'. Voiceless allophones are reduced and are often lost in running speech. Historically, the voiced/voiceless contrast reflects an earlier short/long contrast in final position (cf. Myers and Hanson 2007).

Selected References

- Abramson, Arthur S. 1986. The perception of word-initial consonant length: Pattani Malay. *Journal of the International Phonetic Association* 16: 8-16.
- Abramson, Arthur S. 1991. Amplitude as a cue to word-initial consonant length: Pattani Malay. In *Proceedings of the 12th International Congress of Phonetic Sciences*, 98-101.
- Abramson, Arthur S. 1999. Fundamental frequency as a cue to word-initial consonant length: Pattani Malay. *Proceedings of the XIVth International Congress of Phonetic Sciences*. 591-594.
- Andersen, Torben. 1987. The phonemic system of Agar Dinka. *Journal of African Languages and Linguistics* 9:1-27.
- Andersen, Torben. 1990. Vowel length in Western Nilotic languages. *Acta Linguistica Hafniensia* 22:5-26.
- Andersen, Torben. 2002. Case inflection and nominal head marking in Dinka. *Journal of African Languages and Linguistics* 23:1-30.
- Anderson, A. H., E. G. Bard, C. Sotillo, A. Newlands & G. Doherty-Sneddon. 1997. Limited visual control of the intelligibility of speech in face-to-face dialogue. *Perception and Psychophysics* 39:580-92.
- Antilla, Raimo. 1972. *An introduction to historical and comparative linguistics*. New York: Macmillan.
- Balota, D. A. and J. I. Chumbley. 1985. The locus of word-frequency effects in the pronunciation task: Lexical access and/or production? *Journal of Memory and Language* 24:89-106.
- Blevins, Juliette. 2005a. The role of phonological predictability in sound change: Privileged reduction in Oceanic reduplicated substrings. *Oceanic Linguistics* 44:455-464.
- Blevins, Juliette. 2005b. Understanding antigemination. In *Linguistic diversity and language theories*. Zygmunt Frajzyngier, David Rood, and Adam Hodges (eds.). Amsterdam/Philadelphia: Benjamins. 203-34.
- Blevins, Juliette. 2005c. Yurok verb classes. *International Journal of American Linguistics* 71:327-49.
- Blevins, Juliette. 2006. New perspectives on English sound patterns: 'Natural' and 'Unnatural' in Evolutionary Phonology. *Journal of English Linguistics* 34:6-25.
- Blevins, Juliette. To appear c. Periphrastic agreement in Yurok. In F. Ackerman, J. P. Blevins, and G. Stump (eds.), *Paradigms and Periphrasis*. Stanford, CA: CSLI.
- Blevins, J. To appear d. Evolutionary Phonology and the life cycle of voiceless sonorants. In Sonia Cristofaro and Zúñiga (eds.) *Typological hierarchies in synchrony and diachrony*. Benjamins.
- Blevins, J. and A. Wedel. 2009. Inhibited sound change: An evolutionary approach to lexical competition. *Diachronica* 26.2: 143-83
- Blevins, Juliette. and Andrew Garrett. 1998. The origins of consonant-vowel metathesis. *Language* 74: 508-56.

- Blevins, Juliette. and Andrew Garrett. 2004. The evolution of metathesis. In Bruce Hayes, Robert Kirchner, and Donca Steriade (eds.). *Phonetically driven phonology*. Cambridge: CUP. 117-156.
- Bloomfield, Leonard. 1933. *Language*. New York: Holt.
- Blust, R. 1990. Three recurrent changes in Oceanic languages. In J.H.C.S. Davidson (ed.), *Pacific island languages: Essays in honour of G. B. Milner*. London: SOAS. 7-28.
- Blust, R. 2007. Antiantigeminaton: Canonical constraints in Austronesian languages. *Phonology*.
- Bolinger, D. 1963. Length, vowel, juncture. *Linguistics* 1:5-29.
- Bradlow, A. R. and T. Bent. 2002. The clear speech effect for non-native listeners. *JASA* 112:272-84.
- Brown, W. L. Jr., and E. O. Wilson. 1956. Character displacement. *Systematic Zoology* 5:49-64.
- Bybee, Joan L. 2001. *Phonology and language use*. Cambridge: Cambridge University Press.
- Campbell, Lyle. 1974. On conditions on sound change. *Historical Linguistics: Proceedings of the First International Conference on Historical Linguistics*. J. Anderson and C. Jones (eds.), Amsteram: John Benjamins. 88-95.
- Campbell, Lyle and Jon Ringen. 1981. Teleology and the explanation of sound change. . *Phonologica*, ed. by W. Dressler, O. E. Pfeiffer, and J. R. Rennison, 57-68. Innsbruck: Innsbrucker Beiträge zur Sprachwissenschaft.
- Campbell, Lyle. 1998. *Historical Linguistics: An Introduction*. Edinburgh: University of Edinburgh Press.
- Chafe, W. 1974. Language and consciousness. *Language* 50:111-133.
- DiCano, C.T. 2009. The phonetics of register in Takhian Thong Chong. *Journal of the International Phonetic Association*, 39, 2, 162-188.
- Duez, D. 1992. Second formant locus-nucleus patterns: An investigation of spontaneous French speech. *Speech Communication* 11:417-27.
- Eek, A. 1986. Problems of Estonian word prosody. *Estonian Papers in Phonetics* 1984-85:13-66.
- Eek, A. and E. Meister. 1997. Simple perception experiments on Estonian word prosody. I. Lehiste & J. Ross eds., *Estonian Prosody: Papers from a Symposium*. Tallinn: Eesti Keele Instituut 71-99.
- Ehala, Martin. 2003. Estonian quantity: Implications for moraic theory. In D. Nelson and S. Manninen (eds.) *Generative approaches to Finnic and Saami linguistics*. Palo Alto: CSLI Publications.
- Fowler, C. A. and J. Housum. 1987. Talkers' signaling of "new" and "old" words in speech and listeners' perception and use of the distinction. *Memory and Language* 26:489-504.
- Gahl, Susanne. 2008. "Thyme" and "Time" are not homophones. Word durations in spontaneous speech. *Language* 84(3), 474-496.
- Garrett, Andrew and Juliette Blevins. 2009. Analogical morphophonology. In Sharon Inkelas and Kristin Hanson (eds.). *The nature of the word: Essays in Honor of Paul Kiparsky*. MIT Press.
- Gessner, S. and G. Hansson. 2004. Anti-homophony effects in Dakelh (Carrier) Valence Morphology. *Proceedings of Berkeley Linguistic Society* 30. Berkeley: Department of Linguistics, UC Berkeley. 93-104.
- Goddard, Ives. 1982. The historical phonology of Munsee. *IJAL* 48: 16-48.
- Goldinger, S. D. and W. V. Summers. 1989. Lexical neighborhoods in speech production: A first report. *Research on Speech Perception Progress Report* 15:331-42. Bloomington, IN: Speech Research Laboratory, Indiana University.
- Hajek, John and John Bowden 1999. Taba and Roma: Clusters and Gemimates in Two Austronesian Languages, *Proceedings of the XIVth International Congress of Phonetic Sciences*. San Francisco, 1033-1036.
- Hawkins, S. and P. Warren. 1994. Phonetic influences on the intelligibility of conversational speech. *Journal of Phonetics* 22:493-511.
- Hockett, Charles F. 1954. Two models of grammatical description. *Word* 10.210-231.
- Hoiyer, Harry. 1946. Tonkawa - An Indian language of Texas. In C. Osgood (ed.), *Linguistic Structures of Native America*. New York: Viking Fund Publications in Anthropology 6.
- Jurafsky, D., A. Bell, M. Gregory, & W. D. Raymond. 2001. Probabilistic relations between words: Evidence from reduction in lexical production. In J. Bybee & P. Hopper (eds.) *Frequency and the emergence of linguistic structure*. Amsterdam: John Benjamins.
- Kiparsky, Paul. 1972. Explanation in phonology. In S. Peters (ed.), *Goals of Linguistic Theory*. Englewood Cliffs, NJ: Prentice-Hall. 189-227.
- Kuznetsova, N. 2015. Two phonological rarities in Ingrian dialects. *New trends in Nordic and general linguistics. Linguae and Litterae* 42: 91-117.
- Labov, William. 1994. *Principles of linguistic change, vol. 1: Internal factors*. Oxford: Blackwell.
- Ladefoged, Peter. 1971. *Preliminaries to linguistic phonetics*. Chicago: University of Chicago Press.
- Lane, H. L. and B. Tranel. 1971. The Lombard sign and the role of hearing in speech. *Journal of Speech and Hearing Research* 14:677-709.
- Lehiste, I. 1997. Search for phonetic correlates in Estonian prosody. In I. Lehiste and J. Ross (eds.), *Estonian Prosody: Papers from a Symposium*. Tallinn: Eesti Keele Instituut. 11-35.
- Lieberman, P. 1963. Some effects of semantic and grammatical context on the production and perception of speech. *Language and Speech* 6: 172-87.
- Lincoln, Peter Craig. 1976. *Describing Banoni, an Austronesian language of Southwest Bougainville*. PhD dissertation, University of Hawai'i.
- Lindblom, Björn. 1990. Explaining phonetic variation: a sketch of the H&H theory. In W. J. Hardcastle and A. Marchal (eds.). *Speech Production and Speech Modelling*. Kluwer Academic Publishers.

- Losos, Jonathan B. 2000. Ecological character displacement and the study of adaptation. *Proceedings of the National Academy of Sciences* 97/11:5693-95.
- Luce, Paul A. and David B. Pisoni. 1998. Recognizing spoken words: The neighborhood activation model. *Ear and Hearing* 19:1-36.
- Lyovin, A. 1977. Sound change, homophony, and lexical diffusion. In William S.-Y. Wang (ed.), *The lexicon in phonological change*. The Hague: Mouton. 120-32.
- Malkiel, Yakov. 1968. The inflectional paradigm as an occasional determinant of sound change. In W. P. Lehmann and Y. Malkiel (eds.), *Directions for historical linguistics*. Austin: University of Texas Press. 21-64.
- Matthews, Peter H. 1972. *Inflectional morphology: a theoretical study based on aspects of Latin verb conjugation*. Cambridge: Cambridge University Press.
- Merrifield, William R. 1963. Palantla Chinantec syllable types. *Anthropological Linguistics* 5, no.5:1-16.
- Merrifield, William R. and Jerold A. Edmonson. 1999. "Palantla Chinantec: Phonetic Experiments on Nasalization, Stress, and Tone" *IJAL* 65:303-323.
- Milner, G. B. 1958. Aspiration in two Polynesian languages. *BSOAS* 21: 368-75.
- Moon, Seung-Jae and Björn Lindblom. 1994. Interaction between duration, context, and speaking style in English stressed vowels. *The Journal of the Acoustical Society of America* 96:40-55.
- Munson, Benjamin and Nancy Pearl Solomon. 2004. The effect of phonological neighborhood density on vowel articulation. *Journal of Speech, Language and Hearing Research* 47:1048-1058.
- Myers, Scott and Benjamin Hansen. 2005. The origin of vowel length neutralisation in vocoid sequences: evidence from Finnish speakers. *Phonology* 22:317-44.
- Myers, Scott and Benjamin Hansen. 2007.. The origin of vowel length neutralization in final position: evidence from Finnish speakers. *Natural Language and Linguistic Theory* 25: 157-93.
- Picheny, M. A., N. I. Durlach, and L. D. Braida. 1986. Speaking clearly for the hard of hearing II. Acoustic characteristics of clear and conversational speech. *Journal of Speech and Hearing Research* 29:434-46.
- Raun, Alo and Andrus Saareste. 1965. *Introduction to Estonian Linguistics*. Wiesbaden: Harrassowitz.
- Remijsen, B. & L. Gilley. 2008. Why are three-level vowel length systems rare? Insights from Dinka (Luanyjang dialect). *Journal of Phonetics* 36: 318-344.
- Robins, Robert H. 1959. In defense of WP. *Transactions of the Philological Society* 116-144. Reprinted in *Transactions of the Philological Society* 99.1-36, 2001.
- Smiljanić, Rajka and Ann R. Bradlow. 2005. Production and perception of clear speech in Croatian and English. *Journal of the Acoustic Society of America* 118(3):1677-1688.
- Scarborough, R. 2010. Lexical & contextual predictability: Confluent effects on the production of vowels. *LabPhon* 10.
- Stephenson, Lisa. 2004. Lexical frequency and neighbourhood density effects on vowel production in words and nonwords. *Proceedings of the 10th Australian International Conf. on Speech Science and Technology*: 364-369.
- Tauli, V. 1954. The origin of the quantitative system in Estonian. *Journal de la Société Finno-Ougrienne* 57:1-19.
- Thomas, Kimberley D. 1990. Vowel length and pitch in Yavapai. *JASA* 88: S53.
- Walsh, T. and F. Parker. 1983. The duration of morphemic and non-morphemic /s/ in English. *J of Phonetics* 11:201-6.
- Wang, W. S-Y. 1977 (ed.) *The lexicon in phonological change*. The Hague: Mouton.
- Wedel, Andy. 2006. Exemplar models, evolution and language change. *The Linguistic Review* 23: 247-74.
- Weiner, Jonathan. 1994. *The beak of the finch: A story of evolution in our time*. New York: Knopf.
- Whalen, Doug. 1991. Infrequent words are longer in duration than frequent words and their implications for the interpretation of word frequency effects. *Memory & Cognition* 7(6): 411-19.
- Wise, H. 1983. Some functionally motivated rules in Tunisian phonology. *Journal of Linguistics* 19: 165-181.
- Wright, Richard. 1997. Lexical competition and reduction in speech: A preliminary report. In *Research on spoken language processing: Progress report no. 21* (1996-1997), Indiana University.
- Wright, Richard. 2003. Factors of lexical competition in vowel articulation. In J. Local, R. Ogden, & R. Temple (eds.), *Phonetic Interpretation: Papers in Laboratory Phonology VI*. Cambridge: CUP. 75-87.

VI. Appendix: Refining notions of sound change, competition and contrast

- (17) Perceptual studies. A 'neutralizing' sound change is truly neutralizing when, in ambiguous contexts, speakers can not distinguish competing paradigm members at better than chance levels. (See above for Q2 vs. Q3 in Estonian stressed monosyllables.)
- (18) CHOICE vs. CHANGE, CHANCE. The Principle of Paradigmatic Contrast will hold of sound changes whose primary source is CHOICE (vs. CHANGE, CHANCE), where variation over phonetic exemplars + categorization effects of extreme variants can result in exceptions to regular sound change. Consider exceptions to NC assimilation in the transitive pronominal prefix /-n-/ of Mara (Heath 1981:206-227): compare *na-ŋ-gu-* 2sg/1sg with *na-n-gu-* 3sg/1sg or *na-m-bi-ri-* 2du/1sg with *na-n-bi-ri-* 3du/1sg.
- (19) Sound change vs. analogical change, contact-induced change. The Principle of Paradigmatic Contrast will hold of phonetically based sound changes, but not of analogical change, or contact-induced change.