

## Inhibited sound change

### An evolutionary approach to lexical competition\*

Juliette Blevins and Andrew Wedel

Max Planck Institute for Evolutionary Anthropology / University of Arizona

The study of regular sound change reveals numerous types of exceptionality. The type studied here has the profile of regular sound change, but appears to be inhibited where homophony would result. The most widely cited cases of this phenomenon are reviewed and new cases presented. If sound change can be inhibited by impending homophony, how is this to be represented and understood? Here we offer a model of variation-based sound change where category evolution incorporates lexical competition. Lexical Character Displacement predicts accentuation of differences among similar words when syntagmatic disambiguation is limited. In the cases under discussion, this accentuation inhibits merger. However, as we show, the same principle can inhibit sound change altogether, or give rise to extreme phonological contrasts under similar conditions.

**Keywords:** sound change, exceptionality, anti-homophony, lexical competition, category evolution, character displacement, Evolutionary Phonology, simulation

---

\* Early versions of this paper were presented by the first author at the 12th International Morphology meeting in Budapest, May, 2006, and in 2006 and 2007 at the University of Leipzig, the University of Texas, Austin, the University of California, Berkeley, the University of Stockholm, and Tallinn University. The first author is grateful to these audiences for their feedback. Additional thanks to Howard Berman for discussion of Yurok vowel length, to Andrew Garrett for comments on the nature of exceptionality, and to Bob Harms for details of Estonian *n*-loss. Material contributed by the second author has benefited from feedback from Janet Pierrehumbert, as well as audiences at the University of Arizona, the University of Edinburgh, the University of New Mexico, the University of California, San Diego, The Santa Fe Institute, and The Ohio State University. We also thank three anonymous reviewers, the associate editors, and Joe Salmons for a range of constructive criticism.

### 1. Exceptions to regular sound change

Phonetically-based sound change in historical linguistics is strongly associated with the Neogrammarian tradition of the late 19th century.<sup>1</sup> Within this tradition, sound change was modeled as regular, systematic, and exceptionless. For the Neogrammarians, this aspect of sound change was definitional and operational: “Those changes that were sweeping and observed after several centuries to be essentially exceptionless qualified for the term *Lautgesetz* (sound law), while changes that seemed to affect only particular words or groups of words did not so qualify” (Rankin 2003: 185). This division between regular exceptionless sound change and other changes is one that continues to challenge theoretical models. Sound changes that show exceptions have been sorted and classified in textbooks, historical grammars, and studies of language contact. In general, a pattern of what *appears* to be phonetically-based sound change may show exceptions due to any of the factors in (1).

- (1) Exceptions to sound change regularity
  - i. Apparent exceptions
    - a. What is involved is not a sound change, but an analogical change.
    - b. What is involved is a regular sound change, but subsequent developments (analogical, phonological) create apparent exceptions.
    - c. What is involved is a regular sound change, but sound change is gradual and can be observed ‘in progress’.
    - d. What is involved is a regular sound change, but subsequent language/dialect contact/mixture creates apparent exceptions.
    - e. What is involved is a regular sound change, but apparent exceptions occur in the course of language acquisition due to performance factors, or any of the above.
  - ii. Real exceptions
    - f. What is involved is a sound change, but it is sporadic.
    - g. What is involved is a regular sound change, but it shows exceptions due to direct sound-meaning associations (sound symbolism, onomatopoeia, expressive symbolism).
    - h. What is involved is a regular sound change, but it shows regular exceptions where pernicious homophony would occur.

1. Here, and throughout, we use ‘sound change’ as a shorthand for ‘phonetically-based sound change’, where, under some conceptions, phonetic conditioning and regularity are associated with only the earliest stages of a change. When referring to sound patterns with non-phonetic sources, we refer specifically to the source (e.g., analogy, contact, etc.). The large majority of regular sound changes in the world’s languages have clear phonetic bases (Blevins 2004, 2006, 2008a). Those lacking a clear phonetic basis (Blust 2005) may, under closer inspection, turn out to be phonetically natural after all (Goddard 2007, Blevins 2008b).

Most of the exception types in (1) were recognized already by the Neogrammarians and their contemporaries. Paul (1880) distinguished analogy from regular sound laws, with subsequent work highlighting distinctions between sound patterns whose primary source is analogical (1a), and better known cases where a regular sound change shows exceptions due to secondary effects of analogical change (1b). In this second class we could also include less common cases of written character-based analogy, or regular sound change followed by sporadic phonological change as described by Newman (1996: 99–101) for the history of Cantonese. Exceptionality due to contact or dialect mixture was widely accepted by Neogrammarians (1c), though Schuchardt (1885: 58) opposed this view (1d), suggesting different rates of sound change for different words. One modern variant of this notion is that sound change may have systematic phonetic conditioning factors, but probabilistic application depending on how phonetic factors interact (Durie 1996, Cox & Palethorpe 2008). During the acquisition phase, children produce many words which deviate from adult sound patterns, however, the great majority of these conform to regular patterns as adult performance and competence is acquired (1e). An additional category of irregularity was sporadic or minor sound changes affecting a small number of forms (1f). Osthoff & Brugmann (1878) attempted to associate sporadic application with sound change type, placing metathesis and dissimilation in this class. The strategy is continued in some modern approaches: “What is important is that sporadicity is limited to certain specifiable subtypes of sound change, which therefore can be systematically exempted from the regularity hypothesis” (Hock 1991: 31). In this class might be the “pandemic” facultative nasals and velar stop voicing shifts of Austronesian languages (Blust 1996). Other real exceptions to regularity include corners of language where the relationship between sound and meaning is not arbitrary (1g): sound symbolism, onomatopoeia, and expressive symbolism (Anttila 1972: 85–86, Campbell 1996: 72–77). In these cases, what appears to block regular sound change are distinct representations of meaningful vs. non-meaningful sounds. Non-meaningful sounds are categorized as instances of more abstract phonemes, and undergo regular sound change, while meaningful sounds are not members of these abstract meaningless categories, and therefore resist change.

In this study we focus on a type of exceptionality that is less well-studied than those mentioned above. Regular sound change is apparent, but is characteristically inhibited in certain well defined contexts (1h). We will refer to this type as *inhibited sound change*. Unlike the cases discussed above, these exceptions cannot be explained solely in terms of analogy, analogical restoration, direct-sound meaning correspondences, borrowing, or other secondary mechanisms. A phonetically motivated sound change occurs, and applies everywhere, except where it would create

what Campbell (1996:77) refers to as “pernicious homophony”.<sup>2</sup> Sound change is inhibited when “avoidance of homophony can ... sometimes block otherwise regular sound changes from taking place in certain forms .... While scholars opposed to teleological explanations in linguistics have never been friends of the explanation of certain changes as due to the avoidance of pernicious homophony, such avoidance is solidly documented; that is, it is an undeniable empirical reality”.

The “empirical reality” Campbell refers to involves at least two well studied sound changes whose exceptions have been attributed to homophony avoidance. One is the loss of intervocalic \*s in Classical Greek (Bloomfield 1933:362–364, Campbell 1998:288–289). The other is the loss of word-final \*n in Estonian (Raun & Saareste 1965:62, Campbell 1998:289–290). In §2, these cases and several others are briefly reviewed, followed by detailed presentation of two more convincing cases of inhibited sound change in Dakelh, an Athabaskan language, and Banoni, a Western Oceanic language. A survey of inhibited sound change has never, to our knowledge, been undertaken. One aim of this paper, then, is to contribute to our understanding of sound change typology, by assembling exceptions to regularity of this particular kind and assessing their common features.

A second goal of this study is to understand how and why a particular type of homophony can inhibit sound change. Must we assume, as Campbell does, that sound change is teleological? And what does teleology mean in this context? Within a traditional model of sound change speakers unconsciously perceive and produce words, with articulatory-based sound change occurring gradually, and perceptually-based sound change somewhat more abruptly. However, in both cases, sound change appears to be unconscious, with regularity attributable to basic characteristics of category formation (Blevins 2004:260–268). If, by teleological, one means that speakers evaluate the potential output of a sound change before putting it to use, we are faced with a contradiction, since sound change must

2. Pernicious homophony may result in other irregularities like periphrasis (Lyovin 1977), lexical replacement (Campbell & Ringen 1981, Campbell 1996), and irregular or sporadic change (Öhmann 1934, Campbell 1996, Newman 1996).

Overlapping with homophony-inhibited sound change, but distinct from the exception types in (1) are sound changes with seeming morphological conditioning. Trask (2000:219) defines “morphologically conditioned sound change” as “Any phonological change which occurs regularly except in some morphologically distinguished environment, or, less commonly, which occurs only in a morphologically distinguished environment”. The cases we are interested in are a subset of the first type, involving regularity, except where homophony would result. Cases of the second type, which include the Scottish Vowel Length Rule (Aitken 1981), do not show sound change inhibition under homophony, and are not discussed here. For general discussion of morphologically conditioned sound change and additional references, see Campbell (1996), Crowley (1997:242–244), Trask (2000) and Blevins & Lynch (2009).

be unconscious and automatic, but at the same time, conscious and deliberate. In §3 we attempt to resolve this contradiction by demonstrating that homophony avoidance is an emergent property of one plausible model of lexical competition. The simulations we present are valuable, not only as tools for generating non-teleological homophony avoidance in the course of sound change, but also, more generally, as means for hypothesis-testing in historical linguistics. Interestingly, in this case, the simulations make additional predictions which we explore briefly in §4. Chapter 5 presents a summary of our findings.

Though we will continue to refer to “exceptions” to regular sound change and “inhibited sound change”, a more constructive way to view the empirical record is in terms of multiple factors which influence sound change and regularity. What is thought of as a single sound change is an event cluster involving a complex interaction of phonetic, analogical, lexical, and/or social factors, as outlined in Guy (2003), and modeled by ongoing work of the Language Dynamics Group (Janet Pierrehumbert, Principle Investigator, Northwestern University). Phonetic and non-phonetic factors may contribute to the strong tendency for regularization (e.g., Blevins 2004:260ff.), while dialect mixture, language contact, and analogy are common sources of exceptionality. The fact that some processes appear perfectly regular while others do not is, in part, illusory. At the lowest levels of granularity, regularity may be imperfect, with fine phonetic differences distinguishable across members of the same category (Warner et al. 2004, and references therein). At the same time, at higher levels of analysis, identification of analogical change across paradigms may allow exceptions to sound change to be reclassified as masked cases of regularity (see 2.1 below). With this complex model of sound change as background, we demonstrate, in §2, that lexical competition in the form of “pernicious homophony” can influence the course of sound change. In §2.1 we review impure cases of this type, where other factors are also visible. §§2.2 and 2.3 present seemingly pure cases of inhibited sound change, where lexical competition is the only clearly identifiable factor leading to exceptionality.

## 2. Inhibited sound change

Given a model of sound change with multiple interacting factors, identification of component factors may be difficult. Though the categorization in (1) is useful and instructive, when factors interact and overlap, they may be difficult to identify, or leave no trace whatsoever. In our attempts to identify inhibited sound change (1h), we have found evidence of two basic types: (i) pure inhibited sound change, where lexical competition in the form of “pernicious homophony” is the only clearly identifiable factor leading to exceptionality, and (ii) impure inhibited

sound change, where lexical competition, analogy, and/or sound change may interact, giving rise to cases, which, under monocausal approaches, are attributed solely to analogy, or to secondary phonological developments.

In our survey, cases of inhibited sound change are identified by use of the heuristics in (2). If a sound change satisfies all the conditions in (2), it is classified as a pure case of inhibited sound change. Two cases of this kind are presented in §§2.1 and 2.2 below and provide strong support for the claim that homophony avoidance is a real, independent causal factor in sound change. If a sound change satisfies all conditions in (2) with the exception of either (2d) or (2e), it is classified as a case of impure inhibited sound change.<sup>3</sup> Importantly, in these impure cases, the role of lexical competition is still visible, since analogical change, or subsequent sound change, takes place precisely where inhibited sound change is expected to occur. §2.3 discusses several cases of impure inhibited sound change, including some of the best known cases in the literature.

- (2) Identifying inhibited sound change: some heuristics
- a. The sound change in question is regular and exceptionless in at least one other language.
  - b. The sound change has a well understood phonetic basis.
  - c. There is no known analogical basis for the apparent sound change.
  - d. Exceptions are not due to identifiable subsequent analogical developments.
  - e. Exceptions are not due to identifiable subsequent phonological developments.
  - f. Exceptions are not due to the gradual nature of a change in progress.
  - g. Exceptions are not due to language/dialect contact/mixture.
  - h. Exceptions are not due to direct sound-meaning associations.
  - i. Exceptions occur where pernicious homophony would otherwise result.

### 2.1 Unstressed vowel syncope in Dakelh

Many cases of inhibited unstressed vowel syncope have been reported in the literature. However, most involve inhibition of synchronic alternations, not diachronic developments. This is true, for example, of McCarthy (1986), where synchronic syncope is shown to be blocked in a number of languages if it would result in sequences of adjacent identical consonants. Though McCarthy attributed this

3. When a sound change appears to be highly regular, and phonetically conditioned, a possible role for analogy (2c), as opposed to regular sound change, is rarely explored, unless phonetic conditioning factors are suspect. Some cases of this kind are discussed in Garrett & Blevins (2009).

blocking to the Obligatory Contour Principle, a synchronic universal, subsequent studies suggest that these sound patterns are reflexes of diachronic syncopes with the profile in (2). The overriding generalization is that vowel syncope applied historically, except where it would result in pernicious homophony (2i) (Gessner & Hansson 2004, Blevins 2005a).

In conformance with (2a, b) above, let us take a moment to review typological and phonetic facts about unstressed vowel syncope. Unstressed vowel syncope is widespread cross-linguistically. As an exceptionless sound change, it has occurred in many languages in distinct language families, including Old Irish (Indo-European), Chamorro (Austronesian), and Central Alaskan Yupik (Eskimo-Aleut). Phonetic explanations for unstressed vowel syncope are straightforward: short unstressed vowels range in pronunciation from hyperarticulated full vowels with recognizable qualities to hypoarticulated segments which lack any noticeable formant structure. These hypoarticulated tokens can be interpreted by language learners as consonant release, open transitions, or nothing at all. Given this kind of variation and interpretation, transmission of language from one generation to the next can yield loss of unstressed vowels. Is there a language where unstressed vowel syncope applies everywhere except where pernicious homophony would result (2i), and where exceptions cannot be attributed to other factors (2.d-h)? The answer appears to be yes for Dakelh, as described by Gessner & Hansson (2004).

Dakelh (*aka* Carrier) is a Northern Athabaskan language of central interior British Columbia. The facts reported by Gessner & Hansson (2004) are from the Lheidli dialect, the language described by Gessner (2003) and in ongoing fieldwork. However, the phenomenon in question is shared by all dialects in the Southern branch of Dakelh. In Dakelh, as in many Athabaskan languages, valence prefixes and 'inner subject' prefixes interact in complex sound patterns (Poser 1999, 2000). Some of these involve consonant deletion and/or fusion, while others show vowel/zero alternations. In Dakelh, the valence prefixes are zero, /d-/ , /l-/ and /l-/.<sup>4</sup> The historical forms of the non-zero valence prefixes were \*də-, \*ɬ-, and \*ɬə- respectively with historical syncope resulting in schwa loss (Krauss 1969). The problem is why certain verb forms show a synchronically epenthetic vowel in the 1st person singular and 2nd-person dual/plural of historical \*ɬə-valence forms. Gessner & Hansson's solution to this problem is a simple one: vowels occur in these forms because it is precisely here that historical unstressed vowel syncope was inhibited. As they show, if syncope had applied, homophony between these forms and their \*ɬ-valence counterparts would result. Historical developments are illustrated schematically in (3).

4. On the function of these valence markers, see Gessner & Hansson (2004) and references cited there.

(3) Proto-Athabaskan > Dakelh: \*ə > Ø/ [C\_][CV (Krauss 1969)

	Proto-Athabaskan	VOICING,	H-LOSS,	Dakelh
		N-LOSS,	SYNCOPE	
*ɬə-	1SG	*(...V)-f-ɬə-C...	>	*(...V)-f-ɬə-C... > (...V)-f-ɬə-C... [no syncope]
	2SG	*(...V)-in-ɬə-C...	>	*(...V)-i-ɬə-C... > (...V)-i-ɬə-C...
	3SG	*(...V)-ɬə-C...	>	*(...V)-lə-C... > (...V)-l-C...
	2DU	*(...V)-h-ɬə-C...	>	*(...V)-h-ɬə-C... > (...V)-ɬə-C... [no syncope]
*ɬ-	1SG	*(...V)-f-ɬ-C...	>	*(...V)-f-ɬ-C... > (...V)-s-C...
	2SG	*(...V)-in-ɬ-C...	>	*(...V)-i-ɬ-C... > (...V)-i-ɬ-C...
	3SG	*(...V)-ɬ-C...	>	*(...V)-ɬ-C... > (...V)-ɬ-C...
	2DU	*(...V)-h-ɬ-C...	>	*(...V)-h-ɬ-C... > (...V)-ɬ-C...

Gessner & Hansson (2004) review numerous potential synchronic explanations for the pattern in (3), and show why none is satisfactory. The explanation for this pattern, they argue, is ultimately historical. Regular schwa loss was inhibited precisely where its loss would create pernicious homophony between historical \*ɬə- and \*ɬ-valence forms.<sup>5</sup>

From this brief discussion it should be clear why the unsyncope vowel could not result from analogical restoration. If the sound change applied in an exceptionless way, there would be no CV-valence forms on which analogy could be based. Unsyncope forms in southern Dakelh dialects do not appear to be borrowed either. In the Nak'albun-Dzinghubun branch of Dakelh, the same 1 singular and 2 dual/plural forms show fusion, suggesting assimilation of adjacent consonants with no historical schwa (Gessner & Hansson 2004: 97). Finally, Gessner & Hansson (2004: 97) demonstrate that the unexpected epenthetic vowel could not be a result of secondary epenthesis, since the biconsonantal clusters in question are not otherwise prohibited at the valence-root boundary, while the triconsonantal onsets are regularly resolved by fusion or deletion, not epenthesis.

5. See Gessner and Hansson (2004: 102) for two other corners of the prefixal paradigms where historical syncope was apparently inhibited by pernicious homophony: in certain 3sg forms with /l-/ valence, and in /d-/ forms where historical syncope would result in a loss of contrast between \*də- and zero valences.

Specialists may not all agree with the interpretation of Dakelh historical phonology reviewed here, which follows Gessner & Hansson (2004). An anonymous reviewer notes that instead of Proto-Athabaskan \*ɬə-, one could instead posit \*ɬ-. If the prefix vowels under discussion were historically absent, and inserted by epenthesis, the argument for inhibited regular syncope would disappear. Three factors favor reconstruction of Proto-Athabaskan \*ɬə-, supporting historical syncope. First, external comparison with Eyak (Krauss 1964, 1965) and Tlingit (Leer 1991) supports reconstruction of Proto-Athabaskan \*ɬə-. Second, a vowel-insertion analysis is forced to posit a valence prefix \*ɬ-, which is consonant final, though all the prefixes which precede the valence prefix are reconstructed as vowel-final. Finally, external to Athabaskan, there are other languages where syncope appears to be inhibited under similar conditions (Blevins 2005a).

The history of unstressed vowel loss in Dakelh appears to reflect pure inhibited sound change. The heuristics in (2) are satisfied, and a puzzling synchronic distribution is solved by reference to historical developments.<sup>6</sup> In §3 we turn to modeling these effects. However, before doing this, we describe another apparent case of pure inhibited sound change from Banoni of Southwest Bougainville in 2.2, and cases of impure inhibited sound change in 2.3.

## 2.2 Banoni vowel length merger

Many languages around the world have a contrast between long and short vowels, where the contrast is realized phonetically by segment duration. In examining vowel length across time, we see many instances where a contrast in length is lost in a regular, exceptionless way (2a). Latin is well known for its vowel length contrasts, marked clearly in written texts (Rolfe 1922), but these were lost in the earliest stages of post-Latin Romance languages (Pulgram 1975, Hall 1976). In prehistoric times, similar changes are in evidence. For example, Proto-Pama-Nyungan, the ancestor of most modern Australian languages, had distinctive vowel length in word-initial syllables. Distinctive vowel length contrasts are maintained in certain Paman languages, and a scattering of others, but over a good part of the continent, long and short vowels have merged (Alpher 2004: 109–110). In recent time spans, vowel length mergers are also widely documented. A vowel length distinction inherited from Middle Korean was maintained in most dialects, including Seoul, until the 1960s (Han 1964). However, recent studies show that vowel length is no longer contrastive for Seoul speakers (Jun 1998: 202–203).

What is the phonetic basis of vowel length neutralization (2b)? Context sensitive neutralizations are associated with multiple phonetic factors: lengthening due to long transitions in pre-vocoid position; shortening in closed syllables; and shortening via devoicing word-finally (Myers & Hansen 2005, 2007). Context free mergers are harder to pin down. The merger of vowel categories suggests that general variation along the hyper- to hypoarticulation continuum results in category crossovers. When apparent mergers are examined in-progress, this is indeed what inspection of individual speakers' vowel space reveals (see, e.g., Labov & Baranowski 2006). In cases like the Proto-Pama-Nyungan situation mentioned above, length contrasts were limited to initial stressed syllables. Additional length asso-

6. An additional feature of this particular case of inhibited syncope is that it does not involve inhibition of vowel loss between adjacent identical consonants, i.e. the "antigeminatation" effects suggested by McCarthy (1986). As a consequence, the Obligatory Contour Principle can not be invoked to inhibit syncope in this case. As emphasized by Gessner & Hansson (2004), finding inhibited syncope outside of antigeminatation contexts strengthens the case for visible anti-homophony effects in language change.

ciated with stress could bring the short stressed vowels close enough to the long stressed vowels to blur a clear category boundary, resulting in the mergers seen in most subgroups.<sup>7</sup>

From this general discussion, we turn to a specific case of vowel length neutralization in Banoni, an Austronesian language of Southwest Bougainville (Lincoln 1976a, Lynch & Ross 2002). Banoni is classified as a Western Oceanic language of the Meso-Melanesian Cluster. Since Proto-Oceanic reconstructions are widely agreed on, mapping Banoni sound change is relatively straightforward.<sup>8</sup> The description here relies heavily on Lincoln (1976a), from which all data is taken. Neutralization in vowel length has all the hallmarks of a regular phonetically motivated sound change and meets the heuristics in (2).

Banoni has five short vowels /i e a o u/ and five long vowels. Forms below are written in a phonemic orthography where doubled letters show vowel length and consonants have their approximate IPA values, except that ‘v’ writes [β] (varying with [ɣ] before round vowels). Proto-Oceanic, from which Banoni descends, had no vowel length contrasts. Examination of cognate sets reveals several distinct sources of vowel length in Banoni, including loss of consonants between identical vowels (4a), and assimilation of earlier \*V<sub>1</sub>V<sub>2</sub> sequences (4b–e).

(4) Long vowels in Banoni from earlier VV sequences

	gloss	Proto-Oceanic	Banoni	Comparanda
a.	“fish trap”	*pupu	vuu	Nakanai <i>vuvu</i> , Bauan <i>vuvu</i>
b.	“two”	*rua	too/m	Taiof <i>fua/n</i>
c.	“who?”	*sai, *sei	see, hee	Marovo <i>e sei</i> , Kokota <i>hei</i>
d.	“right”	*mataqu	matoo- (< *matou)	Teop <i>matau</i> , Taiof <i>matou</i>
e.	“new”	*paqoRu	voom (< *vouN)	Taiof <i>foun</i>

These sound changes have resulted in some minimal pairs in Banoni where vowel length is the only contrastive feature, e.g., *voom* “new” vs. *vom* “turtle” (< \*poñu). While words like “new” and “turtle” occur in different syntactic environments, and rarely contrast in running speech, the same cannot be said for bare nouns and their first person singular possessed forms. As shown in (5), many first person sin-

7. We restrict discussion here to phonetic factors. See Labov (1994: 328–331) for a range of factors which are likely to play a role in merger of a former contrast, including: functional load of the contrast; the number of minimal pairs that depend on the contrast; the extent to which the contrast depends on minimal pairs; the number of contrasts already made along the relevant phonetic dimension; the number of phonetic features involved; the discriminability of the contrast; constraints relevant to changes which might allow contrast maintenance.

8. On Proto-Oceanic phonology, see Ross (1998). Proto-Oceanic reconstructions and comparanda are from Blust (1995), Ross et al. (1998), and Greenhill et al. (2005–2007).

gular possessed nouns involve lengthening of the stem-final vowel. Historically, a vocalic suffix \*-V seems to have assimilated to the preceding vowel, similar to the development in (4c), giving rise to final long vowels.

(5) Long vowels in Banoni first person singular possessives

bare noun	1SG possessed noun	gloss
tama	tamaa	“father/my father”
kasi	kasii	“brother/my brother”
punu	punuu	“hair/my hair”
tete	tetee	“grandmother/my grandmother”
vanago	vanagoo	“sister’s child/my sister’s child”

In modern Banoni, as described by Lincoln (1976a), the historical contrast between long and short vowels is being lost. Under stress and intonation patterns, vowel length contrasts can be obscured (Lincoln 1976a: 39), and monosyllabic lengthening makes identification of long vs. short vowels difficult (Lincoln 1976a: 39). Finally, in addition to this ambiguity, “Banoni speakers tend to shorten long vowels, except when necessary for disambiguation” (Lincoln 1976a: 58). In other words, vowel length for forms like those in (4) appears to be variable and no longer contrastive. However, contrasts like those in (5) are maintained. Precisely in these contexts, length neutralization would lead to pernicious homophony.

In addition to the first person singular possessives in (5), there is one other place in Banoni where the vowel length contrast carries a heavy functional load. In the verbal morphology, the first singular transitive suffix is *-aa*, while the third person singular is *-a*. In contrast to the 1st singular possessives, vowel shortening of suffixal *-aa* “1SGOBJ” is taking place. In this case, an independent (sporadic) change of the object pronoun /vai/ to /i/ allows for the maintenance of contrast at the level of the verb phrase, as illustrated in (6).

(6) Vowel length neutralization in Banoni transitive suffixes (Lincoln 1976a: 76–77, 112)

	Abstract/historical	Surface	gloss
a.	/man-aa vai/	mana vai	“give me it”
	give-1SGO it		
b.	/man-a vai/	mana i	“give him/her it”
	give-3SGO it		

However, in other contexts, where there is no distinction elsewhere in the clause, the vowel length contrasts between 1SG and 3SG appear to be maintained, as illustrated in (7) (where C = completive, and F = definite future).

- (7) Maintenance of vowel length contrast in Banoni transitive suffixes (Lincoln 1976a: 183)

	Abstract/historical	Surface	gloss
a.	/ke ta noŋon-aa/ C F hear-1SGO	ke ta noŋonaa	“he hears me”
b.	/ke ta noŋon-a/ C F hear-3SGO	ke ta noŋona	“he hears her”

As with the Dakelh developments, it should be clear why contrasts like those in (5) and (7) are not the result of exceptionless \*V: > V plus analogical restoration (2d). If all length contrasts had been merged at a prior state of the language, on what basis could 1SG possessed forms and 1SG object forms be restored? It is also not clear how these retained long vowels could be secondary phonological developments (2e): there is nothing special which distinguishes final vowels in, for example, first singular possessed forms, from other word types. Language contact can also be ruled out (2g). While Banoni has had continued contact with neighboring non-Austronesian languages, Tok Pisin, and Piva (a neighboring Austronesian language), none of these languages appears to have final long vowels in these grammatical forms (Lincoln 1976b).<sup>9</sup>

In sum, the known history of vowel length in Banoni appears to reflect pure inhibited sound change. The heuristics in (2) are satisfied, and Lincoln’s descriptions are consistent with regular sound change except where pernicious homophony would result. If this is a case of inhibited sound change, it has been caught at a very informative stage: historical vowel length is still audible, though variable and non-contrastive, in words like those in (4). However, if things progress further, to a point where this variability vanishes, the only remnants of the vowel length contrast will be first singular possessive and 1SG object forms. In this hypothetical more advanced stage, evidence for inhibited sound change is gone. All that remains synchronically is a highly unusual phonological distribution: contrastive vowel length limited to subparadigms of nouns and verbs where length is the *only exponent* of a morphosyntactic feature. The model we explore in §3 actually predicts just such distributions, and we return to this finding in §4.

If, on the other hand, the merger of long and short vowels continued without inhibition, the contrast would be presumably lost forever. However, even under these circumstances, there is an evolutionary pattern of inhibition that requires modeling. Sound change does not appear to proceed blindly and automatically. Rather, in cases where lexical competition is fierce, sound change can be inhibited,

9. Lincoln (1976a: 4) states generally that “it seems quite clear that none of this language contact has led to very much grammatical convergence between Banoni or Piva and their non-Austronesian neighbors”.

resulting in surface patterns of exceptionality under homophony, which may ultimately be lost over time.

### 2.3 Impure inhibited sound change

As noted in §1, at least two well studied sound changes involve exceptions attributed to homophony avoidance. One is the loss of intervocalic \*s in Classical Greek (Bloomfield 1933: 362–364, Anttila 1972: 98–99, Campbell 1974, Campbell & Ringen 1981, Campbell 1998: 288–289). The other is the loss of word-final \*n in Estonian (Raun & Saareste 1965: 62, Kiparsky 1965/1971: 19, Kiparsky 1972: 206, Anttila 1972: 79–80, Campbell & Ringen 1981: 62, Campbell 1998: 289–290). In both cases, previous literature notes the possibility that sound change was regular, with exceptions due to subsequent analogical restoration (2d). In our model, both of these cases are classified as ‘impure’ cases of inhibited sound change, since pernicious homophony (2i) appears to play a role, and yet, subsequent analogy (2d) cannot be ruled out.

In Classical Greek, intervocalic \*s > \*h > zero. Regular sound changes of *s* > *h* and *h* > zero are widespread in the world’s languages (Ferguson 1990, Blevins 2004: 144–147), and the phonetic motivation of this sound change is clear. Intervocalic environments are canonical weakening or lenition contexts. A weakened [s] can be misheard as [h] due to the perceptual similarity of these two sounds, and a weak [h] is easy to miss altogether. Examples of this sound change include \*nikasas > \*nikahas > *nikaas* “having conquered” (Doric) and \*steleso: > \*steleho: > *steléo*: “I will send”. Classical Greek \*s did not delete in other positions, with aorist \*-s- and future \*-s- both maintained after consonant-final stems. However, with vowel-final stems, where \*s-loss is expected, there are exceptions like *lú:so*: “I will release” (< \*lu:s-o:), where \*s appears to be maintained. The traditional analysis of these exceptions is that \*s > \*h > zero was regular and exceptionless (Tucker 1969). Subsequent to this change, *s* was analogically restored into paradigms of certain vowel-final roots like \*lu:- “release” and \*poie:- “do” on the basis of C-final stems which maintained *s*. This traditional analysis is at odds with that proposed by Campbell (1998: 288–289) and others where exceptions to \*s-loss are attributed to pernicious homophony. The traditional analysis results in classification of this as a case of impure inhibited sound change; under Campbell’s analysis it is a pure instance of inhibited sound change.

Another widely discussed inhibited sound change is regular loss of word-final \*n in Estonian (Kettunen 1929). Word-final loss of nasals is widespread in the world’s languages, and, like *s*-loss above, has a sound phonetic basis, with perceptual and articulatory components (Hajek 1997). Loss of nasals often results in compensatory lengthening of a preceding vowel, and Viitso (2003: 186) argues for

a similar development in Estonian. Under his analysis, word-final \*-n was lost (or ‘vocalized’), resulting in lengthening of the preceding vowel; a subsequent change shortened long vowels of non-initial syllables. Developments include: \*nainen > *naine*: > *naine* ‘woman’; \*kümnen > \*kümme: > *kümm* ‘ten’; \*kalan > *kala*: > *kala* ‘fish, GEN.SG’. Between the vocalization stage of \*-n and the shortening of unstressed long vowels, a general apocope rule occurred. Under apocope, Estonian lost all final short vowels in disyllabic words with a long initial syllable, and in words of three syllables or more (Viitso 2003: 183), giving rise to developments like *sein* < \**seina* ‘wall, NOM.’, but *seina* ‘wall, GEN.’ < \**seinan* ‘wall, GEN.’.

In South Estonian, Saaremaa, Hiiumaa, Pärnumaa, southern Läänemaa, East Votic and Livonian, final \*-n was vocalized and lost without exception in nouns and verbs (Pajusalu 2003). However, in Coastal, North-East, East and most North Estonian, and in West Votic, \*-n appears regularly in 1SG verb forms, e.g., *saan* ‘I get’, *annan* ‘I give’, *kurjutasin* ‘I wrote’, reflecting the 1SG \*-n (Viitso 2003: 195). As with Classical Greek \*s-loss, there are two competing analyses. Kettunen (1929) argues on the basis of textual evidence from the early 1600s that the progression was one of exceptionless sound change followed by analogical restoration. Restoration of final -n in first singular verb forms was possible because final -n was still pronounced in many phrasal contexts where these verbs were used. Under this analysis, \*-n loss is classified as impure inhibited sound change.<sup>10</sup> An alternative analysis argues that \*-n loss never occurred in first person singular forms, because it would have created pernicious homophony with 2SG imperative verbs, where \*-k was lost finally: \**kan:a-n* ‘I carry’ (not *kan:a*) vs. *kan:a* ‘carry!’ (< \**kan:a-k*), *tule-n* ‘I come’ (not *tule*) vs. *tule* ‘come!’ (< \**tule-k*) (Raun & Saareste 1965: 62, Campbell 1998: 289–290). This is argued for on the basis of correlations between \*-n loss and \*-k loss: inhibition of \*-n loss is limited to Coastal, North-East, East, most North Estonian, and West Votic, where 2SG imperative \*-k was lost as well.<sup>11</sup> Under this view, Estonian \*-n loss would satisfy all the heuristics in (2) and be classified, with the Dakelh and Banoni changes, as a case of pure inhibited sound change.

Another less studied historical development which has also been classified as inhibited sound change is the closely related process of final \*-n-loss in Livonian (Vihman 1976). The sound change is exceptionless, but does not apply to dative -n.

10. Under certain assumptions, this analogical restoration would allow \*-n loss to be classified as an instance of pure inhibited sound change, since the analogue is a predictable surface variant of the target lexeme.

11. However, of exceptionless \*-n loss dialects, which include South Estonian, Saaremaa, Hiiumaa, Pärnumaa, southern Läänemaa, East Votic and Livonian, only Võru South Estonian shows a -ʔ reflex of \*-k in 2SG imperatives (Viitso 2003: 195), showing that the correlation is not so clearly significant.

Complicating this example is a debate as to whether Livonian dative /-n/ is a reflex of \*-n (genitive) or \*-na (cognate with the Finnish and Estonian *essive*). Livonian retention of dative -n, Veps (dialectal) retention of \*-n in the genitive singular, and Estonian (dialectal) retention of \*-n in first singular are all treated as instances of \*-n-loss inhibition by Alvre (1967). If Livonian dative /-n/ is a reflex of \*-na, then the question of \*-n-loss inhibition is moot. If, on the other hand, it is derived from \*-n, it may also be a case of inhibited sound change.

In the context of inhibited sound change, Campbell (1996: 78), following Öhmann (1934), mentions German dialects where “regular sound change (for example, loss of intervocalic *g* and unrounding of *ü*) would have produced homophony for *liegen* ‘to lie (down)’ and *lügen* ‘to lie (tell falsehoods)’”, but provides no details and admits that they show “sporadic changes ... to preserve the phonetic difference between these two words”. Since intervocalic *g* would be preserved elsewhere in the paradigm, it is not clear why regular sound change could not be followed by analogical restoration of *g* in this case. Whether analogical change (2d), or subsequent phonological change (2e) is involved, this example would be classified as a case of impure inhibited sound change.

Another potential case of inhibited sound change is found in the history of Yurok, an Almic language of Northwestern California. A proposed shared innovation defining the Ritwan subgroup (Yurok and Wiyot) within Almic is loss of historical vowel length (Berman 1982). Wiyot is conservative, with no vowel length contrast, while Yurok shows robust length contrasts for all vowels except /e/ and /a:/ (Blevins 2003). Berman (1982: 416) suggests several sources for vowel length, including contraction of VGV sequences, pre-resonant open-syllable lengthening, and monosyllabic vowel lengthening. The question is whether monosyllabic vowel lengthening, in the history of Yurok, qualifies as a case of inhibited sound change under (2). Heuristic (2a) is satisfied, since an exceptionless case of monosyllabic lengthening is found in Warray, a language of northern Australia (Borowsky & Harvey 1997). Heuristic (2b) is also satisfied, since lengthening appears to be related to phonetic durational cues associated with monosyllabic stress feet. In addition, (2i) is nearly satisfied. Monosyllabic vowel lengthening of VC and CVC content words occurs everywhere in Yurok, with two notable exceptions. There is no vowel lengthening in monosyllabic 3rd person singular indicatives. Lengthened vowel in these forms would result in homophony between 3rd singular and 2nd singular indicatives. Compare *to:k* ‘take.1SG’, *to:m* ‘take.2SG’, but *to:m* ‘take.3SG’, all from \**t* -o- (Blevins 2005b). If this were the only exception to monosyllabic lengthening, it would qualify as a good example of pure inhibited sound change. However, a complicating factor is that the verb stem *ʔ-* ‘to be, to exist’, shows 3rd singular indicative *ʔokw*, ‘s/he is, is at; there is’ (cognate with Wiyot *tokw* ‘he remains’, Proto-Algonquian \**takwa* ‘it exists’) and *ʔol* ‘s/he is’. These two verbs



are also exceptions to monosyllabic lengthening, but anti-homophony cannot be invoked, since the 2nd singular indicative is *ʔooʔm*. Plural indicative forms of this same verb are also exceptions to monosyllabic lengthening: *ʔoh* 1PL, *ʔoʔw* 2PL, *ʔot* 3PL. Though a good phonological and analogical account of these other exceptions exists,<sup>12</sup> we cannot rule out the possibility that vowel lengthening was entirely regular, with monosyllabic 3rd singular verbs subsequently shortened on analogy with *ʔokʔw*, ‘s/he is, is at; there is’. For this reason, we classify Yurok monosyllabic lengthening as a case of impure inhibited sound change.

#### 2.4 The status of inhibited sound change

Banoni, speakers

In our survey, we have uncovered at least two examples where a phonetically-based sound change appears to occur everywhere except where pernicious homophony would result. In both Dakelh and Banoni speakers maintain a contrast precisely where homophony might diminish the communicative function of language; elsewhere, the contrast is neutralized by regular sound change. An evolutionary pathway of interest has been identified. A phonetically-based sound change shows itself, and at some point in its development, may be characterized by homophony-based inhibition. This is the pathway we aim to understand and model in the following section. Before doing so, however, we address a central question related to the status of inhibited sound change in the wider context of language change. If inhibited sound change exists, why are there so few examples which satisfy the full list of heuristics in (2)? Why are pure instances of sound change inhibition almost unknown?

We believe that four different factors are involved. First, as we emphasized in §1, the association of sound change inhibition with a single cause, homophony, is artificial. Under the variationist model we assume, a single sound change typically involves a complex interaction of phonetic, structural, lexical and/or social factors. The effects of lexical competition, as modeled in §3, may be masked, erased, or difficult to identify as a consequence of other interfering factors. Yurok provides one example of this complex interaction. Monosyllabic lengthening itself is not straightforwardly identifiable because it only targets content words, and has exceptions in the verbal system. In addition, the exceptions are mostly in contexts of pernicious homophony, but some are not. Until we can fully justify other explanations for these exceptions (see footnote 12), we tentatively classify this as a case

12. A prosodic explanation exists for the failure of lengthening in *ʔokʔw* ‘there is’, since this word often has function word status, and therefore is not expected to undergo monosyllabic lengthening. Other short vowels in the indicative paradigm of *ʔ-* could have been modeled on this analogue.

of impure inhibited sound change, where phonetic factors and analogical change interact.

A second, related reason for the paucity of examples of pure inhibited sound change is that it is normally extremely difficult to eliminate analogy (2d) as a potential source of exceptions. Though some analogues may be intuitively unlikely, there is no theory of analogy yet in place which allows us to empirically evaluate such intuitions.<sup>13</sup> Furthermore, as was clear for the Estonian \*-n loss example, whether we consider (2d) satisfied or not will depend on how we classify Ket-tunen’s (1929) proposal of *n*-restoration in first person singular verbs based on phrasal contexts where final *-n* was preserved before vowel-initial words. Is modeling the phonetic form of a lexeme in one phonological context based on its form in another phonological context ‘analogy’ in the traditional sense of the word? Or is this simply a case of one phonetic variant of a lexeme ‘winning’ out? If we choose the second interpretation, this sound change will satisfy the entire set of heuristics in (2), and merit reclassification.

In addition to the difficulty of eliminating analogy as a potential source of exceptions to sound change, our model also suggests that pernicious homophony may be positively associated, not only with sound change inhibition, but with analogical change, and sporadic sound change as well. In this study, we do not directly consider how lexical competition interacts with analogical change. However, the biases we discuss in §3 lead us to expect that sound change is more likely to be inhibited where strong analogues exist, and that analogy will be more likely in the same contexts.

A fourth reason why so few examples of inhibited sound change are known is that very few people are looking for them. By collecting known examples, listing the heuristics in (2), suggesting prototypes like Dakelh and Banoni, and simulating the evolution of inhibited sound change (see below), we hope to encourage historical and descriptive linguists to look, not only at exceptions to regularity, but at their distribution across the lexicon, and their trajectories over time. If our understanding of lexical competition is on the right track, more examples of sound change inhibition should soon come to light.

### 3. Modeling inhibited sound change

Earlier approaches to apparent cases of inhibited sound change from historical linguists have referred simply to ‘anti-homophony’, ‘pernicious homophony’, or ‘homophony avoidance’ as the cause, with little elaboration (Anttila 1972: 181–182,

13. See Blevins & Blevins (2009) for recent research on analogy which moves in this direction.

Lyovin 1977, Campbell & Ringen 1981). Recent synchronic accounts propose teleological anti-homophony constraints, or constraints demanding lexical contrast, which are claimed to be universal and violable (e.g., Crosswhite 1999, Ichimura 2006). Within the variationist literature, however, modeling functional constraints on contrast maintenance has become more concrete (e.g., Guy 2003: 392–394, Wedel 2004: 120–169), and it is this work that we build on here.

In addition to highlighting the multiple and complex factors involved in a single sound change, a growing number of variation studies suggest that sound change occurs throughout the lifespan (e.g., Labov 1994, Sankoff & Blondeau 2007, and references there). These findings emphasize the constantly evolving nature of sound systems at the level of the individual, and suggest that appropriate models of sound change will be dynamic and evolutionary in nature.<sup>14</sup> A range of evolutionary approaches to sound change are currently being explored, from their origins (e.g., De Boer 2001, Oudeyer 2006), to their emergence in speaker-hearer pairs (e.g., Wedel 2006, 2007) and larger populations (e.g., Niyogi 2006). Similar models are also being used to model specific types and characteristics of sound change, from near-mergers (Yu 2007), to chain shifts (Ettlinger 2007, Maclagan & Hay 2007). Here we pursue a similar evolutionary approach to inhibited sound change. Where previous analyses suggest teleological or goal-directed behavior in homophony avoidance, we attempt to illustrate how sound change inhibition emerges from aspects of language use.

In modeling emergent features of language structure, it is useful to understand how high level features of linguistic systems can be misleading. Sound changes in language often seem to fulfill some larger purpose: reduction of articulatory effort; increase in perceptual contrast; or symmetry in sound inventory composition. In similar ways, evolutionary changes within biological populations can appear to be purposeful. Indeed, we often informally describe evolutionary outcomes in these terms, as when we say that zebras evolved stripes for the purpose of camouflage. However, there are difficulties with this kind of teleological statement. Taken literally it suggests that there is no well-grounded mechanism for the change from a proto-zebra to a zebra with stripes. The great contribution of Darwin's theory of natural selection has been to provide just such a mechanism for this kind of

14. The term “panchronic” is sometime used for approaches where boundaries between diachrony and synchrony are blurred. For example, Joseph & Janda (1988: 194) deny a sharp distinction between synchrony and diachrony, and advocate the view that “there is only a panchronic or achronic dynamism in language” and that therefore “language change is necessarily something that always takes place in the present”. We prefer the term “evolutionary” since modeling of language as a dynamic system makes use of imperfect replication and repeated interaction of multiple factors across time (Ehala 1996, De Boer 2001, Blevins 2004, Luschützky 2004, Ritt 2004, Niyogi 2006, Oudeyer 2006, Wedel 2006, 2007, Sproat 2008).

population-level change through the cumulative effect of many individual-level interactions: seemingly purposeless events at the level of the individual result in apparently purposeful change at the level of the population. Linguistic systems also comprise many nested and interlocking levels that can be described in terms of populations, from the level of speakers in speech communities, through the population of lexemes in an individual lexicon, down to the contents of a single category when conceived in terms of exemplars. Variation is evident at all of these levels, as noted above, and at many of these levels, patterns of variation have been shown to influence production, perception and learning (e.g., Johnson 1997, Goldinger 2000, reviewed in Pierrehumbert 2006). Correspondingly, evolutionary accounts of diachronic language change, like the model proposed here, suggest mechanisms that link the cumulative effect of individual acquisition and usage events to larger-scale pattern change.

The model outlined below is informed by three broad findings concerning the nature of linguistic categories. First, linguistic categories appear to contain a great deal of phonetic detail (Pierrehumbert 2002, Jannedy & Hay 2006, Baayen 2007, and references therein).<sup>15</sup> Second, speakers store generalizations involving phonetic detail at multiple intersecting levels of categorization, for example word and segment (Bybee 2002, Pierrehumbert 2003 and references therein). Third, speakers' categories include a record of previously encountered detail, and this detail influences subsequent categorization and production (Goldinger 2000, reviewed in Pierrehumbert 2001, 2006). The three properties noted, degree of detail, multiple intersecting levels, and episodic storage with feedback on subsequent categorization, are typical of exemplar approaches to cognition (Gahl & Yu 2006).

With respect to the third property, experimental results from adults appear to mimic mini-changes which can snowball over a lifetime. In the area of categorization, for example, it has been shown that artificial stimuli can result in temporary shifts of category boundaries (Eisner & McQueen 2005). Subjects exposed to wordlists in which [s] tokens were biased toward [f], or vice versa, were given a forced-choice phoneme categorization task the next day, and showed shifts of their *s*~*f* category boundaries accordingly. Similar results are evident from production studies. For example, subjects exposed pronunciations of a set of words by a particular speaker show their own pronunciations shifted towards that of the speaker's for up to a week after exposure (Goldinger 2000). Overall, the linkage between categorization and production creates a feedback loop that should allow subtle biases in production or perception to significantly modify category systems

15. Growing consensus on this point is evident in the theme of the 2007 Laboratory Phonology 11 Conference: “Phonetic detail in the lexicon”.

within a speech community over time (Pierrehumbert 2001, Blevins 2004:286–287, Wedel 2007).

Let us now turn to the model and some of its defining properties. The observation that categories include phonetic detail, and are influenced by this detail as they evolve, has important implications for models of category change, and, more specifically, models of sound change. Because noise in production and perception steadily introduces new variants, retention and use of variation should steadily broaden the range of variants encompassed by a category, be it a segment, tone, phonotactic or prosody (Figure 1) (Pierrehumbert 2001). However, categories do not inexorably broaden with experience. Some feature of production, perception, or general cognitive processing appears to introduce a balancing bias towards the category center. What is this bias, and how can the model be configured to mimic it?

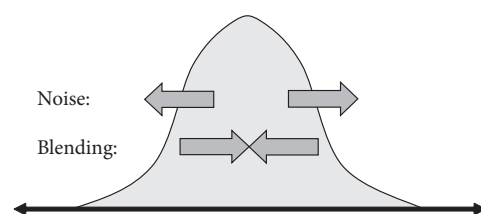


Figure 1. Noise versus blending in perception and production

**Legend:** Noise (upper arrows) creates variation in the course of production or perception. Given some degree of retention of detail in perception and storage, noise promotes broadening of the range of variants stored in a category, abstractly represented here as a distribution in one dimension. Blending of memory traces (lower arrows) in production or perception processes promotes tightening of the distribution over time. In the absence of other factors, the variance of a category should reflect an equilibrium between noise and blending. If the noise and blending are in balance throughout the category distribution, drift of the category center will not be biased in any particular direction.

Research in response biases of cortical fields of neurons in both perception and motor behavior suggests an appropriate mechanism to counteract noise-driven broadening (Guenther & Gjaja 1996). A central result is that the output of a cortical field, whether a perceived experience or a motor gesture, is well predicted by the aggregate response of the entire field, rather than by the output of the most highly activated neuron. From the set of activities of all neurons, one can predict the perceived stimulus or motor output by computing the *population vector*, namely, the sum of all preferred outputs of the set of neurons multiplied by their activities (Georgeopoulos, Schwartz, & Ketter 1986). The important property of the population vector for our purposes is that it is not equivalent to the output of the maximally stimulated neuron. Rather, it is shifted toward the center of the

local distribution of outputs.<sup>16</sup> Given a close mapping between perception and production (Oudeyer 2002, Pierrehumbert 2006), the influence of the population vector of a field of neurons on perception or motor behavior produces a reversion to the mean of the neuronal response distribution. Within a perception/production feedback loop, reversion to the mean promotes tightening of distributions over time.<sup>17</sup> As a result, while noise in production and perception creates pressure for categories to broaden, reversion to the mean creates an opposing pressure for categories to tighten. All else being equal then, these two pressures will find an equilibrium in which the variance of a category appears to be relatively stable (Figure 1).

All else is NOT equal, however, when two categories approach one another (Figure 2). At the distal edges of the two categories, noise and reversion to the mean still have the same opposing effects: one creates pressure for the category boundary to expand, and the other creates pressure for it to contract toward the mean. At the boundary between the two categories, however, they are no longer balanced. This is because the more extreme the variant produced in the direction of the neighboring category, the more likely it is to be assigned to that neighboring category by a listener. This process of extreme variants near category edges being assigned to neighboring categories is a process we call *variant trading* (Guy 1996). As a consequence of variant trading, noise-generated variation at the boundary between two categories fails to counteract the category contracting effect of reversion to the mean, while variation at the distal edges continues to push the category boundaries outward. This imbalance provides a pressure that promotes drift of the two category means away from the boundary between them. In this case the two categories will tend to drift apart until variant trading falls off.

The process that promotes separation between two competing categories through variant trading is mathematically equivalent to a random walk with a wall. In a mathematical random walk, the *average* position of a random walker will remain forever centered on its starting position, even as its path covers more territory over time. Not so, however if there is a wall that prevents the walker's path from continuing in one particular direction. In that case, the walker's average position will drift steadily away from the wall, with the rate of drift slowing as the walker's

16. This perceptual bias has been proposed to underlie the perceptual magnet effect (Kuhl 1991) in which exemplars of an auditory category such as vowel quality are perceived as closer to the category center than they really are (Guenther & Gjaja 1996, Oudeyer 2002).

17. Because averaging of a subset of points in a distribution creates reversion to the mean of that distribution, in numerous exemplar models of perception/production feedback, reversion to the category mean has been modeled by choosing a local set of exemplars within a category and averaging them. See for example Goldinger (1996), Pierrehumbert (2001), and Wedel (2006).

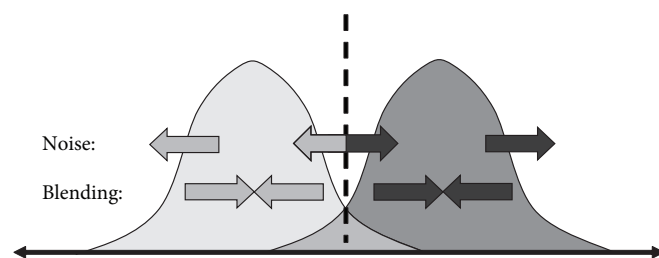


Figure 2. Variant trading between adjacent categories

**Legend:** When two categories are adjacent, the balance of noise and blending is no longer equivalent throughout the category distributions. While blending continues to promote symmetrical tightening of each category, noise no longer has the same broadening tendency at the boundary between the categories. Extreme production variants of each category that cross the category boundary will not be recognized and stored by a listener in the intended category. Rather, they will be stored in the adjacent category. This 'variant trading' removes the balancing effect of noise on the boundary-adjacent side of the category. As a result the net category center movement over time is away from the boundary. Variant trading will not occur if external disambiguating factors are present, since such factors allow extreme variants to be assigned to the intended category. In such cases, net movement of category centers will not be biased away from the category boundary.

average position gets further away. This occurs because excursions away from the wall always run their course, but not all excursions toward the wall do, resulting in a persistent bias in movement away from the wall. The boundary between the two categories in this model is parallel to that mathematical wall. All extreme variants can move the category center away from the boundary, but any variants that fall on the other side of the boundary do not. If we assume for arguments' sake that the same number of extreme variants cross the category boundary in both directions, this is equivalent to a random walker who 'bounces' off the wall.

In the context of the present study, processes like Dakelh vowel loss or Banoni vowel length neutralization arise from natural phonetic processes which themselves reflect variation along a hypo-to-hyperarticulation continuum. As these sound changes occur, productions of neighboring categories approach one another. The imbalance caused by variant trading creates conditions under which the approaching categories start to move apart. Here then, is a model of homophony avoidance without reference to a speaker or listener's goals. A sound change can be inhibited precisely where lexemes are in extreme competition, because it is in this grammatical locus that categorization is most strongly affected by phonetic proximity (Figure 2).

How could variance in the degree of overlap in contextual distribution influence sound change? The information contributing to accurate assignment of a word to a category often inheres in both word-internal and external factors in an

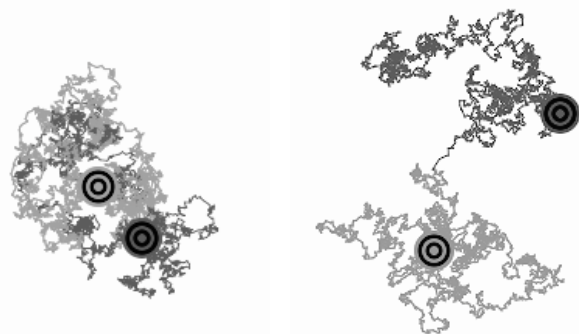
utterance. Internal factors include the phonetic content of a word itself. External factors include the syntagmatic and discourse context. When sufficient contrast is contributed by word-external factors, a near-complete lack of phonetic contrast does not prevent accurate assignment of a percept to a category. As an example, consider normal successful interpretations of essentially homophonous *two* versus *too* or *you* versus 'u' in English. On the other hand, categorization errors between near homophones are more common when word-external factors fail to provide robust disambiguating information, as with English stressed modals *can* versus *can't*. Whether ambiguous, and therefore uncategorized, or misheard as it's opposite, low-level effects of this kind resulting from distributional overlap will have implications for higher-level categorization.

Other words sets that may often have overlapping contextual distributions, and sound the same, are members of the same paradigm. As phonological neighbors and same-category members, external context may sometimes be insufficient to disambiguate between a pair of near-homophones. In this case, word-internal phonetic contrast must carry the burden for accurate category assignment. Under these conditions, we expect an asymmetry in categorization accuracy that is tightly correlated with the ambiguity of the percept: the least ambiguous percepts will be most consistently assigned to the intended category, while categorization of the most ambiguous percepts will be most variable. It is this asymmetry in categorization accuracy that plays a central role in our model, and which defines lexical competition within paradigms.

Consider what happens when external disambiguation allows an extreme variant of a word or morpheme category to be 'correctly' identified by the listener, even when it would otherwise be assigned to a neighboring category. This was the situation described for Banoni in (6), where /man-aa/ "give-1SGO" and /man-a/ "give-3SGO" are disambiguated by the third person object forms in the phrases *mana vai* "give me it", vs. *mana i* "give him/her it". Under these conditions variant trading does not occur, so there is no resistance to category approach: tokens of /man-aa/ and /man-a/ with similar final vowel durations merge. When this is modeled by providing external disambiguation to allow accurate identification of variants by a simulated listener, neighboring categories do in fact merge into one distribution (Wedel 2004). This is simply the normal case of merger under sound change.

The interaction of noise, reversion to the mean, and variant trading between two competing categories can be usefully illustrated through computer simulation. The simulation results illustrated in Figure 3 are for two exemplar-based categories that coexist in a two-dimensional parameter space. Each category contains 100 exemplars, each of which maps to a point in that space. In each time-step of the simulation, an output is produced from each category, and restored as a

new exemplar in one of the two categories. Production from a category proceeds by picking three exemplars from that category at random, taking their average, and then adding a small amount of random noise. Averaging several exemplars from a category produces reversion to the mean of the category distribution, and noise introduces new variation to the pool of exemplars. In the simulation results shown in the right panel of Figure 3, outputs were stored as new exemplars in the category whose mean is closest, allowing variant trading between the two categories at their boundary. In the left panel, outputs were stored as new exemplars in their category of origin regardless of their value, modeling accurate categorization through external disambiguation. When a new exemplar is stored in a category, a randomly chosen existing exemplar is deleted.



**Figure 3.** Simulation of Lexical Character Displacement

**Legend:** The left and right panels show the course of two simulations. Each simulation was seeded with two 50-exemplar categories both centered within the two-dimensional parameter space and run for 1000 cycles. In each cycle, an output was produced from each category by choosing three exemplars at random, averaging them and adding a small amount of random noise. The pathway of each category center is drawn out in light and dark gray respectively, and the position of the category centers at the end of the simulation are shown by the two bull's-eye patterns. In the simulation shown in the left panel, outputs were restored in their originating category. In the resulting absence of category competition, the two category centers engage in independent random walks around the point of origin. In the simulation shown in the right panel, outputs were restored in category with the closest category center, resulting in variant trading across the category boundary. Here, the two category centers immediately separate and remain apart over the course of the simulation.

Let us look closely at Figure 3. In the left-hand panel, showing a simulation run with external disambiguation, we see that the pathways of the category centers wander about the same region of the parameter space. If a new learner acquired two categories based on the distribution of exemplars in this version of the simulation, they would be likely to abstract only one category. This is because the total set of exemplars presents an essentially unimodal distribution. In the right-hand panel, showing a simulation run with category competition, competition between

the two categories results in variant-trading across their boundary, pushing them apart through the mechanisms we have outlined here. A new learner acquiring categories based on this set of exemplars would be more likely to abstract two categories, because the distribution of exemplars is clearly bimodal. Repeated simulations show similar properties, and readers are encouraged to explore these at <http://dingo.sbs.arizona.edu/~wedel/>.

Within this model, any factor in categorization that reduces the contribution of ambiguous variants or increases the contribution of more contrastive variants to a category's evolutionary trajectory will promote greater contrast over time. Consider, for example, that ambiguous variants are less often successfully assigned to any category relative to unambiguous variants (Wedel 2006). Such *variant pruning* removes some fraction of the ambiguous variants from the larger perception/production feedback loop, which increases the relative contribution of more contrastive variants to the category as it evolves both in individuals and within the larger speech community. This or any similar disadvantage in transmission of ambiguous variants relative to more contrastive variants is parallel to *niche selection* in biological evolution. Niche selection refers to the observation that species that occupy overlapping niches tend to quickly diverge under the influence of competition. This occurs because individuals that are specialized to the shared center of the niche suffer more competition, and therefore have lower reproductive rates than those specialized to the edges of the niche. The end result is *character displacement*, where subspecies diversify or radiate across ecological niches.

The proposed effect of the interlocking mechanisms described above can be summarized in terms of *Lexical Character Displacement* (8), where “contextual overlap between similar words” defines the conditions of lexical competition.<sup>18</sup>

#### (8) Lexical Character Displacement

Lexical Character Displacement occurs when contextual overlap between similar words leads to higher error rates in categorization for more ambiguous exemplars. This, in turn, leads to accentuation or retention of phonetic differences between similar words.

18. The analogy here is with ecological character displacement (Brown & Wilson 1956, Losos 2000). When two very similar species come into contact and resources are limited, there will be heavy competition, as with the well studied case of the Galápagos finches (Weiner 1994). This intense competition can result in competitive exclusion, or character displacement. Under character displacement, natural selection favors the individuals in each population whose phenotype allows them to use resources not used by others. A common result is that populations diverge in phenotype and resource use, reducing competition for resources and permitting coexistence. In the case of Darwin's ground finches, diversification of beak type is tied to distinct food sources.

Because it is causally driven by error in the process of categorization, Lexical Character Displacement will be mitigated to the extent that word-external disambiguation supports categorization accuracy.

In general, Lexical Character Displacement will be more common paradigm-internally than elsewhere. As noted earlier, paradigms contain phonologically similar words whose syntagmatic distributions often overlap. For many languages, where single inflected verbs constitute common phrases or utterances, these same inflected verbs are the locus of extreme lexical competition. As this discussion makes clear, the process of lexical character displacement is not equivalent to a blanket anti-homophony constraint. We claim no principle of grammar, or human knowledge, which specifically outlaws words that sound the same. Rather, in the course of language use, there is a real sense in which category competition plays a role in language change. It is this competition at the level of percept categorization which, we argue, gives rise to apparent inhibition of regular sound change where pernicious homophony would result.

Similarly, any factor that increases the contribution of more contrastive variants will promote greater contrast between two categories over time. For example, consider the case in which an independent form within a paradigm serves as an analogical model for the pre-change variant of one member of an incipient homophone pair. The existence of the analogical model may increase the proportion of pre-change variants of the incipiently homophonic form in performance, providing the mechanism identified here with additional fodder for lexical character displacement. An existing analogical model within a paradigm for a pre-change variant should in fact potentiate lexical character displacement, and conversely, cases of analogical restoration within paradigms may, at a mechanistic level, unfold via the general processes described here.

Disambiguation, however, whether by grammatical context, pragmatic context, or intonation contour, is not an all-or-nothing affair. Ambiguous pronunciations of homophonous or near-homophonous word pairs may be disambiguated nearly all the time by external factors, only some of the time, or rarely, as suggested in (9). In (9) we have picked an arbitrary ‘average’ mark, and suggested rough competition rates from our own knowledge of English grammar and usage. We expect that lexical competition rates will be highly variable across individuals, and contexts. For example, if one has never heard the name *Henk* before, then it will not be in obvious competition with *Hank* on first hearing. Or, consider the context of someone reciting a recipe, and saying, *then add two teaspoons of ...*, at which point ambiguity between *thyme* and *time* will be greatly reduced. What we mean to highlight in (9) is that lexical competition is a scalar variable. Though the effects we see in known cases of inhibited sound change point to extreme cases of competition as loci of variant trading and variant pruning, close studies of sound

change in progress may be able to track less extreme cases of competition as focal points for irregular or sporadic changes.<sup>19</sup>

(9) The scalar nature of lexical competition

Lexical Competition	Examples from English	External disambiguation
Extreme	<i>Hank</i> (name) vs. <i>Henk</i> (name)	Rare
Close to extreme	<i>can</i> (modal) vs. <i>can't</i> (modal)	Very uncommon
More than average	<i>rider</i> (noun) vs. <i>writer</i> (noun)	Uncommon
*Average	<i>thyme</i> (noun) vs. <i>time</i> (noun)	*Average
Less than average	<i>cot</i> (noun) vs. <i>caught</i> (verb)	More than average
Mild-None	<i>two</i> (numeral) vs. <i>too</i> (adverb)	Common

In this section we have suggested a model in which contrast and competition occur at multiple interacting levels. As phonetic categories move closer together, the degree of lexical competition in language use plays a greater role in category evolution. The proposed model makes no reference to a speaker's goals or intentions: in this model the listener's role is just as important as the speaker's in shaping sound patterns. While biological evolution is often used as a metaphor for language change, the extreme conditions which lead to sound change inhibition are viewed here as analogues of extreme competition and character displacement in the natural world. Inhibited mergers, as described for Dakelh and Banoni, are inhibited in certain contexts. Within this model, these contexts are those where lexical competition is greatest, and where exemplar-based categorization yields natural maintenance of category boundaries. Finally, while earlier approaches view homophony as an all or nothing matter, the model above is more nuanced: degrees of lexical competition may have different effects; the inhibition of sound change may be gradient across the lexicon; inhibited sound change may be pure, or may interact with other factors, as when inhibited sound change and analogy reinforce each other under Lexical Character Displacement.

#### 4. Further predictions of the model

In this section, we briefly explore two potential implications of Lexical Character Displacement (8), and provide examples that are consistent with these general accounts. Recall that under Lexical Character Displacement, differences be-

19. The scalar nature of lexical competition may be evident in Banoni. If lexical competition is more extreme between bare nouns and their first person possessed forms (5) than between the inflected transitive verbs pairs in (6), then we have the beginning of an explanation for the context-sensitive neutralization of verbs in (6) vs. (7), but the context-independent maintenance of contrast in nouns.

tween similar words are accentuated under extreme competition. In Dakelh and Banoni, the accentuation in question resulted in inhibition of a leniting sound change which applied elsewhere within the lexicon. Here we consider two other ways that this accentuation is expected to show itself in the evolution of sound systems. In the first case Lexical Character Displacement inhibits common trajectories of sound change altogether; all that is visible in the languages in question is an unusual contrast, which, in other languages with similar sound patterns, is typically neutralized. Support for this would come from unexpected stability of otherwise short-lived contrasts whose neutralization would result in homophony among strongly competing lexemes. Sounds patterns conforming to the model are illustrated in §4.1. A second prediction of the model is that rare, extreme phonetic contrasts may themselves emerge and be stabilized by Lexical Character Displacement. Support for this prediction would be a correlation between rare, extreme phonetic features and high functional loads for these features in lexical disambiguation. Examples of such correlations are discussed in §4.2.

#### 4.1 Non-occurring sound change as inhibited sound change

A well known feature of sound change is its stochastic nature. Though we can provide inventories of recurrent sound changes and demonstrate their phonetic bases, we cannot predict precisely when and where a particular sound change will occur. Nonetheless, typological studies of sound patterns and sound change have provided us with a rich set of correlations between particular initial states and subsequent changes, allowing us to hypothesize about causes of sound change, including phonetic factors discussed §2. Just as we may ask what factors are positively associated with a particular sound change, we may also ask if any factors are negatively associated with the same. Are there recurrent cases where all phonetic preconditions for a particular sound change are met, but the change fails globally? Here we suggest that when all or most instances of a particular contrast carry a disambiguating role in strongly competing lexemes, Lexical Character Displacement could inhibit global change of that particular contrast.

As with instances of inhibited sound change (2), we suggest preliminary heuristics for identifying a potentially non-occurring sound change in (10).

- (10) Non-occurring sound change as inhibited sound change: some heuristics
- The sound change in question is regular and exceptionless in at least one other language.
  - The sound change has a well understood phonetic basis.
  - The sound change is frequent cross-linguistically when its conditions are met.

- Its conditions are met in this language.
- If the sound change applied in this language, ambiguity under homophony could result.

One sound change that can be identified as regular and exceptionless in other languages (10a) is initial obstruent degemination. In many languages where geminate obstruents occurred historically in word-initial position, they have undergone degemination (Hock 1991: 89, 163–164).<sup>20</sup> Munsee, an Algonquian language, shows this development (Goddard 1982).

(11) Initial syncope plus degemination in Munsee (Goddard 1982)

Proto-Algonquian	Munsee
a. *wetehkwanī	wtohwan “branch”
b. *keʔθemya	kxəm “your daughter-in-law”
c. *petekwesiwa	ptəkwsəw “he is round”
d. *nepentawa:wa	m̄pəntawa:w “I hear him”
e. *kəkawi: (P.-Eastern Alg.)	kawi “you sleep” (<*kkawi)
f. *papak-	pake:w “it is flat” (<*ppake:w)
g. *nene:me	ne:m “I see (it)” (<*nne:m)
h. *ne:mwa	ne:m “he sees (it)” (<*nne:mw)

Unstressed Proto-Algonquian \*e has been lost in initial syllables yielding consonant clusters (11a–d). If the resulting clusters are geminates, they undergo degemination (11e–h). A perceptual explanation for initial degemination, in particular for voiceless stops, is suggested in Blevins (2004: 181–183). Voiceless geminate vs. singleton stop contrasts are cued primarily by closure duration, and durational differences are difficult to perceive utterance initially, and after other stops. The lack of consistent perceptual cues results in category merger over time.

In contrast to languages like Munsee, more than a dozen Austronesian languages have lost unstressed vowels between identical consonants, but none shows regular word-initial degemination (Blust 1990, Blust 2007). In some of these languages, initial geminates are the only consonant clusters attested, making the sound pattern even more remarkable. Is the lack of word-initial degemination in Austronesian languages simply an instance of the unpredictable nature of sound change? Or could its absence across the family be significant and indicative of interacting factors? We suggest that it may be significant, and that it may be another instantiation of Lexical Character Displacement. Our hypothesis is based on two features of initial geminates in most Austronesian languages. First, in nearly all cases, these geminates evolve from earlier productive CV-reduplication via unstressed vowel

20. Initial geminates may also be the historical target of pre-cluster epenthesis, as in some Arabic and Berber dialects.

loss (Blust 1990, 2007). Second, this CV-reduplication was meaningful, indicating plurality, pluractionality, intensity, emphasis, or the like. As a consequence, vowel loss gave rise to minimal word pairs across the relevant languages. These minimal pairs define paradigms, albeit simple ones consisting of word pairs where one contains an initial singleton, the other an initial geminate.

In (12) we illustrate with data from Proto-Polynesian and Nukuoro, a daughter language showing the evolution of initial geminates. The pairs in (12) are representative: many other word pairs in Nukuoro illustrate a geminate singleton contrast associated with verbal emphasis: e.g., *pono* “to close”, *ppono* “to block”; *kati* “bite”, *kkati* “bite hard”, etc. (Carroll & Soulik 1973).

- (12) Initial geminate evolution in Austronesian: CV-reduplication + syncope (Blust 2007: 15)

Proto-Polynesian	Nukuoro
*piki	piki “caught between 2 or more things, close to”
*pi-piki	ppiki “stuck” (emphatic)
*tuki	tuki “punch, hit, strike”
*tu-tuki	ttuki “to pound” (emphatic)
*kini	kini “pick up w/ fingers, pinch off”
*ki-kini	kkini “pick up or pinch at one time” (emphatic)
*mahaki	maki “sick”
*ma-mahaki	mmaki “sick (plural)”

Since forms like *maki* “sick” and *mmaki* “sick (plural)” compete lexically, our model predicts inhibition of initial degemination. The central difference between cases of inhibited sound change in Dakelh, Banoni, and Nukuoro is that in Nukuoro there are few (if any) initial geminates which *do not* compete lexically with near-homophonous non-geminate forms. As a consequence, the inhibiting effects of degemination are the only ones visible throughout the lexicon.<sup>21</sup>

Lexical Character Displacement predicts the inhibition of sound changes like initial degemination under extreme lexical competition. Given this, it is possible to view geminate maintenance, like that found in many Austronesian languages, as an extreme case of sound change inhibition. Because the geminate/singleton contrast in these languages is the sole realization of a morphosyntactic contrast between non-emphatic/emphatic, singular/plural, repetitive/non-repetitive, etc. pairs, near-homophonous word pairs like the Nukuoro ones in (12) are in direct

21. The realization of the contrast between geminate/non-geminate need not remain a durational one. In Kapingamarangi, a Polynesian outlier closely related to Nukuoro, cognate geminates are sometimes described as aspirated. Our purpose here is to highlight contrast maintenance of a (historical) geminate/non-geminate contrast, and the global absence of contrast neutralization.

competition, overlapping in syntagmatic and discourse contexts. It is this lexical competition which appears to result in the global inhibition of degemination in Nukuoro, and all other Austronesian languages which have undergone similar unstressed vowel syncope leading to initial geminate/non-geminate contrasts.

#### 4.2 Lexical character displacement and extreme contrast

In our discussion of Banoni above, we noted an interesting potential consequence of inhibited sound change. If vowel length neutralization in Banoni applies everywhere except in possessive paradigms and transitive verb paradigms, a skewed distributional sound pattern results. Vowel length is contrastive only in small corners of the grammar where it has a high functional load. Lexical Character Displacement predicts that in these same small corners of grammar, accentuation of phonetic differences should occur, resulting in rare or extreme types of contrasts under similar conditions. Rare or extreme phonological contrasts are those that approach the limits of articulatory complexity and/or perceptual contrast: three-way vowel length contrasts, three-way nasalization contrasts, and maybe even the word-initial contrast between long and short /p/, /t/, and /k/ noted for Nukuoro above (Blevins 2004: 204–208).

As with inhibited sound change, heuristics are suggested for the identification of extreme contrast as a consequence of Lexical Character Displacement. These are set out in (13)

- (13) Extreme contrasts under lexical competition: some heuristics
- The contrast is rare or non-existent in other languages.
  - There is a common sound change which could neutralize the contrast.
  - If the sound change applied in this language, pernicious homophony would result.

In exploring the possibility of such distributional patterns, it has been most useful to start with rare or extreme phonological contrasts, and to work backwards. We illustrate here with the case of Estonian quantity. Estonian is well known for its unusual three-way quantity contrast (Tauli 1954, Eek 1986, Lehiste 1997, Ehala 2003). A unique property of this quantity contrast is that it is not located in a segment or even a single syllable. Rather, the contrast between Q2 and Q3 appears to be relevant for disyllabic sequences of stressed syllable + syllable.<sup>22</sup> While there is some debate as to whether three degrees of quantity are found in other Finno-

22. If these stressed syllables are spliced, and presented alone, native speakers are unable to accurately distinguish Q2 from Q3 (Eek & Meister 1997).



Lappic languages (e.g., Saami, Livonian), no other known language outside of this small group is described with a similar contrast (13a).<sup>23</sup>

Some examples of the three-way quantity contrast in Estonian are shown in (14), where orthographic doubling of a vowel or consonant in the first heavy syllable marks lengthened segments under Q2/Q3 prosodies, and a preceding grave accent (‘) marks a disyllabic Q3 sequence. Though quantity is orthographically marked on the initial syllable it should be kept in mind that one unique property of this system is the domain of contrast: Q1, Q2 and Q3 contrast only in disyllabic sequences where the first syllable is stressed.

- (14) Estonian three-way quantity (Q) contrast
- |   |                |                          |
|---|----------------|--------------------------|
| Q1 occurs in short (CV) stressed syllables: | <i>koli</i>    | “junk”                   |
| Q2 in long (CVV, CVC) stressed syllables:   | <i>kooli</i>   | “school, genitive sg.”   |
|   | <i>kolli</i>   | “bogyman, genitive sg.”  |
| Q3 in long (CVV, CVC) stressed syllables:   | ‘ <i>kooli</i> | “school, partitive sg.”  |
|   | ‘ <i>kolli</i> | “bogyman, partitive sg.” |

The evolutionary origins of the quantity distinction are debated. Here, we follow Ehala (2003), but any account which predicts the limited distribution of the Q2/Q3 contrast in the modern language would do. Under Ehala’s account, loss of the partitive case ending \*-a resulted in phonologization of (previously) subphonemic quantity alternations including grade and vowel length, as schematized in (15), where superscripted characters represent prosodic shortening leading to the evolution of the Q2/Q3 quantity contrast.

- (15) Phonologization of extreme contrast: Estonian quantity (following Ehala 2003)
- | genitive  | partitive   | gloss    |
|---|---|----------|
| *konn <sup>h</sup> an > ko <sup>h</sup> nan > ko <sup>h</sup> na (Q2) | *konn <sup>h</sup> ata > konna <sup>h</sup> > konna (Q3)  | “frog”   |
| *mets <sup>h</sup> an > me <sup>h</sup> san > me <sup>h</sup> sa (Q2) | *mets <sup>h</sup> ata > metsaa <sup>h</sup> > metsa (Q3) | “forest” |
| *loom <sup>h</sup> an > lo <sup>h</sup> man > lo <sup>h</sup> ma (Q2) | *loom <sup>h</sup> ata > loomaa <sup>h</sup> > looma (Q3) | “animal” |
| *laul <sup>h</sup> un > la <sup>h</sup> lun > la <sup>h</sup> lu (Q2) | *laul <sup>h</sup> uta > laulua <sup>h</sup> > laulu (Q3) | “song”   |

The central question is why apparent shortening yielding Q2 in (15) did not result in neutralization to a common two-way length contrast (13b). As with the Dakelh and Banoni examples above, we see phonological contrast maintenance within the context of paradigm-internal contrast (13c): neutralization to a simple two-way quantity distinction would result in homophony of many genitive and partitive nouns. The discussion of Estonian *n*-loss in §1 makes it clear that sound

23. Three degrees of vowel length are found in Dinka, a Nilotic language (Remijsen & Gilley 2008), in Coatlan/San José El Paraíso Mixe (Hooghegen 1959), a Mixe-Zoquean language, and in Yavapai, a Yuman language (Thomas 1990). In these languages the domain of quantity is the segment or syllable, not a disyllabic domain, as in Estonian.

change can, and indeed, often does lead to homophony. At the same time, it seems likely that a proper definition of lexical competition along the lines sketched in §3 may allow us to better understand the evolution and distribution of rare features like the Estonian third quantity.

## 5. Summary

In this paper we have offered empirical and theoretical findings on the nature of sound change, and integrated them with earlier results in the study of variation, typology, computational linguistics, and evolutionary theory. It has been claimed in the past that certain regular sound changes are inhibited by anti-homophony constraints. We have integrated these earlier findings into a complex model of sound change where phonetic, structural, analogical, lexical and/or social factors can interact. Within this integrated model, inhibited sound changes are classified as ‘pure’ when the effects of anti-homophony are the only ones which play a clear role in sound change inhibition. Where other effects like analogy and independent sound changes are also involved, sound change inhibition is ‘impure’. In both cases, as well as others, where the effects of inhibition are masked or lost, we associate these effects with Lexical Character Displacement (8), a concrete proposal associating direct lexical competition with maintenance or accentuation of phonetic differences between the words involved.

In §2, two cases of pure inhibited sound change were described for Dakelh and Banoni. In both cases, a phonetically motivated sound change was seen to sweep through the lexicon, but was deflected by the effects of heightened contrast under lexical competition. Historical syncope appear to be particularly sensitive to these effects, exemplified here by the case of Dakelh, but other sound changes, like vowel length neutralization in Banoni, may show a similar sensitivity. Impure instances of inhibited sound change were reviewed in 2.3, including the well known textbook cases from Greek and Estonian. Overall, the empirical record is as expected: the multi-factorial nature of sound change makes a single factor like lexical competition difficult to isolate, though its effects are visible even when other factors like analogy are involved.

In §3, we offered a theoretical model of sound change inhibition which is both more concrete and more general than earlier proposals. Under this model, sound change is viewed in the context of category evolution. The starting point for sound changes involving vowel syncope and vowel length neutralization are variations in vowel duration along the hyper-to-hypoarticulation continuum. Our model incorporates this kind of detailed variation, and tracks its ongoing contribution to category maintenance across time. Where word-level competition is fierce, we

see clear effects of variant trading and pruning: exemplars which are ambiguous between competing words fail to contribute to their original category, resulting in general movement of the two categories away from each other.

The model is more specific than earlier accounts in highlighting three ingredients that must be present to see sound change inhibition effects: variation along the hyper-to-hypoarticulation continuum; category shifts due to this variation; and extreme lexical competition, which, in many cases is associated with the absence of external cues for lexeme identification. Further specifics involve our ability to simulate the model, and show what sorts of effects result if degrees of noise, memory decay, trading, etc. are varied. The variation-dependence of the model may account for its strong association with processes like unstressed vowel syncope, which are known to be lexically gradient (Bybee 2001). On the other hand, sound changes like nasal-place assimilation, with primary perceptual bases, are expected to dissociate with inhibition, since the role of variation is minimal (Blevins 2004: 31–44).

The model is more general than earlier anti-homophony accounts because there is no reference to homophony *per se*. Variation, competition and ambiguity are present at many different linguistic levels, so that, in principle, the same sort of model might be able to explain contrast maintenance in intonation contours, inhibition of near-mergers, and other apparent anti-homophony effects. At the same time, since the model is not focused on properties of ‘sound change’ as a phenomenon, but rather on how words and categories change over time, a unified account of inhibited sound change, non-occurring sound change, and the evolution of extreme contrasts is possible.

Whether this unified account can be verified will depend in large part on augmenting the empirical database. In addition to offering examples of inhibited sound change and a model of Lexical Character Displacement, we have suggested useful heuristics for identifying more examples of this kind in natural language data, and have provided software which simulates the evolutionary developments and complex trading relationships we suggest. As the empirical basis of our studies grows, so will our understanding of sound change in all its complexity and splendor, and our ability to factor a single sound change into its interacting component parts.

## References

- Aitken, Adam J. 1981. “The Scottish vowel-length rule”. *So Meny People, Longages and Tonges* ed. by Michael Benskin & Margaret L. Samuels, 131–157. Edinburgh: Middle English Dialect Project.
- Alpher, Barry. 2004. “Pama-Nyungan: Phonological reconstruction and status as a phylogenetic group”. *Australian Languages: Classification and the comparative method* ed. by Claire Bowern & Harold Koch, 93–126. Amsterdam: John Benjamins.
- Alvre, Paul. 1967. “On the Baltic-Fennic dative”. *Soviet Fenno-Ugric Studies* 3.171–181.
- Anttila, Raimo. 1972. *An Introduction to Historical and Comparative Linguistics*. New York: MacMillan.
- Baayen, R. Harald. 2007. “Storage and computation in the mental lexicon”. *The Mental Lexicon: Core perspectives* ed. by Gonia Jarema & Gary Libben, 81–104. New York: Elsevier.
- Berman, Howard. 1982. “Two phonological innovations in Ritwan”. *International Journal of American Linguistics* 48.412–420.
- Blevins, James P. & Juliette Blevins, eds. 2009. *Analogy in Grammar: Form and acquisition*. Oxford: Oxford University Press.
- Blevins, Juliette. 2003. “One case of contrast evolution in the Yurok vowel system”. *International Journal of American Linguistics* 69.135–150.
- Blevins, Juliette. 2004. *Evolutionary Phonology: The emergence of sound patterns*. Cambridge: Cambridge University Press.
- Blevins, Juliette. 2005a. “Understanding antigemination”. *Linguistic Diversity and Language Theories* ed. by Zygmunt Frajzyngier, David Rood, & Adam Hodges, 203–234. Amsterdam: John Benjamins.
- Blevins, Juliette. 2005b. “Yurok verb classes”. *International Journal of American Linguistics* 71.327–349.
- Blevins, Juliette. 2006. “A theoretical synopsis of Evolutionary Phonology”. *Theoretical Linguistics* 32.117–166.
- Blevins, Juliette. 2008a. “Consonant epenthesis: Natural and unnatural histories”. *Language Universals and Language Change* ed. by Jeff Good, 79–107. Oxford: Oxford University Press.
- Blevins, Juliette. 2008b. “Phonetic explanation without compromise: The evolution of Mussau syncope”. *Diachronica* 25.1–19.
- Blevins, Juliette & John Lynch. 2009. “Morphological conditions on regular sound change? A reanalysis of \*l-loss in Paamese and Southeast Ambrym”. *Oceanic Linguistics* 48.1.
- Bloomfield, Leonard. 1933. *Language*. New York: Holt.
- Blust, Robert. 1990. “Three recurrent changes in Oceanic languages”. *Pacific Island Languages: Essays in honour of G. B. Milner* ed. by Jeremy H.C.S. Davidson, 7–28. London: School of Oriental and African Studies.
- Blust, Robert. 1995. “Austronesian comparative dictionary”. Computer files. University of Hawaii, Honolulu.
- Blust, Robert. 1996. “The neogrammarian hypothesis and pandemic irregularity”. *The Comparative Method Reviewed: Regularity and irregularity in language change* ed. by Mark Durie & Malcolm Ross, 135–156. Oxford: Oxford University Press.
- Blust, Robert. 2005. “Must sound change be linguistically motivated?” *Diachronica* 22.219–269.
- Blust, Robert. 2007. “Disyllabic attractors and anti-antigemination in Austronesian sound change”. *Phonology* 24.1–36.
- Borowsky, Toni & Mark Harvey. 1997. “Vowel-length in Warray and weight identity”. *Phonology* 14.161–175.
- Brown, W. L. & E. O. Wilson. 1956. “Character displacement”. *Systematic Zoology* 5.49–65.
- Bybee, Joan L. 2001. *Phonology and Language Use*. Cambridge: Cambridge University Press.
- Bybee, Joan. 2002. “Word frequency and context of use in the lexical diffusion of phonetically conditioned sound change”. *Language Variation and Change* 14.261–290.

- Campbell, Lyle. 1974. "On conditions on sound change". *Historical Linguistics: Proceedings of the First International Conference on Historical Linguistics* ed. by John Anderson & Charles Jones, 88–95. Amsterdam: John Benjamins.
- Campbell, Lyle. 1996. "On sound change and challenges to regularity". *The Comparative Method Reviewed: Regularity and irregularity in language change* ed. by Mark Durie & Malcolm Ross, 72–89. Oxford: Oxford University Press.
- Campbell, Lyle. 1998. *Historical Linguistics: An introduction*. Edinburgh: University of Edinburgh Press.
- Campbell, Lyle & Jon Ringen. 1981. "Teleology and the explanation of sound change". *Phonologica* ed. by Wolfgang Dressler, Oskar E. Pfeiffer, & John R. Rennison, 57–68. Innsbruck: Innsbrucker Beiträge zur Sprachwissenschaft.
- Carroll, Vern & Tobias Soulik. 1973. *Nukuoro Lexicon*. Honolulu: University Press of Hawaii.
- Cox, Felicity & Sallyanne Palethorpe. 2008. "Nasalization of /ae/ and sound change in Australian English". Paper presented at Laboratory Phonology 11, Wellington, New Zealand, June 30 — July 2, 2008.
- Crosswhite, Katherine. 1999. "Inter-paradigmatic homophony avoidance in two dialects of Slavic". *UCLA Working Papers in Linguistics 1: Papers in Phonology* 2.48–67.
- Crowley, Terry. 1997. *An Introduction to Historical Linguistics*. 3rd ed. Oxford: Oxford University Press.
- De Boer, Bart. 2001. *The Origins of Vowel Systems*. Oxford: Oxford University Press.
- Durie, Mark. 1996. "Early Germanic umlaut and variable rules". *The Comparative Method Reviewed: Regularity and irregularity in language change* ed. by Mark Durie & Malcolm Ross, 112–134. Oxford: Oxford University Press.
- Eek, Arvo. 1986. "Problems of Estonian word prosody". *Estonian Papers in Phonetics* 1984–85.13–66.
- Eek, Arvo & Einar Meister. 1997. "Simple perception experiments on Estonian word prosody". *Estonian Prosody: Papers from a symposium* ed. by Ilse Lehiste & Jaan Ross, 71–99. Tallinn: Eesti Keele Instituut.
- Ehala, Martin. 1996. "Self-organization and language change". *Diachronica* 13.1–28.
- Ehala, Martin. 2003. "Estonian quantity: Implications for moraic theory". *Generative Approaches to Finnic and Saami Linguistics* ed. by Diane Nelson & Satu Manninen, 51–79. Palo Alto: CSLI Publications.
- Eisner, Frank & James M. McQueen. 2005. "The specificity of perceptual learning in speech processing". *Perception and Psychophysics* 67.224–238.
- Ettlinger, Marc. 2007. "Shifting categories: An exemplar-based computational model of chain shifts". *Proceedings of the 29th Annual Conference of the Cognitive Science Society* ed. by Danielle S. McNamara & J. Greg Tafton, 239–244. Austin, Texas: Cognitive Science Society.
- Ferguson, Charles A. 1990. "From esses to aitches: Identifying pathways of diachronic change". *Studies in Typology and Diachrony* ed. by William Croft, Keith Denning, & Suzanne Kemmer, 59–78. Amsterdam: John Benjamins.
- Gahl, Susanne & Alan Yu. 2006. "Introduction to the special issue on exemplar-based models in linguistics". *The Linguistic Review* 23.213–216.
- Garrett, Andrew & Juliette Blevins. 2009. "Analogical morphophonology". *The Nature of the Word: Studies in honor of Paul Kiparsky* ed. by Kristin Hanson & Sharon Inkelas, 527–545. Cambridge, MA: MIT Press.

- ~~Georgeopoulos, A.P., A.B. Schwartz, & R.E. Ketter~~. 1986. "Neuronal population coding of movement direction". *Science* 233.1416–1419
- Gessner, Suzanne. 2003. *The Prosodic System of the Dakelh (Carrier) Language*. PhD dissertation, University of British Columbia.
- Gessner, Suzanne & Gunnar Hansson. 2004. "Anti-homophony effects in Dakelh (Carrier) Valence Morphology". *Proceedings of Berkeley Linguistic Society* 30 ed. by Marc Ettlinger, Nicholas Fleischer, & Mischa Park-Doob, 93–104. Berkeley: Berkeley Linguistics Society.
- Goddard, Ives. 1982. "The historical phonology of Munsee". *International Journal of American Linguistics* 48.16–48.
- Goddard, Ives. 2007. "Phonetically unmotivated sound change". *Verba Docenti: Studies in historical and Indo-European linguistics presented to Jay H. Jasanoff by students, colleagues and friends* ed. by Alan J. Nussbaum, 115–130. Ann Arbor: Beech Stave Press.
- Goldinger, Stephen D. 1996. "Words and voices: Episodic traces in spoken word identification and recognition memory". *Journal of Experimental Psychology: Learning Memory and Cognition* 22.5.1166–1182.
- Goldinger, Stephen D. 2000. "The role of perceptual episodes in lexical processing". *Proceedings of SWAP Spoken Word Access Processes* ed. by Anne Cutler, James M. McQueen & Rian Zondervan, 155–159. Nijmegen: Max-Planck-Institute for Psycholinguistics.
- Greenhill, Simon J., Robert Blust, & Russell D. Gray. 2005–2007. *The Austronesian Basic Vocabulary Database*. <http://language.psy.auckland.ac.nz/austronesian>.
- Guenther, Frank H. & Marin N. Gjaja. 1996. "The perceptual magnet effect as an emergent property of neural map formation". *Journal of the Acoustic Society of America* 100.1111–1121.
- Guy, Gregory. 1996. "Form and function in linguistic variation". *Towards a Social Science of Language: Papers in honor of William Labov. Vol. 1: Variation and change in language and society* ed. by Gregory R. Guy, Crawford Feagin, Deborah Schiffrin, & John Baugh, 221–252. Amsterdam: John Benjamins.
- Guy, Gregory R. 2003. "Variationist approaches to phonological change". *The Handbook of Historical Linguistics* ed. by Brian D. Joseph & Richard D. Janda, 369–400. Oxford: Blackwell.
- Hajek, John. 1997. *Universals of Sound Change in Nasalization*. (= *Publications of the Philological Society* 31.) Oxford: Blackwell.
- Hall, Robert A., Jr. 1976. *Proto-Romance Phonology*. New York: Elsevier.
- Han, Mieko. 1964. *Duration of Korean Vowels*. Los Angeles: University of Southern California Press.
- Hock, Hans Henrich. 1991. *Principles of Historical Linguistics*, 2nd ed. Berlin: Mouton.
- Hoogshagen, Searle. 1959. "Three contrastive vowel lengths in Mixe". *Zeitschrift für Phonetik und allgemeine Sprachwissenschaft* 12.111–115.
- Ichimura, Larry. 2006. *Anti-homophony Blocking and its Productivity in Transparadigmatic Relations*. PhD dissertation, Boston University.
- Jannedy, Stefanie & Jennifer Hay. 2006. "Modeling sociophonetic variation". *Journal of Phonetics* 34.405–408.
- Johnson, Keith. 1997. "Speech perception without speaker normalization". *Talker Variability in Speech Processing* ed. by Keith Johnson & John W. Mullennix, 145–165. San Diego: Academic Press.
- Joseph, Brian D. & Richard D. Janda. 1988. "The how and why of diachronic morphologization and demorphologization". *Theoretical Morphology: Approaches in modern linguistics* ed. by Michael Hammond & Michael Noonan, 193–213. San Diego: Academic Press.

- Jun, Sun-Ah. 1998. "The accentual phrase in the Korean prosodic hierarchy". *Phonology* 15.189–226.
- Kettunen, Lauri. 1929. *Eestin kielen äännehistoria*. (= SKST 156.) Helsinki: Suomalaisen kirjallisuuden seura.
- Kiparsky, Paul. 1965/1971. *Phonological Change*. PhD dissertation, MIT. Distributed by Indiana University Linguistics Club, 1971.
- Kiparsky, Paul. 1972. "Explanation in phonology". *Goals of Linguistic Theory* ed. by Stanley Peters, 189–227. Englewood Cliffs, NJ: Prentice-Hall.
- Kuhl, Patricia K. 1991. "Human adults and human infants show a 'perceptual magnet effect' for the prototypes of speech categories, monkeys do not". *Perception and Psychophysics* 50.93–107.
- Krauss, Michael E. 1964. "Proto Athapaskan-Eyak and the problem of Na-Dene". *International Journal of American Linguistics* 30.118–131.
- Krauss, Michael E. 1965. "Eyak: A preliminary report". *Canadian Journal of Linguistics* 10.167–187.
- Krauss, Michael E. 1969. "On the classification in the Athapaskan, Eyak, and the Tlingit verb". *International Journal of American Linguistics Supplement* 35:4.49–83.
- Labov, William. 1994. *Principles of Linguistic Change, Vol. 1: Internal factors*. Oxford: Blackwell.
- Labov, William & Maciej Baranowski. 2006. "50ms". *Language Variation and Change* 18.223–240.
- PhD Leer, Jeff. 1991. *The Schetic Categories of the Tlingit Verb*. PhD dissertation, University of Chicago.
- Lehiste, Ilse. 1997. "Search for phonetic correlates in Estonian prosody". *Estonian Prosody: Papers from a symposium* ed. by Ilse Lehiste & Jaan Ross, 11–33. Tallinn: Institute of Estonian Language.
- Lincoln, Peter Craig. 1976a. *Describing Banoni, an Austronesian Language of Southwest Bougainville*. PhD dissertation, University of Hawai'i.
- Lincoln, Peter Craig. 1976b. "Banoni, Piva and Papuanization". *Papers in New Guinea Linguistics* No. 19 ed. by Ger P. Reesink, Lillian Fleischmann, Sinikka Turpeinen & Peter C. Lincoln, 77–105. Canberra: Pacific Linguistics.
- Losos, Jonathan B. 2000. "Ecological character displacement and the study of adaptation". *Proceedings of the National Academy of Sciences* 97:11.5693–5695.
- Luschützky, Hans Christian. 2004. "Voices from the past: A diachronic perspective on voicing". *Folia Linguistica* 38.157–182.
- Lynch, John & Malcolm Ross. 2002. "Banoni". *The Oceanic Languages* 440–456 ed. by John Lynch, Malcolm Ross, & Terry Crowley. Richmond: Curzon.
- Lyovin, Anatole. 1977. "Sound change, homophony, and lexical diffusion". *The Lexicon in Phonological Change* ed. by William S.-Y. Wang, 120–132. The Hague: Mouton.
- Maclagan, Margaret & Jennifer Hay. 2007. "Getting fed up with our feet: Contrast Maintenance and the New Zealand English 'short' front vowel shift". *Language Variation and Change* 19.1–25.
- McCarthy, John J. 1986. "OCP effects: Gemination and antigemination". *Linguistic Inquiry* 17.207–263.
- Myers, Scott & Benjamin Hansen. 2005. "The origin of vowel length neutralization in vocoid sequences: Evidence from Finnish speakers". *Phonology* 22.317–344.
- Myers, Scott & Benjamin Hansen. 2007. "Neutralization of vowel length contrasts in final position". *Natural Language and Linguistic Theory* 25.157–193.
- Newman, John. 1996. "Footnotes to a history of Cantonese: Accounting for the phonological irregularities". *The Comparative Method Reviewed: Regularity and irregularity in language change* ed. by Mark Durie & Malcolm Ross, 90–111. Oxford: Oxford University Press.
- Niyogi, Partha. 2006. *The Computational Nature of Language Learning and Evolution*. Cambridge, MA: MIT Press.
- Öhmann, Emil. 1934. "Über Homonymie und Homonyme im Deutschen". *Suomalaisen Tiedakatemian Toimituksia*, Series B 32.1–143.
- Osthoff, Hermann & Karl Brugmann. 1878. *Morphologische Untersuchungen auf dem Gebiete der indogermanischen Sprachen*. Vol. 1. Leipzig: S. Hirzel.
- Oudeyer, Pierre-Yves. 2002. "Phonemic encoding might be a result of sensory-motor coupling dynamics". *Proceedings of the 7th International Conference on the Simulation of Adaptive Behavior* ed. by Bridget Hallam, Dario Floreano, John Hallam, Gillian Hayes, & Jean-Arcady Meyer, 406–416. Cambridge, Mass.: MIT Press.
- Oudeyer, Pierre-Yves. 2006. *Self-organization in the Evolution of Speech*. Oxford: Oxford University Press.
- Pajusalu, Karl. 2003. "Estonian dialects". *Estonian Language* ed. by Mati Ereht, 231–272. (= *Linguistica Uralica, Supplementary Series* I.) Tallinn: Estonian Academy Publishers.
- Paul, Hermann. 1880/1920. *Prinzipien der Sprachgeschichte*. 5th ed. Halle: Niemeyer.
- Pierrehumbert, Janet. 2001. "Exemplar dynamics, word frequency, lenition, and contrast". *Frequency Effects and the Emergence of Linguistic Structure* ed. by Joan Bybee & Paul Hopper, 137–157. Amsterdam: John Benjamins.
- Pierrehumbert, Janet. 2002. "Word-specific phonetics". *Laboratory Phonology VII* ed. by Carlos Gussenhoven, Tanya Rietvelt & Natasha Warner, 101–139. Berlin: Mouton de Gruyter.
- Pierrehumbert, Janet. 2003. "Probabilistic phonology: Discrimination and robustness". *Probabilistic Linguistics* ed. by Rens Bod, Jennifer Hay, & Stefanie Jannedy, 177–228. Cambridge, MA: The MIT Press.
- Pierrehumbert, Janet. 2006. "The next toolkit". *Journal of Phonetics* 34.516–530.
- Poser, William J. 1999. "Features of Carrier dialects". Ms., University of Pennsylvania and Yinka Déné Language Institute.
- Poser, William J. 2000. "D-Effect related phenomena in Southern Carrier". Paper presented at the *Annual Meeting of SSILA*, 7 January 2000, Chicago, Illinois.
- Pulgram, Ernst. 1975. *Latin-Romance Phonology: Prosodics and metrics*. Munich: Fink.
- Rankin, Robert L. 2003. "The comparative method". *The Handbook of Historical Linguistics* ed. by Brian D. Joseph & Richard D. Janda, 183–212. Oxford: Blackwell.
- Raun, Alo & Andrus Saareste. 1965. *Introduction to Estonian Linguistics*. Wiesbaden: Harrassowitz.
- Remijsen, Bert & Leoma Gilley. 2008. "Why are three-level vowel length systems rare? Insights from Dinka (Luanyjang dialect)". *Journal of Phonetics* 36.318–344.
- Ritt, Nikolaus. 2004. *Selfish Sounds and Linguistic Evolution: A Darwinian approach to language change*. Cambridge: Cambridge University Press.
- Rolfe, John C. 1922. "The use of devices for indicating vowel length in Latin". *Proceedings of the American Philosophical Society* 61.80–98.
- Ross, Malcolm. 1998. "Proto-Oceanic phonology and morphology". *The Lexicon of Proto-Oceanic: The culture and environment of ancestral Oceanic society, 1 Material Culture* ed. by Malcolm Ross, Andrew Pawley, & Meredith Osmond, 15–35. (= *Pacific Linguistics* C-152.) Canberra: The Australian National University.

- Ross, Malcolm, Andrew Pawley, & Meredith Osmond, eds. 1998. *The Lexicon of Proto Oceanic: The culture and environment of ancestral Oceanic society, 1 Material Culture*. (= *Pacific Linguistics* C-152.) Canberra: The Australian National University.
- Sankoff, Gillian & Hélène Blondeau. 2007. "Language change across the lifespan: /r/ in Montreal French". *Language* 83.560–588.
- Schuchardt, Hugo. 1885. *Über die Lautgesetze: Gegen die Junggrammatiker*. Berlin: Oppenheim. [Reprinted and translated in Theo Vennemann & Terence Wilbur. [1972]. *Schuchardt, the Neogrammarian and the Transformational Theory of Phonological Change*. Frankfurt: Athenaum.]
- Sproat, Richard. 2008. "Experiments in morphological evolution". Keynote address. 3rd Workshop on Quantitative Investigations in Theoretical Linguistics, Helsinki.
- Tauli, Valter. 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". *The Journal of the Acoustical Society of America* 88:1.53.
- Trask, Robert L. 2000. *The Dictionary of Historical and Comparative Linguistics*. Edinburgh: Edinburgh University Press.
- Tucker, R. Whitney. 1969. "Chronology of Greek sound changes". *The American Journal of Philology* 90.36–47.
- Vihman, Marilyn. 1976. "Loss of -n in Livonian: A persistent change"? *International Journal of American Linguistics* 42.65–89.
- Viitso, Tiit-Rein. 2003. "Rise and development of the Estonian language". *Estonian Language* ed. by Mati Ereht, 130–230. (= *Linguistica Uralica: Supplementary series* I.) Tallin: Estonian Academy Publishers.
- Warner, Natasha, Allard Jongman, Joan Sereno, & Rachèl Kemps. 2004. "Incomplete neutralization and other sub-phonemic durational differences in production and perception: Evidence from Dutch". *Journal of Phonetics* 32.251–276.
- Wedel, Andrew. 2004. "Category competition drives contrast maintenance within an exemplar-based production/perception loop". *Proceedings of the Seventh meeting of the ACL Special Interest Group in Computational Phonology*, ed. by John Goldsmith & Richard Wicentowski, 1–10. Association for Computational Linguistics, Barcelona, Spain, July 2004.
- Wedel, Andy. 2006. "Exemplar models, evolution and language change". *The Linguistic Review* 23.247–274.
- Wedel, Andy. 2007. "Feedback and regularity in the lexicon". *Phonology* 24.147–185.
- Weiner, Jonathan. 1994. *The Beak of the Finch: A story of evolution in our time*. New York: Knopf.
- Yu, Alan C. L. 2007. "Understanding near mergers: The case of morphological tone in Cantonese". *Phonology* 24.187–214.

## Résumé

L'étude des changements phonologiques normaux révèle nombre d'exceptions. On étudie ici un type de changement qui semble régulier à première vue, mais qui ne s'applique pas s'il s'ensuit de l'homophonie. On revoit les cas les plus connus, et on en présente des nouveaux. Si la menace de l'homophonie empêche le changement, comment comprendre et représenter cet état

des choses? Nous offrons ici un modèle de changement phonologique qui inclut la compétition entre lexèmes. Ce modèle prévoit que seront accentuées les différences entre mots lorsque le contexte ne permet pas de lever l'ambiguïté. En ce cas le fait de les accentuer bloque le changement phonologique. Qui plus est, comme nous le montrons, ce même principe peut mettre fin au changement phonologique en toutes circonstances, ou aboutir à des oppositions phonologiques plus poussées dans des conditions semblables.

## Zusammenfassung

Die Untersuchung von regelmäßigem Lautwandel hat zahlreiche Typen von Ausnahmen erbracht. Der hier untersuchte Typ stellt dem Profil nach regelmäßigen Lautwandel dar, aber wird außer Kraft gesetzt, wenn damit Homophonie entstehen würde. Der Vortrag betrachtet die am häufigsten erwähnten Fälle dieses Phänomens und zeigt neue weniger bekannte Fälle auf. Wie kann man nun den Fakt, dass Lautwandel von drohender Homophonie verhindert wird, darstellen und verstehen? Der Vortrag schlägt ein variationsbasiertes Lautwandel-Modell vor, in welchem die Entstehung von Kategorien den Wettbewerb zwischen lexikalischen Einheiten einschließt. Die lexikalische Merkmalverschiebung ("Character displacement") impliziert, dass im Falle von begrenzter syntagmatischer Disambiguierung Unterschiede zwischen ähnlichen Wörtern hervorgehoben werden, was in den diskutierten Fällen den lautlichen Zusammenfall verschiedener Wörter verhindert. Der Vortrag zeigt aber auch, dass das gleiche Prinzip Lautwandel völlig verhindern oder unter gleichen Bedingungen extreme phonologische Kontraste hervorbringen kann.

## Authors' addresses

Juliette Blevins  
Max Planck Institute  
for Evolutionary Anthropology  
Deutscher Platz 6  
04103 LEIPZIG, Germany  
blevins@eva.mpg.de

Andrew Wedel  
Department of Linguistics  
University of Arizona  
TUCSON, Arizona 85721-0028, U.S.A.  
wedel@email.arizona.edu