Diachronic phonology with Contrastive Hierarchy Theory

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Abstract

I argue that Contrastive Hierarchy Theory (CHT) makes it possible to implement Roman Jakobson's 1931 program for diachronic phonology. CHT computes segmental contrasts by language-particular feature hierarchies and incorporates the Contrastivist Hypothesis, which holds that only contrastive feature specifications can be active in the phonology. This empirical hypothesis is susceptible to be falsified by the 'Oops, I Need That' Problem'. I review two case studies: the evolution of the modern Manchu vowel systems from Classical Manchu, and changes in *i*-umlaut from early Germanic to Old English. Both cases adhere to the Contrastivist Hypothesis and show connections between diachronic change and synchronic analysis as proposed by Jakobson, and between contrast and activity as predicted by CHT.

1. Introduction

In 1931, Roman Jakobson proposed that diachronic phonology must look not only at individual sound changes, but at changes in the contrastive structure of the phonological system (Jakobson 1972 [1931]: 122).[*]

> Once a phonological change has taken place, the following questions must be asked: What exactly has been modified within the phonological system? … has the structure of individual oppositions [contrasts/BED] been transformed? Or in other words, has the place of a specific opposition been changed…?

Attempts to carry out this program have been hampered by the lack of a precise way to characterize 'the structure of individual oppositions' within a phonological system. I will show that Contrastive Hierarchy Theory provides the sort of concrete implementation of contrastive structure that Jakobson's diachronic program requires. I will present two case studies that show the potential of this theory to advance illuminating and empirically testable accounts of phonological change.

In section 2, I briefly review the main tenets of Contrastive Hierarchy Theory. Section 3 underscores the empirical nature of the theory and the types of data that would support or counterexemplify it. Section 4 presents the evolution of the modern Manchu vowel systems from Classical Manchu, and section 5 looks at changes in *i*-umlaut from early Germanic to Old English. Both cases involve the introduction or extension of [round] as a contrastive feature on vowels. Each case presents a test of the theory, and each shows the kind of connections between contrast and activity that the theory predicts. These cases also support Jakobson's claim that problems of synchrony and diachrony are connected.

2. The main tenets of Contrastive Hierarchy Theory (CHT)

Contrastive Hierarchy Theory builds on ideas that go back to Roman Jakobson and N. S. Trubetzkoy and their collaborators; for accounts of the rise and fall of this approach, see Dresher (2009, 2016, 2018) and Dresher & Hall (2021). The theory was revived at the University of Toronto under the name Modified Contrastive Specification (MCS; Dresher, Piggott, & Rice 1994; Dyck 1995; Zhang 1996; Dresher 1998, 2009; Dresher & Rice 2007; Hall 2007, 2011; Dresher 2009; Mackenzie 2013, Dresher, Harvey, & Oxford 2018; etc.). It

[*] This is a condensed version of a talk presented at ICHL 25, Oxford, August 2022. I am grateful to the organizers for inviting me, and to members of the audience for their comments.

has since gone under other names—'Toronto School' phonology, or Contrast and Enhancement Theory—I will refer to it as Contrastive Hierarchy Theory (CHT).

The first major building block of our theory is that contrasts are computed hierarchically by ordered features that can be expressed as a branching tree. Branching trees are generated by the Successive Division Algorithm (Dresher 1998, 2003, 2009), given informally in (1):

(1) The Successive Division Algorithm
Assign contrastive features by successively dividing the inventory until every phoneme has been distinguished.

We assume that the features generated by (1) must be present in underlying representations. Moreover, we assume that features and feature ordering are language particular and thus can vary over space and time. Because of this variation, it is necessary to have criteria for selecting and ordering the features. Phonetics is clearly important, in that the selected features must be consistent with the phonetic properties of the phonemes. For example, a contrast between /i/ and /a/ would most likely involve a height feature like [±low] or [±high], though other choices are possible, e.g. [±front] or [±advanced/retracted tongue root].

Of course, the contrastive specification of a phoneme could sometimes deviate from the surface phonetics. In some dialects of Inuktitut, for example, an underlying contrast between /i/ and /ə/ is neutralized at the surface, with both /i/ and /ə/ being realized as phonetic [i] (so-called 'strong *i*' and 'weak *i*', respectively; Compton & Dresher 2011). In this case, underlying /i/ and /ə/ would be distinguished by a contrastive feature, even though their local surface phonetics are identical. That there are two distinct phonemes can be recognized by their differing effects on neighbouring segments, or by the different ways they are affected by other segments.

As the above example shows, the way a sound patterns can override its phonetics (Sapir 1925). Thus, we consider as most fundamental that features should be selected and ordered so as to reflect the phonological activity in a language, where activity is defined as in (2) (adapted from Clements 2001: 77):

(2) Phonological Activity
A feature can be said to be *active* if it plays a role in the phonological computation; that is, if it is required for the expression of phonological regularities in a language, including both static phonotactic patterns and patterns of alternation.

Another major tenet has been formulated by Hall (2007) as the Contrastivist Hypothesis (3):

(3) The Contrastivist Hypothesis
The phonological component of a language L operates only on those features which are necessary to distinguish the phonemes of L from one another.

That is, *only* contrastive features can be phonologically active. If this hypothesis is correct, then (4) follows as a corollary:

(4) Corollary to the Contrastivist Hypothesis
If a feature is phonologically active, then it must be contrastive.

On this hypothesis, underlying lexical representations consist only of contrastive specifications. These representations form the input to the *contrastive phonology*, which is the domain in which the Contrastivist Hypothesis applies. Stevens, Keyser & Kawasaki (1986) propose that feature contrasts can be *enhanced* by other features with similar acoustic effects (see also Keyser & Stevens 2006). Our hypothesis is that enhancement takes place after the contrastive phonology, when further phonetic detail is specified.

A further assumption that I will make here is that features are binary, and that every feature has a marked and unmarked value. I assume that markedness is language particular (Rice 2003; 2007; cf. Trubetzkoy 1939) and accounts for asymmetries between the two values of a feature, where these exist. That is, I assume that it is possible for both values of a contrastive feature to be active, or only one value. In the latter case, we expect the unmarked values to serve as defaults, and be more or less inert. Where it is relevant to indicate markedness, the marked value of a feature F is designated as [F], and the unmarked value as [non-F]. Where markedness is not relevant to an analysis, [±F] designates both values.

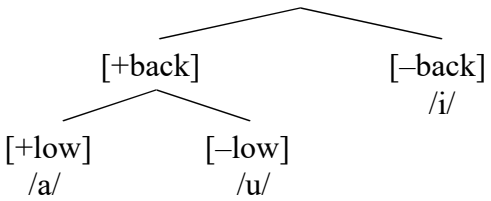
3. An empirical theory: The 'Oops, I Need That' Problem

It is important to stress that the Contrastivist Hypothesis is an empirical hypothesis; although a three-vowel system might be characterized in different ways, it can never have more than two contrastive features. A four-phoneme inventory can have a minimum of two features and a maximum of three. In general, the minimum number of features required by n elements = the smallest integer $\geq \log_2 n$, and the maximum number of features = n–1. Thus, it is possible that a phonological system might display more activity than the contrastive features can support; this is what Nevins (2015) calls the 'Oops, I Need That' Problem. This problem refers to a situation where a non-contrastive feature is needed by the phonology. According to the Contrastivist Hypothesis, this situation should not arise, because only contrastive features should be active. Thus, the 'Oops, I Need That' Problem would indicate an apparent counterexample to the Contrastivist Hypothesis.

I observe that the 'Oops, I Need That' Problem is a typical problem of the sort that empirical theories should have: that is, there are situations in which the theory might be wrong. Thus, this is a good problem to have; phonological theories that never have this kind of problem may not be making any empirical claim. Of course, the best situation is where we could *potentially* have an 'Oops, I Need That' Problem that does *not* arise. I will show some cases where this problem could easily arise but doesn't; these cases thus provide support for the theory.

In testing the Contrastivist Hypothesis it is important to understand that, in a hierarchical system, it is possible to have contrastive features that are technically predictable from the other features. Consider, for example, the features of /a/ in the system in (5). Since /a/ is the only [+low] vowel in the inventory, its [+back] specification is redundant. It is not removed, however, because in a feature hierarchy, contrasts exist at different levels: [±back] groups /a, u/ against /i/, and [±low] distinguishes /a/ from /u/.

(5) Contrastive hierarchy [back] > [low]



Thus, it is *not* the case that all redundant feature specifications must be removed from a system of contrastive specification. This fact often puts a few more features in play than would be the case in nonhierarchical contrastive approaches. This characteristic will play an important role later: it makes possible the existence of 'deep allophones', allophones that consist only of contrastive features.

4. From the Classical Manchu vowel system to the modern Manchu languages

The evolution of the Classical Manchu vowel system to the vowel systems of Spoken Manchu and Xibe provides a nice illustration of Jakobson's point: an individual change in one part of

the system can alter the contrastive status of other parts of the system in important ways that lead to further changes.[1] This case also shows the close connection between contrast and activity posited by Contrastive Hierarchy Theory, as well as between synchrony and diachrony.

Classical Manchu has the six vowel phonemes shown in (6).

(6) Classical Manchu vowel system

/i/		/u/
		/ʊ/
	/ə/	
		/ɔ/
	/a/	

Three notable kinds of phonological activity involving vowels are ATR harmony, labial harmony, and palatalization.

ATR harmony: /u, ə/ are [+ATR], /ʊ, ɔ, a/ are [–ATR], and /i/ is neutral. All vowels in a word except /i/ must agree in [±ATR]. /u/ alternates with /ʊ/, and /ə/ alternates with /a/ and /ɔ/.

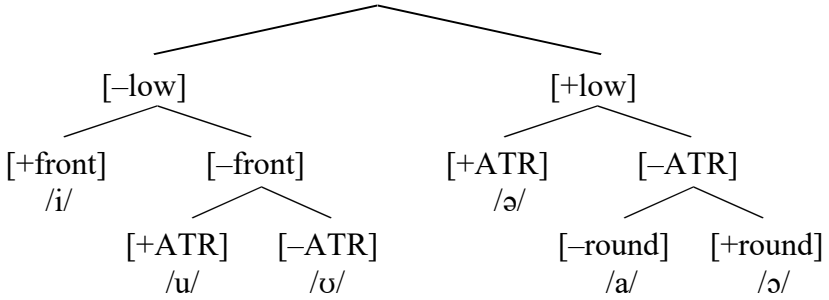
Labial (rounding) harmony: A suffix vowel /a/ becomes /ɔ/ when preceded by a non-initial /ɔ/ (or by two successive /ɔ/ vowels). I assume that this harmony involves the feature [±round] (or [±labial]).

Palatalization: The vowel /i/ provokes the palatalization of neighbouring consonants. /i/ must therefore have a feature that can do this, which we call [±front] (or [±coronal]).

Finally, we need to assume a height contrast to distinguish between the two [+ATR] vowels /u, ə/, and to divide the [–ATR] /ʊ/ from /a, ɔ/. The patterns of alternation suggest that we need only one height feature, which we can call [±low] (or [±high]).[2]

The patterns of feature activity are consistent with the feature hierarchy in (7), which is based on Zhang (1996) as modified by Ko (2018): all vowels except /i/ have an [ATR] feature; only the [+low, –ATR] vowels participate in labial harmony; and /i/ is the only vowel with the palatalizing feature [+front].

(7) Classical Manchu contrastive hierarchy: [low] > [front] > [ATR] > [round]



The vowel systems of the modern Manchu languages developed from a system like (7) by a number of steps. Already in Classical Manchu the distinction between /u/ and /ʊ/ was being lost: /ʊ/ was neutralized to [u] except after back consonants. Eventually, /ʊ/ was lost completely as a contrastive phoneme. Now the entire burden of the [ATR] contrast fell on the contrast between /ə/ and /a/. But in the absence of the /u/ ~ /ʊ/ contrast, this contrast could easily be

[1] For further discussion and references, see Zhang (1996) and Dresher & Zhang (2005), on which this section is based, as well as Ko (2018).

[2] Because there are only two height classes, it is not obvious if the feature should be called [low] or [high]. This could ultimately be decided by considerations of markedness or the phonetic ranges of the vowels. In languages with more than two height classes (say, high/mid/low), both [low] and [high] may be needed, and are clearly distinct.

reinterpreted as a height contrast. Indeed, in Spoken Manchu the reflex of the old /ə/ has mid-high or high allophones, supporting the idea that it has been reclassified as a high (or non-low) vowel.

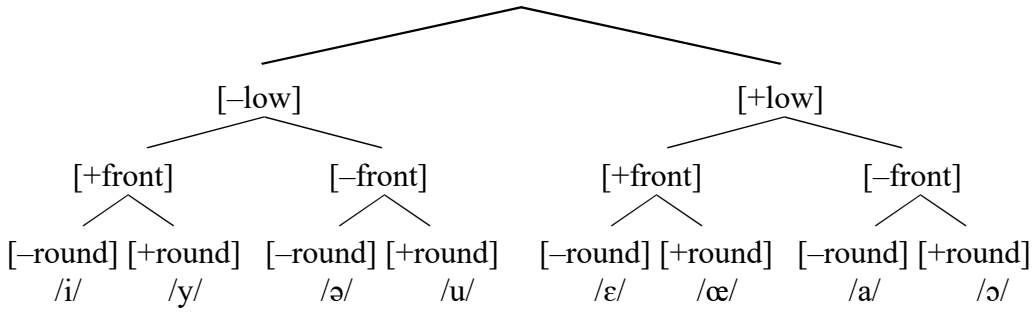
The new status of /ə/ in turn provoked a change in the specification of /u/, because now a new contrast must be drawn between /u/ and the new [–low] /ə/. An obvious candidate is [round], which already marks a contrast in the [+low] vowels. Zhang (1996) and Dresher & Zhang (2005) propose that the [±round] contrast is extended into the [–low] region. The new [+round] specification of /u/ had some interesting consequences which provide support for our analysis.

First is the creation of two new vowels in Spoken Manchu, /ɛ/ and /y/. Zhang (1996) observes that /ɛ/ often corresponds to Classical Manchu *a* followed by *i*. /ɛ/ ([+low, +front]) is thus a combination of the features of /i/ ([+front]) and /a/ ([+low]). Similarly, /y/ corresponds to sequences of Classical Manchu *i…u* or *u…i*. Its [+front] feature clearly comes from /i/; its [+round] feature can only come from /u/. The fact that /u/ can contribute [+round] to a new phoneme indicates that [+round] is an active feature on /u/. By hypothesis an active feature must be contrastive; that /u/ is contrastively [+round] in later Manchu is a prediction of our analysis.

Like Spoken Manchu, the modern Manchu language Xibe (or Sibe) has the new phonemes /ɛ/ and /y/, as well as /œ/, most likely derived from *ɔ…i* sequences. Unlike Spoken Manchu, Xibe retains a labial harmony rule in which /ə/ alternates with /u/ in suffixes. As far as I know, this is the only Manchu-Tungus language in which /u/ participates in labial harmony (see Ko 2018 for a survey). This is explained by the contrastive status of /u/ following the reclassification of /ə/ as a [–low] vowel following the loss of /ʊ/.

To sum up, the contrastive hierarchy of the Xibe vowel system is given in (8); though having one feature less than Classical Manchu, it has three more vowels, using every slot in the tree. The feature [±round], confined to the [+low] vowels in most Manchu-Tungusic languages, is extended to the [–low] vowels with dramatic effects.

(8) Xibe contrastive hierarchy: [low] > [front] > [round]



In our account, it is not a coincidence that in Classical Manchu (7) labial harmony could be triggered only by /ə/ and not by /u, ʊ/. The ordering of the features makes it impossible for /u/ and /ʊ/ to be assigned contrastive [+round]. Could the features have been reordered to allow for this? Not easily: the options are summarized in (9).

(9) Alternate feature hierarchies for Classical Manchu?
   a. [low] > [round] > [ATR] > [front]: If we move up [±round], then /u, ʊ/ are assigned [+round]; but now /i/ has no [+front] feature that can trigger palatalization.
   b. [front] > [round] > [low] > [ATR]: If we we put both [±front] and [±round] at the top, all the phonetically round vowels become [+round], but all the other vowels are lacking a height feature, which they can be shown to need.

Both options in (9) result in Oops, I Need That! Rather, the account we originally proposed, in which [+round] is confined to the low vowel /ɔ/, appears to best account for all the data. As Trubetzkoy (2001: 20 [1936]) remarked, the correct classification of an opposition 'depends on one's point of view', by which I understand that a system of contrasts can be analyzed in different ways. But 'it is neither subjective nor arbitrary, for the point of view is implied by the system'; that is, the patterns of phonological activity suggest what the correct analysis is.

As we will see, the status of the feature [±round] is an important issue also in the history of Old English, to which we now turn.

5. From Proto-Germanic to Old English: The short vowels

Proto-Germanic is commonly assumed to have had the four short vowels */i/, */e/, */a/, */u/ (Ringe 2006).[3] It also had long vowels, but these will not be relevant here. Proto-Germanic is interesting for two reasons: first, because its later evolution into West Germanic and Old English raises some interesting diachronic issues that we will look at soon; second, because all the ingredients of a CHT analysis have already been assembled by Antonsen (1972)! Elmer Antonsen was an American linguist and runologist who made many contributions to the study of Germanic phonology. His utilization of a contrastive feature hierarchy is only implicit: he draws no trees and he does not discuss it at all. However, his article is a nice illustration of CHT argumentation *avant la lettre*. Dresher (2018) finds that Antonsen is only one of several 20th century Germanic phonologists who made implicit use of contrastive feature hierarchies.

Antonsen (1972: 133) proposes the feature specifications in (10) for the Proto-Germanic short vowel system. Notice that they show a pattern of underspecification that is characteristic of a branching tree: the first feature applies to all the phonemes, and the scopes of the remaining features get progressively smaller.

(10) Feature specifications for Proto-Germanic short vowels (Antonsen 1972)

	*/a/	*/u/	*/i/	*/e/
Low	+	–	–	–
Rounded		+	–	–
High			+	–

Antonsen (1972: 132–133) supports these feature specifications by citing patterns of phonological activity (neutralizations, harmony, and distribution of allophones) and loan word adaptation from Latin. Thus, based on the evidence from the descendant dialects, he assumes that */a/ had allophones *[a, æ, ə, ɒ], which all have in common that they are [+low]. Further, there is evidence that */i/ and */u/ had lowered allophones before */a/, again suggesting that */a/ had a [+low] feature that could affect vowel height. And there is no evidence that */a/ had any other active features that played a role in the phonology by affecting neighbouring segments, or that grouped */a/ with other segments as a natural class.

As the feature that distinguishes */u/ from */i/ and */e/, Antonsen chooses [round]. His reason is that all the allophones of */u/ were rounded. I will return shortly to this specific aspect of the analysis.

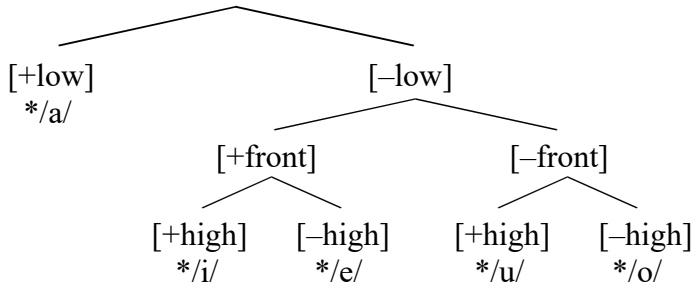
Antonsen observes that the contrast between */i/ and */e/ was neutralized in environments that affected tongue height (before high front vowels, low vowels, and before nasal clusters). He argues that this supports distinguishing */i/ and */e/ by one feature, [high]. He notes that the negative specifications of */e/ are consistent with it being 'the only vowel which does not cause umlaut assimilations in a preceding root syllable'.

As elegant as this analysis is, I will follow the majority, including Lass (1994), Ringe (2006: 148), and Purnell & Raimy (2015), in assuming that the feature that distinguishes */i, e/

[3] This section is based on Dresher (2018), which see for further discussion and references.

from */u/ is [front], not [round]. The reason is that */i/ could cause allophonic fronting of */u/, which suggests it had an active feature [+front]. In West Germanic, the lowered allophone of */u/ that was originally caused by */a/ eventually developed into a new phoneme */o/. With this change, the contrastive feature hierarchy for the West Germanic short vowels looks as in (11). Note that the feature [round] is still not contrastive at this point.

(11) West Germanic contrastive hierarchy 1: [low] > [front] > [high]



The rule of *i*-umlaut began in early Germanic as a phonetic process that created fronted allophones of the back vowels when */i(ː)/ or */j/ followed (see Dresher 2018 for references). For example, West Germanic */u/ and */oː/ (12a) are fronted to *[y] and *[ø], respectively, before /i/ in the following syllable (12b).

(12) West Germanic/Old English *i*-umlaut

Gloss	'evil.NOM.SG'	'foot-NOM.PL'
a. West Germanic	*ubil	*foːt+i
b. *i*-umlaut	*ybil	*føːt+i
c. *i*-lowering/deletion	yfel	føːt

i-umlaut crucially preserves the rounded nature of the fronted vowels; but in our analysis of the West Germanic vowel system (11), [round] is not contrastive. Uh-oh! Is this an 'Oops, I Need That' Problem? No! For independent reasons, many commentators, beginning with V. Kiparsky (1932) and Twaddell (1938), proposed that *i*-umlaut began as a late phonetic rule, and was not part of the contrastive phonology. Therefore, [round] is available as an enhancement feature at the point that */u, o/ are fronted.

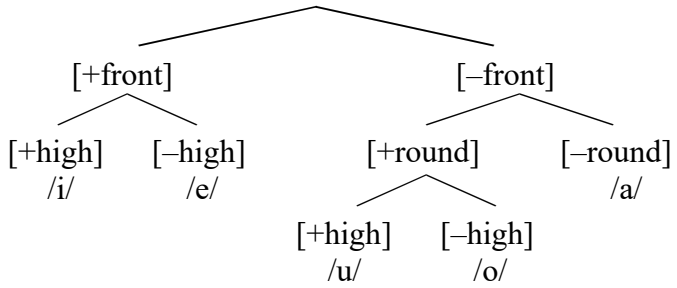
There is evidence, however, that *i*-umlaut became a lexical rule over time,; that is, it became a part of the contrastive phonology. Already in early Old English (12c), the unstressed /i/ trigger of *i*-umlaut was either lowered after a light syllable, as in *yfel*, or deleted after a heavy syllable, as in føːt. These changes made *i*-umlaut opaque on the surface (i.e., its phonetic motivation is obscure on the surface). In many cases, the *i*-umlaut trigger became unrecoverable to learners. A similar weakening of the *i*-umlaut triggers occurred in Old High German (P. Kiparsky 2015). According to standard accounts, this eventually led to the phonologization of [y(ː)] and [ø(ː)] as new phonemes. For example, in Old English the underlying form of 'evil' was eventually restructured from /ufil/ to /yfl/ (Dresher 1985: 77).

This account has led to considerable discussion (see P. Kiparsky 2015 and Dresher 2018: 25 for references). Here I will focus on two questions: First, *why* does *i*-umlaut enter the contrastive phonology? P. Kiparsky (2015) suggests that it is because the front rounded allophones were perceptually more salient than their triggers (cf. Jakobson, Fant, & Halle 1952 on Russian [ɨ]), which were becoming progressively weaker as time went on. I find this explanation to be quite compelling, but it raises another question: *How* do the products of *i*-umlaut enter the contrastive phonology when they involve non-contrastive features that originate in enhancement? As we have seen, this type of change can come about when the linguistic data that form the input to a new generation of learners is critically different from that

to which the previous generation was exposed. In that case, the new learners are liable to see the contrastive structure of the phonological system in a new way.

Let us revisit the stage when *i*-umlaut was still a post-enhancement rule. Adapting Kiparsky's idea, I propose that the perceptual salience of the front rounded allophones caused learners to hypothesize that [round] is a contrastive feature. It was not part of the earlier West Germanic feature hierarchy; but another contrastive hierarchy that includes [round] can be constructed. One such hierarchy is shown in (13). This new hierarchy, however, requires demoting [low] to make room for [round]. This is how contrastive hierarchies work: one can introduce or promote a feature, but there is a trade-off: another feature has to be demoted. Hopefully not a feature that we need!

(13) West Germanic contrastive hierarchy 2: [front] > [round] > [high]



In the new feature hierarchy, when *i*-umlaut changes the [–front, +round, α high] vowels /u, o/ to [+front], the result is new front rounded vowels with the features [+front, +round, α high] which begin as allophones. Although they are allophones, they can arise in the contrastive phonology because they consist only of contrastive features. They are thus what Moulton (2003) calls 'deep allophones'; he was referring to the Old English voiced fricatives [v, ð, z], which can be shown to be predictable allophones of the voiceless fricatives /f, θ, s/. These allophones also arise early in the contrastive (lexical) phonology, as demonstrated by the fact that the rule that voices fricatives has characteristics of a lexical rule (Kim 2001).[4] Deep allophones are possible because contrastive features can be predictable in a hierarchical approach. As discussed by P. Kiparsky (2015), these deep, or 'lexical' allophones are what Korhonen (1969) has called 'quasi-phonemes'.

One question has been left hanging: In the new hierarchy, /a/ no longer has the [+low] feature which was very important at an earlier period. Do we now have a 'Oops, I Need That' Problem? No! /a/ no longer needs a [+low] feature! I know of no evidence—in Old English, for example—that /a/ causes lowering of other segments, or otherwise needs an active [+low] feature. This is in striking contrast to earlier stages of the language, where there is evidence that */a/ caused lowering. This connection between contrast and activity is exactly what Contrastive Hierarchy Theory predicts. When an active feature is demoted so that it is no longer contrastive, it may not remain active.

6. Conclusion

I have shown some examples of how Contrastive Hierarchy Theory can contribute to diachronic phonology. Contrastive hierarchies have been fruitfully applied to phonological change in a variety of languages.[5] There is reason to suppose that a similar contrastive hierarchy approach

[4] Moulton (2003: 169–72) proposes that the status of the voiced fricatives as deep allophones paved the way for their later phonemicization in Middle English.

[5] See Dresher et al. (2018: 293n 7) for a list. To those can be added Voeltzel (2016), Schalin (2017), and Sandstedt (2018) on Scandinavian, and Purnell et al. (2019) on Old English.

can be fruitful also with respect to morphosyntactic features, as has been argued by Cowper & Hall (2017, 2019).

Finally, contrary to the tendency in some earlier theories—and in some contemporary ones—to see sound change as totally separate from the synchronic grammar, in the cases I have discussed there is a connection between synchronic contrastive structure and the type of changes that it is liable to undergo. I will conclude by recalling the last sentence of Jakobson's (1972 [1931]) article with which I started: He writes (p. 138; emphasis original):

> Attempts to identify *synchrony*, *static*, and the domain of application of *teleology* on the one hand and, on the other, *diachrony*, *dynamic*, and the sphere of mechanical causality illegitimately narrow down the frame of synchrony, make of historical linguistics a conglomerate of disparate facts, and create the superficial and harmful illusion of an abyss between the problems of synchrony and diachrony.

References

Antonsen, Elmer H. 1972. The Proto-Germanic syllabics (vowels). In Frans van Coetsem & Herbert L. Kufner (eds.), *Toward a grammar of Proto-Germanic*, 117–40. Tübingen: Max Niemeyer.

Clements, G. N. 2001. Representational economy in constraint-based phonology. In T. Alan Hall, (ed.), *Distinctive feature theory*, 71–146. Berlin: Mouton de Gruyter.

Compton, Richard & B. Elan Dresher. 2011. Palatalization and 'strong *i*' across Inuit dialects. *Canadian Journal of Linguistics/Revue canadienne de linguistique* 56: 203–28.

Cowper, Elizabeth & Daniel Currie Hall. 2017. The rise of contrastive modality in English: A neoparametric account. *Linguistic Variation* 17(1): 68–97

Cowper, Elizabeth & Daniel Currie Hall. 2019. Scope variation in contrastive hierarchies of morphosyntactic features. In David W. Lightfoot & Jonathan Havenhill (eds.), *Variable properties in language: Their nature and acquisition*, 27–41. Washington: Georgetown University Press.

Dresher, B. Elan. 1985. *Old English and the theory of phonology.* New York: Garland Publishing. Reissued 2019 in *Routledge Library Editions: Phonetics and Phonology*, Volume 4. London & New York: Routledge.

Dresher, B. Elan. 1998. On contrast and redundancy. Presented at the annual meeting of the Canadian Linguistic Association, Ottawa. Ms., University of Toronto.

Dresher, B. Elan. 2003. Contrast and asymmetries in inventories. In Anna-Maria di Sciullo (ed.), *Asymmetry in grammar, volume 2: Morphology, phonology, acquisition*, 239–57. Amsterdam: John Benjamins.

Dresher, B. Elan. 2009. *The contrastive hierarchy in phonology*. Cambridge: Cambridge University Press.

Dresher, B. Elan. 2016. Contrast in phonology 1867–1967: History and development. *Annual Review of Linguistics* 2: 53–73.

Dresher, B. Elan. 2018. Contrastive feature hierarchies in Old English diachronic phonology. *Transactions of the Philological Society* 116(1): 1–29.

Dresher, B. Elan & Daniel Currie Hall. 2021. The road not taken: *The Sound Pattern of Russian* and the history of contrast in phonology. *Journal of Linguistics* 57(2), 405–44.

Dresher, B. Elan, Christopher Harvey, & Will Oxford. 2018. Contrastive feature hierarchies as a new lens on typology. In Larry Hyman & Frans Plank (eds.), *Phonological typology,* 273–311. Berlin: de Gruyter Mouton.

Dresher, B. Elan, Glyne Piggott, & Keren Rice. 1994. Contrast in phonology: Overview. *Toronto Working Papers in Linguistics* 13, iii–xvii.

Dresher, B. Elan & Keren Rice. 2007. Markedness and the contrastive hierarchy in phonology. https://dresher.artsci.utoronto.ca/contrast/

Dresher, B. Elan & Xi Zhang. 2005. Contrast and phonological activity in Manchu vowel systems. *Canadian Journal of Linguistics/Revue canadienne de linguistique* 50(1–4), 45–82.

Dyck, Carrie. 1995. *Constraining the phonology–phonetics interface, with exemplification from Spanish and Italian dialects.* Toronto: University of Toronto Doctoral dissertation.

Hall, Daniel Currie. 2007. *The role and representation of contrast in phonological theory.* Toronto: University of Toronto Doctoral dissertation.

Hall, Daniel Currie. 2011. Phonological contrast and its phonetic enhancement: Dispersedness without dispersion. *Phonology* 28(1): 1–54.

Jakobson, Roman. 1972 [1931]. Principles of historical phonology. In Allan R. Keiler (ed.), *A reader in historical and comparative linguistics*, 121–38. New York: Holt, Rinehart & Winston. [English translation of Prinzipien der historischen Phonologie, *Travaux du cercle linguistique de Prague* 4: 247–67, 1931. Copenhagen: Nordisk Sprog- og Kultur Forlag.]

Jakobson, Roman, C. Gunnar M. Fant, & Morris Halle. 1952. *Preliminaries to speech analysis*. MIT Acoustics Laboratory, Technical Report, No. 13. Reissued by MIT Press, Cambridge, Mass., Eleventh Printing, 1976.

Keyser, Samuel Jay & Kenneth N. Stevens. 2006. Enhancement and overlap in the speech chain. *Language* 82(1): 33–63.

Kim, Suksan. 2001. Lexical Phonology and the fricative voicing rule. *Journal of English Linguistics* 29(2): 149–61.

Kiparsky, Paul. 2015. Phonologization. In Patrick Honeybone & Joseph Salmons (eds.), *The handbook of historical phonology*, 563–79. Oxford: Oxford University Press.

Kiparsky, Valentin. 1932. Johdatusta fonologiaan. *Virittäjä* 36: 230–50.

Ko, Seongyeon. 2018. *Tongue root harmony and vowel contrast in Northeast Asian languages*. Wiesbaden: Harrassowitz Verlag.

Korhonen, Mikko. 1969. Die Entwicklung der morphologischen Methode im Lappischen. *Finnisch-Ugrische Forschungen* 37: 203–62.

Lass, Roger. 1994. *Old English: A historical linguistic companion*. Cambridge: Cambridge University Press.

Mackenzie, Sara. 2013. Laryngeal co-occurrence restrictions in Aymara: Contrastive representations and constraint interaction. *Phonology* 30(2): 297–345.

Moulton, Keir. 2003. Deep allophones in the Old English laryngeal system. *Toronto Working Papers in Linguistics* 20: 157–73.

Nevins, Andrew. 2015. Triumphs and limits of the contrastivity-only hypothesis. *Linguistic Variation* 15(1): 41–68.

Purnell, Thomas & Eric Raimy. 2015. Distinctive features, levels of representation and historical phonology. In Patrick Honeybone & Joseph Salmons (eds.), *The handbook of historical phonology*, 522–44. Oxford: Oxford University Press.

Purnell, Thomas, Eric Raimy, & Joseph Salmons. 2019. Old English vowels: Diachrony, privativity, and phonological representations. Language 95(4): e447–73.

Rice, Keren. 2003. Featural markedness in phonology: Variation. In Lisa Cheng & Rint Sybesma (eds.), *The second Glot International state-of-the-article book: The latest in linguistics*, 387–427. Berlin: Mouton de Gruyter.

Rice, Keren. 2007. Markedness in phonology. In Paul de Lacy (ed.), *The Cambridge handbook of phonology*, 79–97. Cambridge: Cambridge University Press.

Ringe, Donald. 2006. *A history of English: From Proto-Indo-European to Proto-Germanic (A linguistic history of English, Vol. 1)*. Oxford: Oxford University Press. Oxford Scholarship Online. www.oxfordscholarship.com

Sandstedt, Jade. 2018. *Feature specifications and contrast in vowel harmony: The orthography and phonology of Old Norwegian height harmony*. Edinburgh: University of Edinburgh Doctoral dissertation.

Sapir, Edward. 1925. Sound patterns in language. *Language* 1(2): 37–51.

Schalin, Johan. 2017. Scandinavian umlaut and contrastive feature hierarchies. *NOWELE* 70(2): 171–254.

Stevens, Kenneth N., Samuel Jay Keyser, & Haruko Kawasaki. 1986. Toward a phonetic and phonological theory of redundant features. In J. S. Perkell & D. H. Klatt (eds.), *Invariance and variability in speech processes*, 426–49. Hillsdale, NJ: Lawrence Erlbaum.

Trubetzkoy, N. S. 1939. *Grundzüge der Phonologie*. Göttingen: Vandenhoek & Ruprecht.

Trubetzkoy, N. S. 2001 [1936]. A theory of phonological oppositions. In Anatoly Liberman (ed.), *Studies in general linguistics and language structure*, 14–21. Translated by Marvin Taylor & Anatoly Liberman. Durham, NC: Duke University Press. [Essai d'une théorie des oppositions phonologiques. *Journal de psychologie normale et pathologique* 33 (1936), 5–18.]

Twaddell, W. Freeman. 1938. A note on OHG umlaut. *Monatshefte für deutschen Unterricht* 30: 177–181.

Voeltzel, Laurence. 2016. *Morphophonologie des langues scandinaves: Hiérarchie segmentale et complexité syllabique*. Nantes: University of Nantes Doctoral dissertation.

Zhang, Xi. 1996. *Vowel systems of the Manchu-Tungus languages of China*. Toronto: University of Toronto Doctoral dissertation.