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Contrastive Feature Hierarchies in Synchronic and Diachronic Phonology*

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ABSTRACT. This paper presents the main tenets of contrastive hierarchy theory, aka Modified Contrastive Specification or "Toronto School" phonology. I propose that the language learner's task is to arrive at a set of ordered contrastive features that account for the phonological patterning of the input language. I then show how contrastive features supplemented by post-phonological enhancement features contribute to synchronic (Tokyo Japanese) and diachronic (West Germanic) accounts of phonological patterns.

Keywords: phonological contrast, feature hierarchies, enhancement, Tokyo Japanese, West Germanic

1. Introduction

Contrastive hierarchy theory[1] (Dresher 2009) posits that contrastive features are computed hierarchically, and that only contrastive features are manipulated by the phonology. Additional features become available in the post-lexical component or later; an important class of such features are those that enhance the effects of contrastive features. I will briefly set out the main tenets of this theory in §2, and then illustrate how it applies to the synchronic phonology of Tokyo Japanese in §3. In §4, I show how an enhancement feature in West Germanic can become contrastive, and how "deep allophones" can exist in the lexical phonology.

2. Contrastive hierarchy theory

I have argued (Dresher 2009) that contrasts are computed hierarchically by ordered features that can be expressed as a branching tree. Branching trees are generated by what I call the Successive Division Algorithm (Dresher 2009:16–17), given informally in (1).

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

I assume that the ordering of features is language particular. Therefore, it is necessary to have criteria for selecting and ordering the features. Phonetics is important in that the selected features must be consistent with the phonetic properties of the phonemes. However, the contrastive specification of a phoneme can deviate from its surface phonetics. In some dialects of Inuktitut, for example, an underlying contrast between /i/ and /ɨ/ is neutralized at the surface, with both /i/ and /ɨ/ being realized as phonetic [i] (Compton and Dresher 2011). In this case, /i/ and /ɨ/, which behave differently and have different effects on neighboring sounds, would be distinguished by a contrastive feature, even though their surface phonetics are identical.

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.

A second major tenet has been formulated by Hall (2007) as the Contrastivist Hypothesis:

(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.

Another assumption 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) and accounts for asymmetries between the two values of a feature, where these exist. I will designate the marked value of a feature *F* as [F], and the unmarked value as [non-F]. I will refer to the two values together as [±F].

Unless a vowel is further specified by other contrastive features (originating in another vowel or in the consonants), it is made more specific only in a post-phonological component. Stevens et al. (1986) propose that feature contrasts can be *enhanced* by other features with similar acoustic effects (see also Keyser and Stevens 2006). Thus, the feature [back] on a non-low vowel can be enhanced by adding {round}, and [non-low] can be enhanced by {high}.[2] Enhancements are not universally necessary, however (Dyck 1995; Hall 2011).

Finally, the assumption that the contrastive feature hierarchy is innate makes it unnecessary to posit that individual features are innate. I assume that features must inevitably "emerge" in the course of language acquisition because it is the learner's task to arrive at a set of hierarchically ordered contrastive features. The contrastive hierarchy and Contrastivist Hypothesis together account for why phonological systems resemble each other in terms of representations, without requiring individual features to be innate (Dresher to appear a; b). On this view, the concept of a contrastive hierarchy is the glue that binds phonological representations and makes them appear similar from language to language.

3. Tokyo Japanese vowel features (Hirayama 2003)

Hirayama's (2003) analysis of Tokyo Japanese vowels illustrates a number of the principles set out in the previous section. Hirayama bases her analysis on patterns of activity, including epenthesis into loan words from English, vowel coalescence, affrication of consonants, and vowel devoicing.

3.1 Epenthesis into loan words from English

A vowel is inserted into a loan word from English that contains a consonant cluster or word-final consonant (Kubozono 2001). After most English consonants /u/ is inserted, as shown in (5). If /u/ is the default epenthetic vowel, we will assume, with Hirayama (2003), that it has no marked features, other things being equal.[3]

(5) Epenthetic /u/ after most English consonants

	English	Gloss	Japanese
a.	/paɪp/	'pipe'	/paipu̲/
b.	/bif/	'beef'	/biihu̲/
c.	/krɪsməs/	'Christmas'	/ku̲risu̲masu̲/
d.	/θrɪl/	'thrill'	/su̲riru̲/

The vowel /i/ is inserted after English /ʃ, tʃ, dʒ/ (6a–c) and, in older loans, after front /k/ (6d). Hirayama observes that /i/ is chosen so as to maintain the palatality of the preceding consonants, which presumably share a front feature with /i/. Hirayama (2003) calls this feature [coronal]; I will call it [front], but it amounts to the same thing.

(6) Epenthetic /i/ after English /ʃ, tʃ, dʒ/ and front /k/

	English	Gloss	Japanese	Phonetic
a.	/brʌʃ/	‘brush’	/burasi/	[buraɕi]
b.	/bitʃ/	‘beach’	/biiti/	[biːt͡ɕi]
c.	/dʒʌdʒ/	‘judge’	/djaddi/	[ʄ͡ʑaʄːʑi]
d.	/keɪk/	‘cake’	/keikki/	[keekᵢ]

An /o/ is inserted after English /t, d, h/ (7). Hirayama (2003) suggests that /u/ is not chosen because it would create allophones of the preceding consonants that would make them too far from the English sounds.

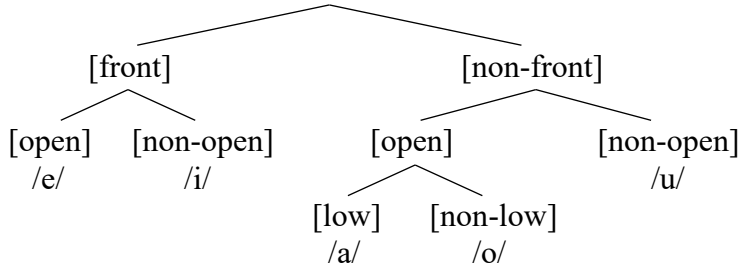
(7) Epenthetic /o/ after English /t, d, h/

	English	Gloss	Japanese	*Result before /u/
a.	/tɛnt/	‘tent’	/teNto/	*[…t͡su]
b.	/dræmə/	‘drama’	/dorama/	*[d͡zu…]
c.	/hwaɪt/	‘white’	/howaito/	*[ɸu…t͡su]

Based on epenthesis, we conclude that [front] is marked in Japanese. We assume that /u/ is also not marked for height: Hirayama proposes that the height feature is [low], comprising /e, o, a/. I will call this feature [open], since the only vowels that are [non-open] are the high vowels. It remains to distinguish /o/ and /a/. I depart from Hirayama’s analysis in this regard: I suppose that /a/ is more marked than /o/, because /o/ is epenthetic after /t, d, h/, not /a/. I will call this third feature [low].

We have seen no evidence that would decide the ordering of [±front] and [±open] in the hierarchy; either ordering would work. For concreteness, I will put [±front] first.[4] Then [±open] is ordered second and [±low] is ordered after [±open]. This gives the feature ordering [±front] > [±open] > [±low], where “[±F] > [±G]” indicates that feature [±F] is ordered before [±G]. A tree diagram of the vowel features of Tokyo Japanese is given in (8).

(8) Tokyo Japanese vowel feature hierarchy: [±front] > [±open] > [±low]



The terminal contrastive features for each vowel in (8) are given in (9). They give the desired markedness values with respect to the choice of epenthetic vowel: /u/ has no marked features, and is the default epenthetic vowel; /i/ is the least marked [front] vowel, when [front] is required; and /o/ is the next-least marked [non-front] vowel.

(9) Contrastive features for each Tokyo Japanese vowel

/i/	/e/	/a/	/o/	/u/
[front]	[front]	[non-front]	[non-front]	[non-front]
[non-open]	[open]	[open]	[open]	[non-open]
		[low]	[non-low]	

3.2 Vowel coalescence

Another process involving vowels is vowel coalescence, whereby two adjacent vowels combine to form one long vowel (Kubozono 1999; 2001; McCawley 1968); some examples are given in (10).

(10) Examples of vowel coalescence

	Underlying	Gloss	Surface	Coalescence pattern
a.	/osie+te/	'tell me'	*oseete*	/ie/ > [ee]
b.	/sugo+i/	'amazing'	*sugee*	/oi/ > [ee]
c.	/mazu+i/	'bad in taste'	*mazii*	/ui/ > [ii]
d.	/atarasi+ku/	'new'	*atarasjuu*	/iu/ > [uu]
e.	/uma+i/	'good'	*umee*	/ai/ > [ee]
f.	/omae/	'you'	*omee*	/ae/ > [ee]
g.	/taka+ku/	'tall, high'	*takoo*	/au/ > [oo]

Hirayama (2003) follows Causley (1999) in proposing that the resolution of vowel hiatus should reflect the feature specifications of the vowels involved. Specifically, all things being equal, it is the *marked* features that decide the quality of the resultant vowel, while unmarked features are inert in coalescence (see also St-Amand 2012 for a similar analysis of vowel coalescence in Québec French). In Japanese, markedness decides the *height* of the resulting vowel; the *place* is determined by the place of the rightmost vowel.

When /i/ coalesces with /e/ (10a), the result is [ee]. The place is taken from the second vowel, /e/; this yields [front] (11b). Height comes from marked features: in this case, the only marked height feature also comes from /e/, which contributes [open] (11c). The result is a vowel that is [front, open], which yields [ee].

(11) Coalescence of /ie/ > [ee]

a.	Underlying segments	V1 = /i/	V2 = /e/	
	Features	[front, non-open]	[front, open]	
b.	Place from V2	[front]		
c.	Height: marked features	[front, open]		= [ee]

When /o/ coalesces with /i/ (10b), the result is again [ee]. The place is taken from /i/, yielding [front]. The only other marked feature is [open], from both /o/ and /e/; the result is [front, open] = [ee].

When /u/ coalesces with /i/ (10c), the result is [ii]. The only marked feature is [front], on /i/. Since /i/ is the second vowel, its place feature is transferred to the resultant vowel (12b). There are no marked height features in either /u/ or /i/; but there is no Japanese vowel that is just [front]. Therefore, to achieve an interpretable representation, we must add the default height (12c), which is [non-open], resulting in [ii].

(12) Coalescence of /ui/ > [ii]

a.	Underlying segments	V1 = /u/	V2 = /i/	
	Features	[non-front, non-open]	[front, non-open]	
b.	Place from V2	[front]		
c.	Add default height	[front, non-open]		= [ii]

When /i/ coalesces with /u/ (10d), the result is [uu]. The place is taken from /u/, yielding [non-front]. As there are no more marked features, the default height [non-open] is added as in (12), now yielding [uu].

When /a/ coalesces with /i/ (10e), the result is [ee]. The place is taken from V2, /i/, giving [front] (13b). /a/ has two marked height features, [open] and [low]. However, the combination [front, open, low] does not exist in Japanese, and cannot be created by coalescence.

Therefore, one of [open] or [low] must be deleted. Since [low] depends on [open], it is deleted (13d); the result is [front, open] = [ee]. The coalescence of /a/ with /e/ (10f) is similar.

(13) Coalescence of /ai/ > [ee]

a.	Underlying segments	V1 = /a/	V2 = /i/	
	Features	[non-front, open, low]	[front, non-open]	
b.	Place from V2	[front]		
c.	Height: marked features	[front, open, low]		(*ill-formed*)
d.	Delete [low]	[front, open]		= [ee]

When /a/ coalesces with /u/ (10g), the result is [oo]. As Hirayama (2003) points out, there is a problem here. The place feature, [non-front], comes from /u/, which is correct. However, /a/ contributes the marked features [open] and [low]. The result is a vowel specified [non-front, open, low], that is, *[aa], which is incorrect.

In order to obtain [oo], we need to add a feature to /u/ that /a/ does not have; Hirayama (2003) suggests [peripheral], defined by Rice (2002) as dorsality or labiality or both. However, the only way we can add more vowel features is by enhancement or by other post-lexical processes. Hirayama (2003) argues that vowel coalescence does in fact occur in the post-lexical component (Pulleyblank 1983; P. Kiparsky 1985). The reason is that vowel coalescence in Japanese is variable and depends on style differences. According to Lombardi (1996), an optional process that depends on style and speed is post-lexical (or later).

Following Hirayama's (2003) account, I will suppose that vowels that are not [low] enhance their [non-front] feature with another place feature. Rather than {peripheral}, I will call it {back}. This enhancement does not apply to [low] vowels, hence it does not apply to /a/. I assume also that high vowels enhance [non-open] with {high}. Adding these enhancement features to the representations in (9) gives us the post-lexical representations in (14).

(14) Post-lexical features for each Tokyo Japanese vowel

/i/	/e/	/a/	/o/	/u/
[front]	[front]	[non-front]	[non-front]	[non-front]
			{back}	{back}
[non-open]	[open]	[open]	[open]	[non-open]
		[low]	[non-low]	
{high}				{high}

Returning to the coalescence of /a/ + /u/ to /oo/, once we add the enhancement features (15a), we transfer [non-front] and {back}, the place features of /u/ (15b).[5] There are three marked height features (counting enhancement features as marked): [open] and [low] from /a/, and {high} from /u/ (15c). The features [low] and {high} cancel each other out (or alternatively, are not compatible with the features {back} and [open]); we are left with [non-front], {back} and [open], which is ill-formed, but can be remedied by adding the unmarked [non-low] (15e), yielding [oo].

(15) Post-lexical coalescence of /au/ > [oo]

a.	Underlying segments	V1 = /a/	V2 = /u/	
	Contrastive features	[non-front, open, low]	[non-front, non-open]	
	Enhancement features		{back, high}	
b.	Place from V2	[non-front], {back}		
c.	Add marked height features	[non-front], {back}, [open], [low], {high}		
d.	Delete [low] and {high}	[non-front], {back}, [open]		(*ill-formed*)
e.	Add default height	[non-front], {back}, [open], [non-low]		= [oo]

3.3 Affrication and high vowel devoicing

Two processes that involve the high vowels /i/ and /u/ are affrication of coronal consonants and high vowel devoicing. Coronal plosives /t, d/ are affricated before high vowels /i, u/ (16), and the high vowels /i, u/ devoice between voiceless obstruents (17) (Hirayama 2003, citing Kubozono 1999; Sugito 1997; Vance 1987; see also Hirayama 2009).

(16) Affrication of /t, d/ before the high vowels /i, u/

a. /t, d/ ⟶ palatal affricate [t͡ɕ, d͡ʑ] / ____ *i, j*
b. /t, d/ ⟶ alveolar affricate [t͡s, d͡z] / ____ *u*
c. /t, d/ ⟶ dental plosive [t̪, d̪] / ____ elsewhere (*e, a, o*)

(17) Devoicing of high vowels /i, u/ between voiceless obstruents

/i, u/ ⟶ [–voice] [i̥, u̥] / C ____ C [kɯ̥tsɯ̥ɕi̥ta] ‘sock(s)’
[vl, obst] [vl, obst]

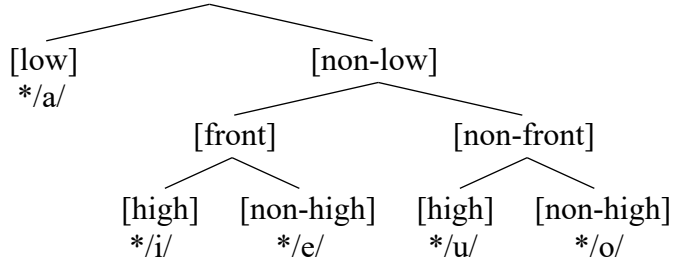
Hirayama (2003) proposes that these processes are also postlexical, because they create allophones rather than change one phoneme into another. Hirayama (2009) points out that high vowel devoicing shows other characteristics of post-lexical rules: it applies across a word boundary, it has no exceptions, its outputs are gradient, and it is not categorical. Therefore, as these rules are post-lexical, they are able to refer to the enhancement feature {high}, which picks out /i/ and /u/.[6]

Without disputing that these rules apply post-lexically in Japanese, I observe that it is possible to have rules that create allophones in the lexical (contrastive) phonology. The West Germanic pre-history of Old English and Old High German gives an example of this, as well as illustrating how an enhancement feature can become contrastive.

4. Contrastive hierarchies in diachronic phonology: West Germanic *i*-umlaut[7]

At a certain time, the West Germanic vowel system had five short and five long vowels (Antonsen 1965; Ringe and Taylor 2014:106). I have argued (Dresher 2017) that at this stage West Germanic had the vowel feature hierarchy [±low] > [±front] > [±high], as shown in (18).[8] The feature [round] is *not* contrastive at this point.

(18) West Germanic vowel feature hierarchy 1: [±low] > [±front] > [±high]

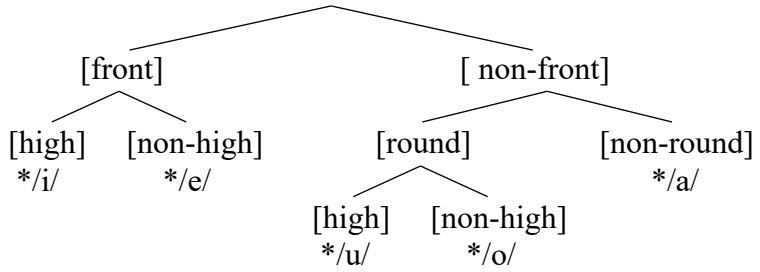


The rule of *i*-umlaut began in early Germanic as a phonetic process that created fronted allophones of the back vowels when */i(:)/ or */j/ followed. Given our analysis of the West Germanic vowel system, the result of fronting */u, o/ in the contrastive phonology would be to simply make them identical to */i, e/. But *i*-umlaut crucially preserves the rounded nature of the fronted vowels: */u, o/ become *[y, ø], respectively. Therefore, the enhancement feature {round} must be in play at the point that */u, o/ are fronted. This conclusion is consistent with the assumption of many commentators, beginning with V. Kiparsky (1932) and Twaddell (1938), that *i*-umlaut began as a late phonetic (or post-lexical) rule.

There is evidence, however, that over time *i*-umlaut became a lexical rule, even while it was still creating fronted allophones of the vowels */u/ and */o/ (Janda 2003; P. Kiparsky

2015). I posit that at a certain stage learners began to conclude that [round] was a contrastive vowel feature, along with [front] and [high]. A new feature hierarchy can be constructed in which [round] is contrastive over the non-front vowels; [low] is now demoted (19).

(19) West Germanic vowel feature hierarchy 2: [±front] > [±round] > [±high]



Now, changing the [non-front, round] vowels to [front] results in new front rounded vowels which begin as allophones of */u, o/. 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," referring to the Old English voiced fricatives which also arise early in the lexical phonology. Deep allophones are possible because contrastive features are not all necessarily unpredictable in a hierarchical approach.

Notes

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[1] The theory has gone under various names: Modified Contrastive Specification (Avery and Rice 1989; Dresher et al. 1994), Contrast and Enhancement Theory (Hall 2011), or "Toronto School" phonology. See Dresher (2015) for a more complete summary of the theory.

[2] I follow Purnell and Raimy (2015) in indicating enhancement features in curly brackets.

[3] One can imagine that epenthetic vowels in some languages must have certain marked features; however, I assume that we require positive evidence that this is the case.

[4] I follow Trubetzkoy (1939:92) in positing the front/back contrast as the main one in Japanese vowels.

[5] It is not clear whether markedness continues to play a role once enhancement features are added, and how enhancement features fit in. I will assume here that it does, and that enhancement features are considered to be marked.

[6] Note that [non-open] also applies only to high vowels. I assume that phonology can refer to unmarked features.

[7] See Dresher (2017) for more detailed discussion and references of the material in this section.

[8] I will henceforth disregard vowel length, as the short and long vowel systems were symmetrical at this time.

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