

CONTRASTIVE SPECIFICATION IN OPTIMALITY THEORY: THE REVENGE OF THE AFFRICATES*

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1. Introduction

The purpose of this paper is to identify, and suggest a solution to, an incompatibility between the framework of Optimality Theory and the theory of contrastive specification of phonological features. Combining any form of underspecification with Optimality Theory is problematic, because Optimality Theory enforces maximal transparency between input and output forms. Mackenzie and Dresher (2003) suggest a way of implementing contrastive specification in an Optimality-Theoretic constraint hierarchy. While this approach works for the Nez Perce vowel harmony data treated by Mackenzie and Dresher, various non-structure-preserving processes, such as assimilatory voicing of affricates in Russian and Czech, present a potential problem for constraint-based contrastive specification. The present paper outlines the basic theoretical difficulty (§2) and Mackenzie and Dresher's approach to it (§3); shows why the Slavic voicing data are problematic (§4); and suggests a solution in which Mackenzie and Dresher's feature co-occurrence constraints are replaced by anti-alignment constraints (§5).

2. The basic theoretical difficulty

In recent work in phonology, contrastive specification and Optimality Theory have each been highly constructive in their ability to prompt researchers to formulate new kinds of questions and to approach existing data in new lights. The central idea of contrastive specification is that only contrastive features are present in the underlying representations of segments or active in the phonological computation (see, e.g., Dresher 2003 and Hall 2007 for more detailed discussion). Optimality Theory (Prince and Smolensky 1993, 2004) as applied to phonology holds that the phonological computation is based on ranked violable constraints.

Because contrastive specification is a theory of representations and Optimality Theory a theory of constraint interaction, their claims might in principle be expected to be orthogonal, and the task of combining them straightforward. However, there are two tenets of Optimality Theory that work together to ensure

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that underlying representations (inputs) will resemble surface forms (outputs) as closely as possible, and which thus work against any attempt to impose underspecification. These principles are Richness of the Base, which holds that the range of possible input forms is not restricted in any language-particular way, and Lexicon Optimization, which states that when more than one input produces the same well-formed output, the one that is stored in the lexicon is the one that minimizes the (faithfulness) violations incurred by the output. According to these two principles, then, the most transparent underlying representations are selected from the widest possible range of choices. Furthermore, constraints are by hypothesis universal, and so they cannot be prevented from referring to redundant features, as the contrastive or redundant status of a feature varies from one language to another.

Inkelas (1995, 1996) demonstrates the possibility within Optimality Theory of what she refers to as archiphonemic underspecification. Archiphonemic underspecification of a feature $[\pm F]$ arises through Inkelas's revised version of Lexicon Optimization in either of two sets of circumstances. When there is a three-way contrast consistently $[+F]$ segments, consistently $[-F]$ segments, and segments that alternate between the two (as is the case with the feature $[\pm \text{voice}]$ on obstruents in Turkish), the alternating segments can be underspecified because no other representation is consistent with their surface patterning. Underspecification is also possible when all relevant segments alternate between $[+F]$ and $[-F]$ at the surface, and any one of $[+F]$, $[-F]$, or $[\emptyset F]$ in the input would yield the attested set of outputs (as is the case with the feature $[\pm \text{ATR}]$ on vowels in Yoruba). What remains impossible under Inkelas's approach, as noted by Hall (2005), is underspecification of predictable non-alternating feature values. This is precisely the kind of underspecification that is central to the contrastivist hypothesis, which holds that only contrastive (i.e., unpredictable) feature values are phonologically active.

3. A solution or three

Mackenzie and Dresher (2003) suggest one way of enforcing contrastive specification in OT; they propose an algorithm, shown in (1), for translating a contrastive hierarchy (Dresher 2003) into a constraint hierarchy that mandates faithfulness to contrastive features and weeds out redundant ones.

- (1) Converting a contrastive hierarchy into a constraint hierarchy (Mackenzie and Dresher 2003: 288–289)
 - a. Go to the next contrastive feature in the list, F_i . If there are no more contrastive features, go to (e).
 - b. In the next stratum of constraints, place any co-occurrence constraints of the form $*[\alpha F_i, \Phi]$, where Φ consists of features ordered higher than F_i .¹

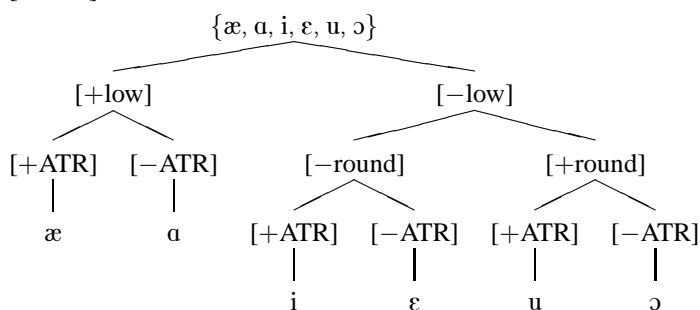
¹ Cf. in particular the “marking statements” of Calabrese (1995).

- c. In the next stratum, place the constraint IO-IDENT[F_i].²
- d. Go to (a).
- e. In the next constraint stratum, place the constraint *[F], and end.

For example, the contrastive hierarchy of vowel features in Nez Perce (2) translates into the constraint ranking in (3):

(2) Nez Perce vowels (Mackenzie and Dresher 2003: 286)

- a. Contrastive hierarchy for Nez Perce vowels: $[\pm\text{low}] \gg [\pm\text{round}] \gg [\pm\text{ATR}]$



b. Divisions in the Nez Perce vowel inventory

		[-round]	[+round]		
	[+ATR]	i	u	[+ATR]	
[-low]	[-ATR]	ε	ɔ	[-ATR]	[-low]
[+low]	[+ATR]	æ		[+ATR]	[+low]
	[-ATR]		a	[-ATR]	

(3) Mackenzie and Dresher's constraint hierarchy for Nez Perce
 IDENT[LOW] \gg *[+LOW, ROUND] \gg IDENT[ROUND] \gg IDENT[ATR]
 \gg *[F]

The crucial aspects of the ranking in (3) are listed in (4).

- (4) a. IDENT[LOW] \gg *[F]
The feature $[\pm\text{low}]$ is contrastive for all segments.
- b. IDENT[LOW] \gg *[+LOW, ROUND] \gg IDENT[ROUND] \gg *[F]
The feature $[\pm\text{round}]$ is non-contrastive for [+low] segments, but contrastive elsewhere in the inventory.
- c. IDENT[ATR] \gg *[F]
The feature $[\pm\text{ATR}]$ is contrastive within both the [+low] and the [-low] subinventories.

² Mackenzie and Dresher's IO-IDENT (henceforth simply IDENT) constraints are violated by changing or deleting a feature specification. In the latter respect, they are similar to MAX constraints.

- d. $*[F] \gg \text{IDENT}[F_k]$, for all $F_k \notin \{[\pm\text{low}], [\pm\text{round}], [\pm\text{ATR}]\}$
 Any other features are non-contrastive (within the vowel inventory;
 contrastive features in the larger segmental inventory are ignored here).

The ranking in (3) does two important things: it disallows vowels that do not occur in Nez Perce (e.g., rounded low vowels), and it ensures that redundant features are omitted from representations of vowels that *do* occur in Nez Perce (e.g., [+back] on the [+round] vowels). The former task is one that is generally considered to be part of what an Optimality-Theoretic constraint grammar for a language ought to do, as constraints are responsible for static phonotactic restrictions as well as for phonological alternations; the latter is an implementation of the contrastivist hypothesis.

Mackenzie and Dresher do not explicitly state how their constraints interact with the other constraints in the grammar. There are three obvious possibilities:

1. The contrastive hierarchy constraints serve as a filter that mediates between the rich base and the rest of the phonological grammar.
2. The contrastive hierarchy constraints are mixed in with all the other constraints in the grammar.
3. The contrastive hierarchy constraints are mixed in with other constraints in the first stratum of a multi-stratal version of Optimality Theory (e.g., Kiparsky 2000, 2002). Contrastive specification is enforced in the same stratum that deals with structure-preserving alternations; non-structure-preserving processes are effected in a subsequent stratum.

If the first possibility is taken to be the case, then this amounts to a retreat from the principle of Richness of the Base; language-specific restrictions on feature combinations are permitted to apply to the input to the constraint grammar proper. Adopting this interpretation reduces the significance of the fact that the contrastive hierarchy is implemented as a ranked list of constraints; in the absence of direct interaction with other constraints, any other formal mechanism capable of filtering out the same feature combinations would do as well.

The second possibility is perhaps the most challenging one to implement, and it is the one that will be pursued in the remainder of this paper. In order for this approach to succeed, the constraints enforcing contrastive specification must not interfere with the constraints that ensure the appropriate surface realizations of segments in all their environments.

The third possibility represents a potentially fruitful compromise between the first two—it allows the contrast-enforcing constraints to interact directly with some of the other constraints in the grammar, but also draws a principled line between a stratum of the grammar in which the structure of the underlying inventory (including contrastive underspecification) is preserved and a stratum in which representations may arise that do not occur underlyingly.

4. The revenge of the affricates

The difficulty of combining contrastive hierarchy constraints with the rest of the grammar becomes evident when we consider non-structure-preserving processes. One example of the relevant sort of process is voicing assimilation as it applies to affricates in various Slavic languages, including Russian and Czech. Halle (1957, 1959) famously used the Russian example to argue against redundant rules and levels of representation mandated by principles of Structuralist phonemics (see also Anderson (2000) for discussion of the significance and context of Halle's claims). Here, I will use the Czech case to illustrate the problems that arise from combining contrastive hierarchy constraints with the rest of the constraint grammar.

4.1 Regressive voicing assimilation

The underlying consonant inventory of Czech is shown in Table 1. Of particular interest here are the affricates, /ts/ and /tʃ/, which have no phonemic voiced counterparts.

MANNER	VOICING	PLACE			
		bilabial/ labiodental	dental/ alveolar	palatal/ postalveolar	velar/ glottal
STOP	voiceless voiced	p b	t d	c ⟨tʰ⟩ ɟ ⟨dʰ⟩	k g
AFFRICATE	voiceless		ts ⟨c⟩	tʃ ⟨č⟩	
FRICATIVE	voiceless voiced	f v	s z	ʃ ⟨š⟩ ʒ ⟨ž⟩	x ⟨ch⟩ ɦ ⟨h⟩
NASAL	voiced	m	n	ɲ ⟨ň⟩	
TRILL	voiced		r	ɹ ⟨ř⟩	
LATERAL	voiced		l		
GLIDE	voiced			j	

Table 1: The phonemic consonant inventory of Czech

Regressive voicing assimilation applies to obstruent clusters. Obstruents in pre-sonorant position retain their underlying voicing values; obstruents followed by other obstruents assimilate. (Word-final obstruents are voiceless.) The basic pattern is illustrated in (5).

- (5) Regressive assimilation (of the prepositions *s* /s/ 'with' and *z* /z/ 'from')
- s lesem* [slesem] 'with a forest' /___ [+son]:
 - z lesa* [zlesa] 'from a forest' /s/=[s], /z/=[z]
 - s mužem* [smuʒem] 'with a man'
 - z muže* [zmuʒe] 'from a man'

e.	<i>s domem</i>	[zdomem]	‘with a house’	/___ [-son,+voice]:
f.	<i>z domu</i>	[zdomu]	‘from a house’	/s, z/ = [z]
g.	<i>s hradem</i>	[zɦradem]	‘with a castle’	
h.	<i>z hradu</i>	[zɦradu]	‘from a castle’	
i.	<i>s polem</i>	[spolem]	‘with a field’	/___ [-voice]:
j.	<i>z pole</i>	[spole]	‘from a field’	/s, z/ = [s]
k.	<i>s chybou</i>	[sxibou]	‘with a mistake’	
l.	<i>z chyby</i>	[sxibi]	‘from a mistake’	

The pattern can be generated by the constraints shown in (6).³

- (6) Constraints driving voicing assimilation and final devoicing
- IDENT[SON] Underlying values of [\pm sonorant] are preserved in the output.
 - *[+SON, -VOI] Sonorants must not be voiceless.
 - IDENT[VOI]/___ [+SON] Underlying values of [\pm voice] are preserved before sonorants.⁴
 - *[+VOI]/___# Word-final segments are voiceless.
 - AGREE[VOI] Contiguous obstruents agree in voicing.
 - IDENT[VOI] Underlying values of [\pm voice] are preserved.

For regressive voicing assimilation in non-final clusters, the crucial rankings are those in (7): voicing values are preserved before sonorants, but faithfulness to underlying voicing features in other environments is subordinated to the preference for clusters to agree in voicing.

- (7) IDENT[VOI]/___ [+SON] \gg AGREE[VOI] \gg IDENT[VOI]

4.2 The affricates

Although voiced affricates /dʒ/ and /dʒ̥/ do not occur contrastively in Czech, they do arise through regressive assimilatory voicing of /ts/ and /tʃ/, as in (8).

³ For an OT analysis of the same facts using privative features (in which the same difficulties arise), see Hall (2007: §5.3.1). For a derivational analysis, see Hall (2007: §2.3).

⁴ As has been pointed out by A.-M. Tessier (p.c.), the effect of this constraint should, in the context of a theory of contrastive underspecification, be made to follow from the fact that [+sonorant] segments do not have contrastive values for [\pm voice]. There are various ways in which this could be accomplished, potentially leading to various reformulations of the directional featural anti-alignment constraints in (19) below. Here, I will simply use IDENT[VOI]/___ [+SON] for the sake of expository convenience.

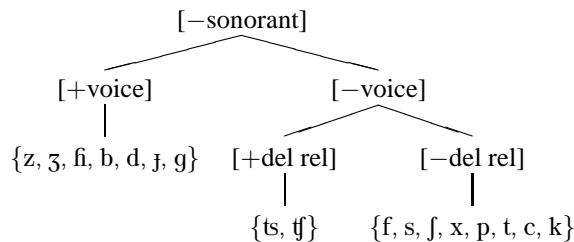
- (8) Voiced affricates arising from regressive assimilation
- lec+který* [letskeri:] ‘many a’ (MASC. NOM. SG.)
 - lec+kdo* [ledzgdɔ] ‘someone’ (NOM. SG.)
 - léčeb+ný* [le:tʃebni:] ‘therapeutic’ (MASC. NOM. SG.)
 - léčb+a* [le:ɟba] ‘cure’ (NOM. SG.)

The phonemically unpaired voiceless affricates /ts/ and /tʃ/ do trigger regressive assimilatory devoicing of other obstruents, as illustrated in (9).

- (9) Regressive assimilation triggered by /ts/, /tʃ/
- dcer+a* [ttsera] ‘daughter’ (NOM. SG.)
 - z+cel+a* [stsela] ‘in full’
 - v+cít+it* [ftsi:cit] ‘to feel, empathize’
 - v+čas* [ftʃas] ‘in time’
 - z+část+i* [stʃa:sci] ‘in part’
 - z+čern+at* [stʃernat] ‘to blacken’

This indicates that in the contrastive feature hierarchy, [\pm voice] must take scope over the feature(s) distinguishing affricates from other segments, so that /ts/ and /tʃ/ will be contrastively [–voice] (as Calabrese (1995) and Dresher (1998) note for Russian).⁵

- (10) Partial contrastive hierarchy for Czech obstruents⁶



The hierarchy in (10) translates into the constraint ranking in (11).

- (11) IDENT[SON] \gg *[+SON, VOI] \gg IDENT[VOI] \gg *[+VOI, DEL REL] \gg IDENT[DEL REL] \gg *[F]

Segments specified as [+voice] are forbidden by this ranking to have any specification for [\pm del rel]. (A surface segment with no value for [\pm del rel] will be realized phonetically as a non-affricate by default.)

⁵ For simplicity, I assume that affricates are distinguished from non-affricates by a single feature specification [+del(ayed) rel(ease)]; a combination of feature values such as [–continuant, +strident] could just as easily be used instead. The scope of [\pm del rel] with respect to features other than [\pm voice] is also not crucial to the analysis presented here. (It would, for instance, make good logical sense to subordinate [\pm del rel] to [\pm continuant].)

⁶ I omit here the problematic segments /v/ and /ʋ/, on which see Hall (2007).


4.3 Putting the constraints together

Combining the relevant portions of the constraint rankings in (7) and (11) yields the partial grammar in (12):

- (12) IDENT[VOI]/ [+SON] ≫ AGREE[VOI] ≫ IDENT[VOI] ≫ * [+VOI, DEL REL] ≫ IDENT[DEL REL]

This ranking, however, incorrectly predicts that regressive assimilation will be structure-preserving—specifically, that it will not give rise to voiced affricates. Underlying affricates followed by voiced obstruents will indeed undergo assimilatory voicing, but with concomitant deaffrication, as shown in the tableau in (13).

- (13)

/le:ʈba/		IDENT[VOI]/ <u> </u> [+SON]	AGREE[VOICE]	IDENT[VOICE]	* [+VOI, DEL REL]	IDENT[DEL REL]
* 	[le:ɰba]			*		*
(8d)	[le:ɰba]			*	*!	
	[le:ʈba]		*!			
	[le:ʈpa]	*!		*!		

If we follow the contrastive hierarchy and rank * [+VOI, DEL REL] over IDENT[DEL REL], then we incorrectly predict structure-preserving assimilation of affricates, as in (13). However, if we promote IDENT[DEL REL] to allow voiced affricates in surface forms such as those in (8), then we incorrectly predict that underlying voiced affricates will be possible, too.

5. A complicated rescue

What we need is a way of permitting /ɰ/ and /ɰ/ to arise through the effects of assimilation, but not otherwise. However, given standard OT assumptions, it is not possible to constrain input forms directly, nor does the grammar have access to the derivational history of surface forms—outputs are selected, not derived. In order to rule out the illicit forms, then, we must be able to distinguish assimilated and underlying voiced affricates based only on material in the output forms.

5.1 Featural anti-alignment

The key feature of a voiced affricate that arises through voicing assimilation is that it shares the feature [+voice] with an adjacent obstruent. This suggests that

we can make the necessary distinction by replacing Mackenzie and Drescher's co-occurrence constraints with featural anti-alignment constraints such as the one in (14):⁷

(14) DISALIGN[+VOICE, DEL REL]:

The output contains no instances of the features [+voice] and [\pm del rel] such that the leftmost segment associated with each feature is the leftmost segment associated with the other and the rightmost segment associated with each feature is the rightmost segment associated with the other.

Depending on exactly how sub-segmental structure is represented, there are a few different possible formalizations of a constraint such as (14); McCarthy's (2004) Span Theory provides one likely framework. Here, I will remain as agnostic as possible on the question, noting only that it is necessary to be able to talk about features as extending over sequences of adjacent segments.

The kinds of structures allowed and disallowed by DISALIGN[+VOICE, DEL REL] are illustrated in (15):⁸

(15)

		DISALIGN[+VOICE, DEL REL]
a.	$\begin{array}{c} [+del\ rel] \\ \\ \text{d} \\ \\ [+voice] \end{array}$	*
b.	$\begin{array}{c} [+del\ rel] \\ \diagdown \quad \diagup \\ \text{d} \quad \text{d} \\ \diagup \quad \diagdown \\ [+voice] \end{array}$	*
c.	$\begin{array}{c} [+del\ rel] \\ \\ \text{d} \quad \text{b} \\ \diagup \quad \diagdown \\ [+voice] \end{array}$	✓
d.	$\begin{array}{c} [+del\ rel] \\ \diagdown \quad \diagup \\ \text{d} \quad \text{t} \\ \quad \\ [+voice] \quad [-voice] \end{array}$	✓

⁷ Cf., e.g., Buckley (1998), Downing (1998), and Inkelas (1999) for other uses of anti-alignment constraints involving different levels of phonological structure.

⁸ The effects of this anti-alignment constraint are reminiscent of Itô, Mester, and Padgett's (1995) LICENSE[VOICE] constraint, which allows nasals to be specified for [Voice] if and only if they share the feature with an adjacent obstruent.

Featural anti-alignment will make it possible to allow configurations like (15c), as in [le:ɕba], while ruling out ones such as (15a) and (15b), which involve underlying voiced affricates. $\text{DISALIGN}[+\text{VOICE}, \text{DEL REL}]$ also allows sequences like (15d), which do not occur in Czech, but such clusters will be ruled out by $\text{AGREE}[\text{VOICE}]$.

We can therefore revise the rules for translating a contrastive hierarchy into a constraint ranking as in (16).⁹

- (16) Converting a contrastive hierarchy into a constraint hierarchy (first revision)
- For every feature F_i such that F_i is contrastive in inventory I :
 - $\text{IDENT}[F_i] \gg *[\text{F}]$
 - For all Φ such that Φ is a set of feature values defining a subinventory $I_\Phi \subset I$ in which F_i is not contrastive, and such that there is no Φ' such that $\Phi' \subset \Phi$ and Φ' defines a superinventory $I_{\Phi'} \supset I_\Phi$ in which F_i is also not contrastive:
 - $\text{DISALIGN}[F_i, \Phi] \gg \text{IDENT}[F_i]$
 - For every feature F_j such that some value of F_j is in Φ :
 - $\text{IDENT}[F_j] \gg \text{DISALIGN}[F_i, \Phi]$
 - For every feature F_k such that F_k is not contrastive in inventory I :
 - $*[\text{F}] \gg \text{IDENT}[F_k]$

Replacing $*[+\text{VOICE}, \text{DEL REL}]$ with $\text{DISALIGN}[+\text{VOICE}, \text{DEL REL}]$ in the tableau from (13), we now obtain the correct output form, as shown in (17).

(17)

/le:ɕba/	$\text{IDEN}[\text{VOI}]/\text{---}[\text{+SON}]$	$\text{AGREE}[\text{VOICE}]$	$\text{IDENT}[\text{VOICE}]$	$\text{DISALIGN}[+\text{VOI}, \text{DEL REL}]$	$\text{IDENT}[\text{DEL REL}]$
[le:ɕba]			*		*!
☞ [le:ɕba]			*		
[le:ɕba]		*!			
[le:ɕpa]	*!		*!		

⁹ In addition to replacing Mackenzie and Dresher's co-occurrence constraints with DISALIGN constraints, I have also stated the rules in declarative rather than procedural terms.

5.2 One more glitch

Unfortunately, $\text{DISALIGN}[+\text{VOICE}, \text{DEL REL}]$ cannot discriminate between sequences such as $[\text{ɟba}]$, which can arise through spreading as in (8d), and ones such as $*[\text{bɟa}]$, with the structure in (18), which in Czech could arise only from an underlying form containing a voiced affricate.

(18)

	$\text{DISALIGN}[+\text{VOICE}, \text{DEL REL}]$
	✓

Rather than simply stipulating that a constraint along the lines of $*[+\text{VOICE}, +\text{DEL REL}]/__ [+ \text{SONORANT}]$ is ranked high in Czech, it would be preferable to derive a constraint ranking ruling out $*[\text{bɟa}]$ and its ilk automatically through the rules for translating the contrastive hierarchy.

It is insufficient to say that $[+\text{voice}]$ and $[\pm \text{del rel}]$ should not align at both edges at once; they must more specifically be prohibited from aligning at the right edge. Rather than $\text{DISALIGN}[+\text{VOICE}, \text{DEL REL}]$, we need a constraint $\text{DISALIGN-R}[+\text{VOICE}, \text{DEL REL}]$. The position of this constraint in the grammar can be automatically derived from the contrastive hierarchy through reference to the existence of a positional faithfulness constraint that refers to the feature $[\pm \text{voice}]$ and specifies an environment on the right—i.e., the existence of $\text{IDENT}[\text{VOICE}]/__ [+ \text{SONORANT}]$ (or whatever other constraint preserves underlying voicing features in this context; cf. fn. 4.) A suitably revised version of the translation rules is shown in (19).

(19) Converting a contrastive hierarchy into a constraint hierarchy (final version)

- For every feature F_i such that F_i is contrastive in inventory I :
 - $\text{IDENT}[F_i] \gg *[\text{F}]$
 - For all Φ such that Φ is a set of feature values defining a subinventory $I_\Phi \subset I$ in which F_i is not contrastive, and such that there is no Φ' such that $\Phi' \subset \Phi$ and Φ' defines a superinventory $I_{\Phi'} \supset I_\Phi$ in which F_i is also not contrastive:
 - $\text{DISALIGN}[F_i, \Phi] \gg \text{IDENT}[F_i]$
 - For every feature F_j such that some value of F_j is in Φ :
 - $\text{IDENT}[F_j] \gg \text{DISALIGN}[F_i, \Phi]$

- For all X such that there is a positional faithfulness constraint of the form $\text{IDENT}[F_j]/X_ :$
 - $\text{IDENT}[F_j]/X_ \gg \text{DISALIGN-L}[F_i, \Phi] \gg \text{IDENT}[F_i]$
- For all Y such that there is a positional faithfulness constraint of the form $\text{IDENT}[F_j]/_Y :$
 - $\text{IDENT}[F_j]/_Y \gg \text{DISALIGN-R}[F_i, \Phi] \gg \text{IDENT}[F_i]$
- For every feature F_k such that F_k is not contrastive in inventory I :
 - $*[F] \gg \text{IDENT}[F_k]$

This set of rules gives us the further constraint rankings in (20):

- (20) $\text{IDENT}[\text{VOICE}]/_ [+SON] \gg \text{DISALIGN-R}[+VOICE, \text{DEL REL}] \gg \text{IDENT}[\text{DEL REL}]$

The rules in (19) do not explicitly rank $\text{DISALIGN}[+VOICE, \text{DEL REL}]$ and $\text{DISALIGN-R}[+VOICE, \text{DEL REL}]$ with respect to each other, but we can assume that the more specific constraint (the one penalizing alignment on both sides) is ranked above the more general one (the one penalizing alignment on the right-hand side) as a matter of course (see, e.g., Beckman 1998: 34–35).

This leads to the ranking shown in the tableaux in (21), which now correctly disallows $*[\text{b}\text{ɟ}\text{a}]$, as shown in (21a), while permitting $[\text{ɟ}\text{b}\text{a}]$ —which can be derived either from underlying $/\text{t}\text{f}\text{b}\text{a}/$, as in (21b), or from underlying $/\text{ɟ}\text{b}\text{a}/$.¹⁰

(21) a.

$/\text{b}\text{ɟ}\text{a}/$	$\text{IDENT}[\text{VOI}]/_ [+SON]$	$\text{AGREE}[\text{VOICE}]$	$\text{IDENT}[\text{VOICE}]$	$\text{DISALIGN}[+VOI, \text{DEL REL}]$	$\text{DISALIGN-R}[+VOI, \text{DEL REL}]$	$\text{IDENT}[\text{DEL REL}]$
$[\text{b}\text{ɟ}\text{a}]$						*
$[\text{ɟ}\text{b}\text{a}]$					*!	
$[\text{b}\text{t}\text{f}\text{a}]$	*!	*	*			
$[\text{p}\text{t}\text{f}\text{a}]$	*!		**			

¹⁰ Lexicon Optimization will prefer $/\text{ɟ}\text{b}\text{a}/$ as the underlying representation—so Czech will end up having underlying voiced affricates after all, but only in environments where they would arise through assimilation anyway.

b.

/tʃba/	IDENT[VOI]/— [+SON]	AGREE[VOICE]	IDENT[VOICE]	DISALIGN[+VOI, DEL REL]	DISALIGN-R[+VOI, DEL REL]	IDENT[DEL REL]
☞ [tʃba]			*			
[jba]			*			*!
[tʃba]		*!				
[tʃpa]	*!		*			

6. Conclusions

The revised translation rules in (19) provide a way of generating constraint rankings that will deal with unidirectional non-structure-preserving assimilation processes by relating DISALIGN constraints to positional faithfulness constraints. While these rules make a principled connection between the constraints in the regular Optimality-Theoretic grammar and those needed for the implementation of the contrastive hierarchy, they are somewhat complicated, and they might need to become more so in order to accommodate other kinds of assimilatory patterns, such as harmony. The precise formulation of the necessary DISALIGN constraints depends, of course, on how subsegmental structure and ‘spreading’ (or feature-sharing) are best represented in Optimality Theory, a question that is independently well worth looking into. Finally, the possibility of incorporating constraints enforcing a contrastive hierarchy into a multi-stratal version of Optimality Theory remains a strong alternative possibility, as it has the potential to eliminate the need for some of the formal devices proposed here.

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