Calgary (Working) Papers in Linguistics Volume 22, Winter 2000

2000-01

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Wilhelm, A. (2000). A closer look at coalescence: the Slave D-effect*. Calgary Working Papers in Linguistics, 22(Winter), 59-92.
http://hdl.handle.net/1880/51435
journal article

A Closer Look at Coalescence: The Slave D-Effect*

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1. Introduction

In this paper, I will offer an in-depth account of one type of coalescence, the Athapaskan D-effect, which occurs when *d* meets a consonant-initial verb stem. For example in Slave, a Northern Athapaskan language:

(1) a. /ná-ʔede-ne-**d**-∅-táh/ —> [náʔedena.**ta**] '3 kicked 3-self' (Rice 1989:445)

b. /lé-ye-**d**-∅-ɣe/ —> [léye.**ge**] 'it is cut' (Rice 1989:444)

I will analyze the Slave D-effect in the framework of Optimality Theory (Prince & Smolensky 1993). My analysis will cover the full range of phenomena and will not refer to morphological information. This makes it superior to previous analyses of the D-effect, e.g., Lamontagne & Rice 1994, 1995, which have to refer to morphological information, and which do not account for all D-effect alternations. I will propose constraints guiding the inner workings of coalescence (which features of which input segment are maintained), thus shedding light on the nature of coalescence in general. Finally, I will show that my analysis is more valid universally, as it is compatible with accounts of coalescence in child language (Ganandesikan 1995).[1]

Before beginning the analysis, I will introduce the D-effect (section 1.1.), review previous accounts (section 1.2.), and present my hypothesis and assumptions (section 1.3.). The actual analysis first discusses the constraints motivating coalescence (section 2) , and full coalescence (section 3). Then the inner workings of coalescence are discussed by major feature groups: place (section 4), manner (section 5), laryngeal features (section 6), nasals (section 7). The conslusions are presented in section 8.

1.1. The D-Effect

The D-effect is a well-known phonological alternation in Athapaskan languages. It is just one of the many instances of fusion which occur among the verb stem and the closer (called "conjunct") prefixes in these polysynthetic languages. In the D-effect, a *d* and certain stem-initial consonants are coalesced, (1b), while before other stem-initial consonants *d* seems to be deleted, (1a).

The source of the *d* is either one of the so-called classifiers, or the first person dual/plural subject agreement prefix. The four Athapaskan classifiers, *Ø, l-, ɬ-* and *d-* (Krauss 1969; Slave *Ø, l-, h-* and *d-* respectively) are the prefixes closest to the verb stem. They often have a derivational and valency-changing function. For example, the classifier *d-* is used in many, but not all, passives and reflexives. There are also numerous instances where the classifiers do not have any obvious function, but seem to be lexicalized. All four classifiers undergo fusion or deletion (for an OT account of the l-classifier in Navajo and Chipewyan, see Causley 1997).

The next-closest prefixes, immediately preceding the classifier, are those which mark subject agreement. The affix for first person dual/plural subject has the form *(V)Vd* , for example, *íd-* in Slave (Rice 1989). If the classifier is *Ø,* the final *d* of this prefix directly meets the stem-initial consonant and shows the same behavior as the d-classifier[2].

The following will be an Optimality Theory (OT) analysis of the D-effect in Slave. Slave is a Northern Athapaskan language consisting of four dialects: Hare, Bearlake, Mountain, and Slavey. Unless otherwise noted, examples will be from Slavey (Rice 1989). (1) below, is an overview of the D-effect in Slavey. All consonant phonemes and their interactions with *d* are shown. *d* plus bolded segments results in a new segment, given in brackets; all other segments remain unchanged after *d,* and *d* seems deleted. (Actual examples will follow throughout the analysis.)

(2) **Slavey consonant inventory & D-effect** (based on Rice 1989):

v.l.. unasp.	(b)	$d^{\eth}$	d	dz	dl	dʒ	g	
v.l.. asp.		t^{θ}	t	ts	tl	tʃ	k	
glottalized		$t^{\theta'}$	t'	ts'	tl'	tʃ'	k'	**ʔ** (> t')
prenasalized	(mb)		(nd)					
v.l.. fric.		**θ** (> $d^{\eth}$)		**s** (> dz)	**ɬ** (> dl)	**ʃ** (> dʒ)	**x** (> g)	h
vcd. fric.		**ð** (> $d^{\eth}$)		**z** (> dz)	**l** (> dl)	**ʒ** (> dʒ)	**ɣ** (> g)	
glides	(w)		(r)			y (> dʒ)		
nasals	**m** (> b)		**n** (> d)					

Some comments on this inventory are in order. Note that the symbols for the stops do not reflect their laryngeal quality: voiceless ("plain") stops are represented by the symbols [d] etc., voiceless aspirated stops by the symbols [t] etc. This convention suggests that voicing is distinctive in stops, an assumption not shared by all Athapaskanists.

The symbol *y* is used for IPA [j]. This segment is in free variation with *ʒ*, and both show the same D-effect *dʒ*. The phonemic status of the segments in brackets, *b, mb, nd, w, r,* is not well established. *b* occurs mostly in loan words, and in native *ʔabá* 'father'. The prenasalized stops *mb, nd* are allophones of /m/ and /n/ respectively. They occur mostly in prefixes, more rarely in stems. *w* is unusual in Slavey and not found in the other dialects. Finally, *r* occurs in some loan words, and is otherwise an allophone of /d/ in onset position.

Also worthy of note is the fact that *h* does not occur stem-initially, and is the only permissible coda (as well as the epenthetic consonant) in the language.

In short, the segments *h, w, mb, nd* do not or only very rarely occur stem-initially, hence do not undergo the D-effect, and will be omitted from my analysis. I will also not treat *y* separately, but subsume it under the analysis of *ʒ*.

Three broad patterns of the D-effect can be observed from this table. First of all, if possible, the outcome of the D-effect is a full combination of all features of the two underlying segments, as in *d* + coronal fricative —> coronal affricate, and *d* + *ʔ* —> *t'*. If no full combination is possible, there are two further possibilities: (i) *d* plus a (dorsal) fricative or a nasal results in a coalesced segment which retains some features of each underlying segment, and (ii) *d* plus a stop results in a stop, which looks like deletion of *d*.

1.2. Previous Analyses

Most descriptions of the D-effect are simply lists of rules for those segments undergoing changes, with a note that *d* is deleted before all segments not listed. It is usually left to the reader to find out what these other segments are, and whether there is a general pattern. The first and groundbreaking formal analysis of the D-effect was presented in Howren (1971). Howren suggests "that the multiplicity of rules might be reduced to a single principle: the output segment is a recombination of sets of features from each of the input segments" (Howren 1971:99). He proposes a general rule which basically merges the stricture ([-cont]) of the *d* with the place, voicing and nasality features of the stem-initial consonant. In other words, the D-effect is always coalescence, never deletion. To make the general rule work for all the languages he discusses, Howren assumes abstract phonemic representations and derivations in which various language-specific adjustment rules further change the outputs of the D-effect rule until the actual surface forms are achieved.

Subsequent discussions of the D-effect are mostly language-specific analyses using derivations with ordered rules. Some, e.g., Rice (1987), Hargus (1988), Randoja (1990), Shaw (1991) propose that the d-classifier, which is never seen overtly, consists of only the feature [-cont] or [stop]. This is consistent with Howren (1971) in that only the stricture of the d-classifier is maintained. These analyses need ordered rules as well as constraints to adjust ill-formed rule outputs.

The first and only analyses in the framework of Optimality Theory (OT) are offered by Lamontagne & Rice (L&R). They do not take up Howren's idea that there is one general process, and that the coalesced segment always contains features of *both* input segments. Instead, the D-effect is divided into two separate processes, coalescence with some segments, ***and deletion*** with other segments.

L&R (1994) is a typology of Athapaskan languages. It shows that the D-effect occurs in those languages where preserving syllable structure is more important than the loss or addition of a segment/feature—in OT terms, syllable structure constraints are ranked above faithfulness constraints. In languages with the reverse ranking (preserving syllable structure is less important than preserving the segmental makeup of a form), epenthesis or syllabification of *d* as coda occurs . However, for the D-effect languages, L&R only discuss deletion and do not attempt to analyze the cases of true coalescence.

L&R (1995) discusses the constraints needed in those cases where coalescence is favored over deletion, as in *d+x* —> *g*. It proposes a new constraint "*Multiple Correspondence (*MC)" (L&R 1995:218), which bans fusion of segments (but not deletion), and argues that coalescence results if a language ranks *MC over constraints banning deletion (such as "PARSE" of L&R 1995:215).

However, L&R's analyses have two weaknesses. First, in the version of faithfulness theory needed to formulate the *MC constraint (correspondence rather than containment theory), it becomes difficult to predict those cases where apparent deletion occurs. L&R cite constraints against feature cooccurrence and against identical features in a single segment. I will show in section 4 that neither of these can successfully ban coalescence. Second, L&R have to use morphological information (alignment of left root edge and left syllable edge) to predict which segment is deleted and to predict the featural makeup of the coalesced segment. Also in section 4, I point out that the same patterns can be observed *within* a morpheme, and that these cases are not satisfactorily explained by morphological constraints. In fact, the wrong features are predicted to be maintained.

In the Athapaskan literature and in general, it seems to me that most accounts of coalescence shed little light on the nature of the process. While it may be predicted under which circumstances coalescence (rather than deletion/epenthesis/etc.) occurs, there is usually no or only a weak explanation of the featural makeup of the coalesced segment. Particularly in OT, coalescence seems to be a "black box": the input and the output are known, but not what happens inside the black box to create this particular output from these particular inputs. It is one of the goals of my analysis to look inside this black box, and to find out which constraints are operative in determining the makeup of the output segment.

1.3. Hypothesis and Assumptions

The central hypothesis of my analysis, based on Howren's insight, is that the D-effect is always coalescence. This includes the cases of apparent deletion, which I will call "vacuous coalescence". I propose that such a uniform treatment is not only possible and more elegant than the deletion analysis, but that it is actually required by OT, which does not allow reranking of constraints within a language. Moreover, such an analysis sheds light on the motivation and the nature of the D-effect, and of coalescence in general.

I propose that coalescence is consistently motivated by the need to preserve as much of the input as possible, while having to meet certain well-formedness/markedness constraints (e.g., syllable structure constraints). Similarly, the featural makeup of the coalesced segment is determined by the interaction between (featural) faithfulness and markedness constraints. This, then, is the nature of coalescence: a sort of compromise between markedness and faithfulness, at the cost of linearity. Most of the constraints active in coalescence are independently evident in the phonology of the language; constraints using morphological information are not necessary.

The analysis is carried out in Optimality Theory and shares the theory's assumptions. Universal grammar is thought to consist of universal constraints, many of which conflict. Forced to choose which of any two conflicting constraints to obey, individual languages rank the constraints in a particular way. The language-specific constraint hierarchy selects an optimal output candidate for each input: the candidate with the least violations of high-ranking constraints.

The theory is representational and output-oriented. Intermediate stages between the input (underlying representation) and the output (surface representation) do not exist. Inputs and output candidates are generated freely; the constraints apply only to the output, testing each candidate for well-formedness and faithfulness, and selecting a single optimal one.

The relevant well-formedness/markedness constraints will be presented throughout the analysis. For the evaluation of faithfulness, I am adopting the Correspondence Theory of faithfulness (e.g., McCarthy & Prince, to appear; S_1 is the string of segments of the input, S_2 of the output):

(3) Correspondence Theory
Given two strings S_1 and S_2, **correspondence** is a relation $\Re$ from the elements of S_1 to those of S_2. Elements $\alpha \in S_1$ and $\beta \in S_2$ are referred to as **correspondents** of one another when $\alpha \Re \beta$.

In Correspondence theory, the faithfulness constraints Parse and Fill are replaced by Max and Dep, respectively:

(4) Max: Every element of S_1 has a correspondent in S_2.

Dep: Every element of S_2 has a correspondent in S_1.

This means that deletion is represented as the actual loss of a segment (under violation of Max), rather than as an unparsed segment. Likewise, epenthesis means the real insertion of a segment in the output string (violating Dep). Notice that colaescence does not violate Max or Dep because each input segment has a corresponding output segment and vice versa (featural identity of correspondents is not required by Max/Dep). For example:

(5) /lé-ye-**d**-Ø-**ɣ**e/ —> [léye.ge] 'it is cut' (Rice 1989:444)

INPUT: l_1 $é_2$ y_3 e_4 $\mathbf{d_5}$ $\mathbf{ɣ_6}$ e_7

OUTPUT: l_1 $é_2$ y_3 e_4 $\mathbf{g_{5,6}}$ e_7

By looking at the indices, one can see that this representation claims that output *g* corresponds to both input *d* and input *ɣ*. This is well motivated since *g* retains features of each input correspondent, as I will demonstrate in the following sections.

All other relevant faithfulness constraints will be introduced in the course of the analysis.

2. Constraints motivating coalescence

Coalescence is one strategy employed in Athapaskan to deal with medial consonant clusters. As most (conjunct) prefixes have the form (C)V̀ and most stems have the form CV(C) (Krauss & Golla 1981), medial clusters do not usually arise. The only exception to this pattern are the classifiers (C) and 1Pl subject agreement (VC), resulting in an input ...*V<u>CC</u>VC*. As demonstrated by L&R (1994), different Athapaskan languages resolve this situation in different ways. Consider the following examples:

(6) <u>Ahtna:</u>
/qw+**D**=**b**a'/ —> [qω**d.ba**'] 'it became twilight' (Lamontagne & Rice 1994:344 (Kari 1990:650))

(7) <u>Koyukon:</u>
/no+ɣə+**D**+nəG/ —> [naɣə**də.n**əG] 'it (string, seam, cloth) unravelled' (L & R 1994:345 (Axelrod 1993:38))

(8) <u>Slave:</u>
/ná-ʔede-ne-**d**-Ø-táh/ —> [náʔedena.**t**a] '3 kicked 3-self' (R 1989:445)
/na-í-**d**-Ø-seh/ —> [nahí.**dz**eh] '3 lets out a yell, yells again' (R 1989:444)

Ahtna-type languages keep both consonants at the cost of allowing codas. They violate the constraint NoCoda while obeying the constraints Dep and Max. Koyukon-type languages obey NoCoda and Max. In order to be able to keep both consonants (as onsets), schwa is inserted in violation of Dep. Thus, we have the following rankings:

(9) a. <u>Ahtna-type</u>
Max, Dep >> NoCoda

b. <u>Koyukon-type</u>
Max, NoCoda >> Dep

Slave-type languages obey NoCoda and Dep and, as all Athapaskan languages, *Complex (=no complex onsets or codas). They violate some other faithfulness constraint, which for now I will call "Faith". The following tableau[3] shows the constraint ranking for Slave:

(10)

na-í-**d**$_1$-Ø-s$_2$eh	Dep	*Complex	NoCoda	Faith
nahíd$_1$.z$_2$eh rt rt			*!	
nahí.d$_1$ə.z$_2$eh rt rt	*!			
nahí.d$_1$z$_2$eh rt rt		*!		
=> nahí.dz$_{12}$eh rt				*

The question is, of course, which faithfulness constraint is violated in Slave. It is not Max, since every element in S_1 has a correspondent in S_2. Max does not demand complete (featural) identity of the correspondents, nor is it violated if two elements share a correspondent. L&R (1995:218) propose that the violated constraint is *Multiple Correspondence:

(11) *Multiple Corespondence(=*MC)
Elements of the input and the output must stand in a one-to-one correspondence relationship with each other.

*MC is symmetrical, banning multiple corresondents in either the input or the output. McCarthy & Prince (to appear) use a more specific constraint which asymmetrically bans multiple correspondents in the input:

(12) Uniformity
No element of S_2 has multiple correspondents in S_1.

For the present analysis it does not matter which of these two constraints is used. Since I have no evidence in Slave of multiple output correspondents, I prefer to use the more specific constraint, Uniformity.

To sum up, Slave-type languages have the following constraint ranking:

(13) NoCoda, *Complex, Dep, Max >> Uniformity

This is the ranking which motivates coalescence. Coalescence occurs when (syllable) markedness constraints and segmental faithfulness are high-ranked. In other words, coalescence is a strategy to maintain an unmarked (syllable) structure without deleting or inserting a segment.

Any markedness constraint (plus Dep and Max) can motivate coalescence. Gnanadesikan (1995) is an example of coalescence satisfying *Complex, and in Pater (to appear) coalescence (nasal substitution) occurs to satisfy another type of markedness constraint, *NÇ, which bans nasal/voiceless obstruent sequences.

Satisfying markedness and segmental faithfulness comes at the cost of non-uniformity[4]. In addition, certain input features are lost (violating Faith[F]) when the output cannot retain all features of both input segments. Before I determine the relevant constraints on the featural level (cf. sections 4–7), I briefly want to discuss the cases of full coalescence, where no features are lost. They provide additional evidence that Max is not violated, i.e., that coalescence is not deletion.

3. Full coalescence: segmental and featural faithfulness

Full coalescence, fusion of two segments without loss of features, occurs in Slave when the resulting segment is permitted in the inventory of the language. There are two cases: *d* + *ʔ* (14), and *d* + coronal fricative (15).

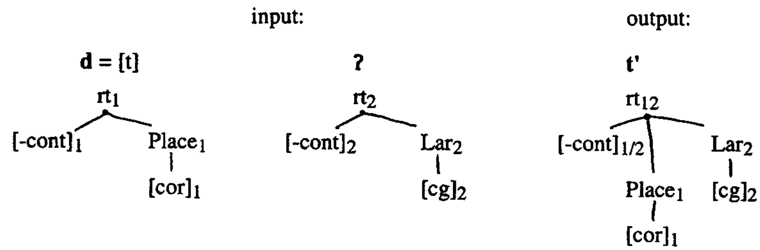
(14) /í**d**-Ø-ʔáh/ —> [hí**t'**á] 'we eat' (R 1989:440)

(15) a. /dah-ʔede-de-í-**d**-Ø-**ɬ**eh/ —> [daʔededí.**dl̯**éh] '3 hangs 3-self' (R 1989:444)

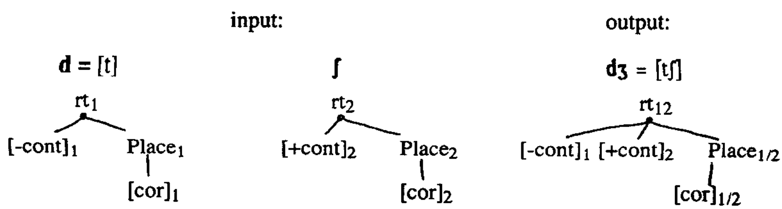
b. /be-k'é-go-de-**d**-Ø-**ʃ**on/ —> [bek'égode.**dʒ**ǫ] 'it is known of 3' (R 1989:444)

The output of full coalescence is a segment which corresponds to both input segments. So, Max is not violated: there is no deletion. In addition, full coalescence obeys featural faithfulness: *t'* retains all features of both input segments, as shown in (16). Likewise, the coronal affricates of (15) contain all input features, including both the stop's feature [-cont] and the fricatives' feature [+cont], compare (17).[5]

(16)



(17)



Assuming that features are entities which can stand in correspondence, each input feature corresponds to an identical output feature, and vice versa. Thus, there are no violations of Max[F] and Dep[F].[6] Full coalescence is perfectly faithful at the featural level, as well as at the segmental level. The only constraint violated is Uniformity. Tableau (18) sums up full coalescence:

(18)

í**d**$_1$-∅-ʔ$_2$áh	Max	Max[F]	Uniformity
hí.ʔ$_2$áh	*!	*!	
hí.**d**$_1$á	*!	*!	
=> hí**t'**$_{12}$á			*

If full coalescence would result in a segment not permitted in the language, certain input features must be lost. This is "partial" coalescence, where featural faithfulness is violated. The following sections examine the featural constraints and rankings which determine the structure of the output segment. I will begin with place features.

4. Place

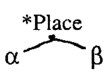
4.1. d + noncoronal fricative

When *d* meets a noncoronal fricative, the output is not an affricate, but a stop at the place of the fricative:

(19) /lé-ye-**d**-∅-**ɣ**e/ —> [léye.ge] 'it is cut' (R 1989:444)
*[léye**dɣ**e], *[léye**gɣ**e], *[léye**dz**e]

Full coalescence, as in *[léye**dɣ**e], is banned here because Slave does not allow segments which have two different places of articluation (cf. L&R 1995). This is a constraint from Slave's "background phonology" (McCarthy & Prince, to appear). I am calling the constraint SamePlace:

(20) SamePlace (=SamePl):



where α, β are features.

Also active in Slave's background phonology is a constraint/constraint family which bans all affricates but coronal ones. How could this be formulated? First of all, consider that affricates are more marked universally than simple stops or simple fricatives. There are languages which have only plain stops, but there do not seem to be languages which have only affricates. Maddieson (1984) notes that all languages have stops, and "a language with only one stop series almost invariably has plain voiceless plosives..." (p. 27). For this reason I am assuming the existence of a constraint *Affric, dominating *Stop (and *Fricative).

Since Slave (like many other languages) allows only coronal affricates, *Affric must be broken down into more specific constraints by place of articulation:[7]

(21) *Affric, *Affric >> *Affric
[dors] [lab] [cor]

The full hierarchy may actually rank *Affric[dors] above *Affric[lab]. This is supported by the extent of affrication in the High Germanic Sound Shift: Low German languages like English and Dutch have only coronal affricates; High German has coronal and labial affricates, and Upper German (Swiss German) has coronal, labial, and dorsal affricates (e.g., von Polenz 1978).

(21) has the effect of ruling out the dorsal affricate *[léyeg**ɣ**e]. So far, all the proposed constraints are independently needed to account for the Slave consonant inventory. They select the stop in [léye.ge] as the optimal candidate, thus yielding the correct output. ([léye.ge] may violate lower-ranked *Stop, which is not included in the tableau. The choice of stop versus fricative is examined in section 5.)

(22)

$d_1 + \gamma_2$	SamePl	*Affric [dors],[lab]	*Affric [cor]
$d\gamma_{12}$	*!	*!	*
$g\gamma_{12}$		*!	
dz_{12}			*
=> g_{12}			

However, these constraints by themselves cannot determine the place of articulation of the stop, which could be coronal [d] or dorsal [g]. In order to decide between these two candidates, I adopt the following hierarchy from Pulleyblank (1998):

(23) Max[dors], Max[lab] >> Max[cor]

This hierarchy means that, in the case of a place conflict, the more marked place is maintained, since faithfulness to a marked place dominates faithfulness to an unmarked place. Such a hierarchy is known as "Markedness-as-Faithfulness" because markedness is reflected in the ranking of faithfulness constraints, and has been proposed by Pulleyblank (1998) and Kiparsy (1994). Again, there may be a subranking of Max[dorsal] >> Max[labial] (Gnanadesikan 1995), which is irrelevant to this analysis.

(19) together with SamePl and the affricate hierarchy yields the correct output:

(24)

$d_1 + ɣ_2$	SamePl	*Affric [dors],[lab]	Max [dors],[lab]	Max [cor]	*Affric [cor]
$dɣ_{12}$	*!	*!			*
$gɣ_{12}$		*!		*	
dz_{12}			*!		*
d_{12}			*!		
=> g_{12}				*	

Note that the candidate [d_{12}] contains no features of the input segment [$ɣ_2$]. It is therefore not in correspondence with [$ɣ_2$] and should be indexed as [d_1]. So, to be precise, this candidate is also ruled out by Max. Does this mean that we do not need the hierarchy in (21)? No; it is still needed to determine the place of articulation of coalesced stops, as I will now show.

4.2. d + stop

When *d* coalesces with another stop, it is also the most marked place which is maintained.

(25) a. /í**d**-Ø-**kwe**/ —> [hí**kwe**] 'we cut' (Bearlake; R 1989:441)

b. /ʔededeyį-**d**-Ø-**k'**o/ —> [ʔededeyį**k'**o] '3 stretched 3-self' (R 1989:470)

The same constraints as those in the analysis of fricatives account for these facts. SamePl militates against stops with two places of articulation, and the Markedness-as-Faithfulness hierarchy selects the candidate with the more marked place of articulation:

(26)

	Max	SamePl	Max [dors],[lab]	Max [cor]	*MC
$d_1 + k'_2$: dk'_{12}		*!			*
d_{12}			*!		*
=> k'_{12}				*	*

So, the hierarchy in (23) is well-motivated, as it accounts for the place of articulation of coalesced stops as well as coalesced stops plus fricatives.

L&R (1994, 1995) use constraints containing morphological information to account for the place of articulation of the coalesced segment. Assuming that in the case of *d* + stop there is deletion rather than coalescence, they propose that (27) decides which input segment is deleted:

(27) Align-L (Root) (L&R 1994:344)

$[_{Root} = [_{\sigma}$

Align-L (Root) "requires coincidence of left root edge and left syllable edge" (ibid.) and will therefore always force deletion of the d-classifier rather than of the stem- (or root-)initial consonant. However, this does not explain the choice of place in *d* + noncoronal fricative, where there is no deletion. Here, L&R have to extend Align-L to the featural level. They have to assume a high-ranked Align-L ([Place]) which forces maintenance of the stem-/root-initial place feature. Not only is this an unusual constraint, it also fails to explain the choice of place if coalescence occurs root-internally, as it does in child language:

(28) /twi/ —> [pi] 'tree' (Gnanadesikan 1995:14)

Alignment predicts that the place feature [coronal] of the root-initial consonant, rather than the feature [labial] of the second consonant, should be kept, yielding [ti]. This is obviously wrong. Instead, as Gnanadesikan observes, it is the *more marked* place which is kept. The child language facts are consistent with the markedness-as-faithfulness hierarchy, rather than with Alignment.

A second argument against the Alignment analysis comes from the case of *d+ʔ—> t'*. If, as Lombardi (1996) suggests, glottals are not placeless, but have a place feature [pharyngeal], then Alignment predicts that [pharyngeal], which is stem-initial, will be maintained over coronal, yielding the wrong output [ʔ̰].

In contrast, the markedness-as-faithfulness hierarchy still predicts the correct output. This is because in Lombardi's theory [pharyngeal] is the least marked place, less marked than [coronal]. The markedness-as-faithfulness hierarchy would then look as follows,

(29) Max[dors], Max[lab] >> Max[cor] >> Max[phar]

and it would still yield the desired result: a coronal [t'][8]. L&R, on the contrary, would have to make the strange assumption that [ʔ] is not pharyngeal in order for their analysis to work in Lombardi's framework.

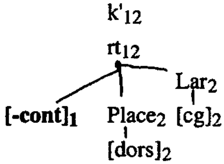
It seems, then, that my analysis, which uses markedness-as-faithfulness to predict the place of a coalesced segment, is able to handle a broader realm of phenomena and theories than the Alignment analysis. It can account for *d + ʔ —> t'* whether glottals are placeless or [pharyngeal], while the Alignment constraint only works if glottals are placeless. And, more importantly, markedness-as-faithfulness can explain root-internal coalescence in child language, where Alignment predicts an output with the wrong place of articulation. Clearly, the problem with L&R's Alignment analysis is that it uses a constraint referring to morphological information. I conclude that my analysis of place features in coalescence in terms of markedness has to be favored over that of L&R.

4.3. Vacuous coalescence

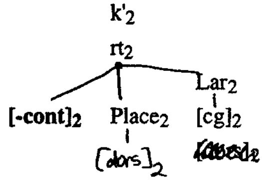
As already mentioned in the introduction, there is another difference between L&R's and my analysis. L&R assume that the D-effect with stops involves deletion, while I follow Howren (1971) and propose that even with stops, there is (vacuous) coalescence rather than deletion. The difference between vacuous coalescence and deletion is illustrated in (30) for example (25).

(30) *d + k' —> k'*

a. vacuous coalescence



b. deletion



The subtle and formal difference between these two representations is that (30a) contains features of both input segments, while (30b) doesn't. Because (30a) has features of both input segments, it is in correspondence with both of them, and represents a coalesced segment. In contrast, (30b) is not in correspondence with the input d_1 (featurally), so it is a case of deletion. L&R do not make this formal distinction between (30a) and (30b). They simply assume deletion whenever the output looks identical to only one of the input segments. However, (30a) is theoretically possible and, I argue, even desired, for the following reasons.

First of all, it is in fact impossible to rule out (30a). Given the ranking which motivates coalescence in the first place, Max >> Uniformity, (30a) will always win over (30b), as evident in tableau (31), an expanded version of tableau (26).

(31)

		Max	SamePl	Max [dors],[lab]	Max [cor]	*MC
$d_1 + k'_2$:	dk'_{12}		*!			*
	d_{12}			*!		*
(30b):	k'_2	*!			*	
(30a):	=> k'_{12}				*	*

In order to force deletion (30b), as the optimal candidate, the opposite ranking would be necessary. In other words, there is a ranking paradox: Max >> Uniformity for the coalescence cases versus Uniformity >> Max for the deletion cases.

In order to avoid this paradox, L&R use a third, independent constraint to rule out coalescence: the "Shared Feature Convention" (following Steriade 1982). However, the Shared

Feature Convention only prohibits like features within a single segment, something like *k'* with the feature [-cont]$_1$ as well as the feature [-cont]$_2$. But this is different from (30a), which contains only one feature of each kind. Thus, the Shared Feature Convention cannot rule out (30a). As I said above, there is no way of ruling out (30a), therefore vacuous coalescence will always win over deletion.

Secondly, the fact that vacuous coalescence always wins over deletion is the desired result, because it provides a more consistent and insightful analysis of the D-effect. If the D-effect is always coalescence, it is always motivated by the same constraints, namely high-ranking segmental faithfulness in conjunction with high-ranking syllable structure constraints. As pointed out in the introduction, this is a unified account of the D-effect which sheds light on its nature: The D-effect occurs in order to be segmentally faithful while having to satisfy markedness (syllable structure constraints). As much as possible of the input, i.e., of both consonants, is maintained. Through coalescence, deletion is avoided, thus segmental faithfulness (Max) is respected. Coalescence also maintains as many input features as possible, thus also obeying featural faithfulness (Max[F]) as much as possible. Segmental and featural faithfulness come at the cost of uniformity, which is a type of linearity (McCarthy & Prince, to appear): the linear sequence of the input segments/features is lost.

If the D-effect were sometimes coalescence and sometimes deletion, there would be no uniform motivation for it, as reflected in the ranking paradox mentioned above. Sometimes segmental and featural faithfulness would be more important than uniformity/linearity (coalescence), and sometimes the priorities would be reversed (deletion), all without apparent reason, as no independent constraint could be found to motivate such a reversal.

For this reason, an analysis of the D-effect in which coalescence always wins over deletion is more insightful and more desirable.

I conclude that my account of the D-effect consistently as coalescence is superior to the commonly held "split" view, and that it is in fact the only possible analysis in OT. Gnanadesikan (1995) in her analysis of cluster reduction in child language comes to the same conclusion.

4.4. Summary

This section has established that the place of articulation of a coalesced segment is determined by a markedness-as-faithfulness hierarchy, which selects the candidate with the most marked place as optimal. Also active are two constraints from Slave's backgroud phonology, SamePlace and a *Affric hierarchy. They serve to exlude noncoronal affricates as outputs of the D-effect and in the language in general.

The constraint(s) Align-L (L&R 1994, 1995) were rejected as explanation of place of articulation because they do not cover as wide a range of data as the markedness-as-faithfulness hierarchy. In particular, Align-L cannot explain the choice of place in root-internal coalescence in child language.

Finally, I have shown that the D-effect always involves coalescence and never deletion, contrary to the commonly held view. I have argued that in OT, it is impossible to analyze the instances of vacuous coalescence as deletion, and that a uniform account of the D-effect as coalescence provides more insight into the nature of this phenomenon.

5. Manner

Next, I am concerned with explaining the manner of articulation of the coalesced segment. This question only arises in the case of *d* plus noncoronal fricatives (nasals will be dealt with in section 7). As shown in the previous section, they cannot become affricates, so a choice has to be made whether to maintain the feature [-cont] of the d-classifier or the feature [+cont] of the stem-initial fricative. As the following examples show, the feature [-cont] is maintained.

(32) /lé-ye-**d**-Ø-**ɣ**e/ —> [léye.ge] 'it is cut' (R 1989:444)
*[léye.**ɣ**e] *[léye.**z**e]

This can be derived from the respective faithfulness constraints:

(33) Max[-cont] >> Max[+cont]

$d_1 + ɣ_2$	Max[-cont]	Max[+cont]
z_{12}	*!	
$ɣ_{12}$	*!	
=> g_{12}		*

Such a ranking is well-motivated. It reflects the fact that universally, stops are less marked than fricatives: All languages have stops, but not all languages have fricatives in their inventory. While there are languages which have only stops, there are no languages which have only fricatives and no stops (Maddieson 1984). In OT, these typological facts are derived by combining the constraints *[-cont], *[+cont], Max[-cont] and Max[+cont]. A language with stops only ranks *[+cont] above the other three constraints, banning all fricatives. A language with stops and fricatives ranks Max[-cont] highest (using only *[-cont] >> *[+cont] does not work; it bans all stops, resulting in an unattested language with fricatives but without stops).

(34) Max[-cont] >> Max[+cont], *[-cont], *[+cont]

		Max[-cont]	Max[+cont]	*[+cont]	*[-cont]
g:	=> g				*
	ɣ	*!		*	
ɣ:	g		*!		*
	=> ɣ			*	

Thus, a language with stops and fricatives has the subranking *Max[-cont] >> Max[+cont]*, as in (33).

The question arises, however, whether this ranking will not perhaps ban *all* fricatives in Slave, i.e., whether it is too powerful. This is not the case. Stops are only chosen over fricatives in coalescence, where the output is checked against two input segments. A fricative output results if the input is a single fricative, as can be seen in (34) for input *ɣ*. Here, Max[-cont] is simply irrelevant.

A comparison between (33) and (34) reveals an interesting fact: While the markedness of fricatives is not respected in the inventory, it is respected in coalescence. In other words, the unmarked manner emerges in coalescence!

It seems to me, then, that there is a type of emergence of the unmarked which has not yet been noticed. Usually, the unmarked emerges as follows (cf. McCarthy & Prince, to appear). A markedness constraint C is dominated by I-O Faithfulness and as a consequence is inactive in the language as a whole: *I-O Faith >> C*. It can emerge, however, in a domain such as reduplicants which are not subject to I-O Faith, but to B-R Identity: *I-O Faith >> C >> B-R Identity* . Since the markedness constraint C dominates this third constraint, B-R Identity, the unmarked emerges in the reduplicant.

In coalescence, there are no two different domains. So the unmarked cannot emerge because C dominates the domain-specific constraints. Instead, the unmarked emerges because the dual input provides a *choice* between faithfulness to a marked or to an unmarked feature, a choice not usually given in the computation for best output.

I leave it to future research to determine the status of this possible new type of emergence of the unmarked.

To return to the analysis of the D-effect, Max[-cont] and Max[+cont] interact with the constraints established in section 4. The following tableau provides a summary of all the constraints involved in determining the place and manner of a coalesced segment.

(35)

		Max	SamePl	Max [-cont]	Max [dors]/ [lab]	*Affric [dors]/ [lab]	Max [cor]	Max [+cont]	*Affric [cor]	Unif.
$d_1+\gamma_2$	$d\gamma_{12}$		*!			*				*
	$g\gamma_{12}$					*!	*			*
	dz_{12}				*!				*	*
	z_{12}			*!	*!					*
	γ_{12}			*!			*			*
	d_2	*!			*!			*		
=>	g_{12}						*	*		*
d_1+z_2	z_{12}			*!						*
	d_{12}							*!		*
=>	dz_{12}								*	*
d_1+dz_2	dz_2	*!								
	d_{12}							*!		*
=>	dz_{12}								*	*
d_1+g_2	dg_{12}		*!							*
	d_{12}				*!					*
	g_2	*!					*			
=>	g_{12}						*			*

The constraints yield the correct forms in all cases and provide a unified account of the D-effect.

However, one last observation needs to be made. Notice that place of articulation is obtained by a markedness-as-faithfulness hierarchy, while manner of articulation is determined by an opposite hierarchy, where faithfulness to a less marked feature dominates faithfulness to a more marked one. I will call the latter type of hierarchy "markedness-as-markedness". These two distinct hierarchies capture the fact that in the D-effect, the most marked place and the least marked manner are kept. Several questions come to mind:

Are there phenomena which show reversed hierarchies, i.e. markedness-as-markedness for place, and markedness-as-faithfulness for manner? To my knowledge, markedness-as-faithfulness has only be suggested for place features. But why should there be such an asymmetry? Is there an inherent difference between place and manner features, which brings about the asymmetric behavior? In addition to coalescence, assimilation will provide fruitful exploration grounds for these questions.

In summary, manner of articulation of the coalesced segment is determined by a markedness hierarchy: Max[-cont] >> Max[+cont]. This ensures that the less marked manner of articulation is chosen in coalescence. Interestingly, this means that coalescence is another way of getting emergence of the unmarked (for manner of articulation).

6. Laryngeal features

The behavior of laryngeal features in the D-effect seems puzzling at first. Consider the following examples:

(36) a. /Ø-**s**eh/ —> [he**z**eh] '3 yells/shouts'
b. /na-í-**d**-Ø-**s**eh/ —> [nahí**dz**eh] '3 lets out a yell, yells again'
c. (obj) /léyį-Ø-**x**e/ —> (obj) [léyį**ɣ**e] '3 cut obj'
d. /lé-**d**-Ø-xe/ —> [léye**g**e] 'it is cut' (R 1989:444)

(37) a. /ná-ne-į-Ø-**t**áh/ —> (obj) [náneį**t**a] '3 kicked (obj)'
b. /ná-ʔede-ne-na-**d**-Ø-**t**áh/ —> [náʔedena**t**a] '3 kicked 3-self' (R 1989:445)

What is puzzling is that *d* seems to voice fricatives, but fails to voice stops. This confusion arises if one assumes that *d* has a feature [voice], as the symbol suggests. But recall that the voiced-stop symbols are used for voiceless unaspirated stops. If one compares the behavior of stops to that of fricatives, it becomes apparent that the stops do not have a feature [voice]. The patterns are as follows:

Stops (in stem-initial position) show no laryngeal alternations. They are phonetically plain or aspirated or glottalized, never voiced, and do not show any voicing or other assimilation. In contrast, stem-initial fricatives are phonetically voiced or voiceless. They are voiced between voiced segments and voiceless if preceded by a voiceless segment (usually [h]).[9]

I follow Rice (1993, 1994) in conluding from these patterns that there must be a fundamental difference between stops and fricatives in Slave. Fricatives pattern with sonorants; stops are the only true obstruents of the language. This difference can be captured by using different features for stops and fricatives: Distinctive laryngeal features for stops are [cg] and [sg]. Fricatives have no laryngeal features underlyingly, but have voiced allophones between voiced segments. In other words, [voice] can spread to fricatives but not to stops.

In OT, this background phonology translates into the following constraints: There is a universal constraint which bans voicing on obstruents, *Voi/Obs (cf. Pulleyblank 1997). Since neither stops nor fricatives have voiced phonemes, for both *Voi/Obs must dominate Max[voi].[10] As can be seen in tableau (38), irrespective of the input, the outputs never have a feature [voi].

(38)

			*Voi/Obs	Max[voi][11]
/s/	=>	s		
		z [voi]	*!	
/z/ [voi]	=>	s		*
		z [voi]	*!	
/d/	=>	d		
		d [voi]	*!	
/d/ [voi]	=>	d		*
		d [voi]	*!	

The voiced fricative allophones occur because of a constraint which requires identical voicing values of adjacent segments. I am not concerned here with the correct formalization of this constraint. It could be something like Spead[voi] (cf. Lombardi 1996) or a free interpretation of

ICC[voi] (Pulleyblank 1997). I will opt for the latter. ICC[voi], then, dominates *Voi/Obs, yielding voiced fricatives between voiced segments, as in (36a, c) above.

(39)

	ICC[voi]	*Voi/Obs	Max[voi]
a. /Ø-seh/ (= 33a)			
heseh	*!		
=> hezeh [voi]		*	*
b. /léyį-Ø-xe/ (=33c)			
[léyįxe]	*!		
=> [léyįγe] [voi]		*	*

Note that the same outputs would result if the underlying fricatives were voiced.

Stops do not undergo voicing. This can be captured in several different ways. One is to build into the definition of ICC[voi] that it does not apply to stops. Another is to split *Voi/Obs into two constraints, *Voi/Stop and *Voi/Fric. They would have to be ranked as follows,

(40) *Voi/Stop >> ICC[voi] >> *Voi/Fric >> Max[voi][12]

where *Voi/Fric replaces the *Voi of (39). The ranking in (40) ensures that stops do not undergo voicing, while fricatives do. Furthermore, since OT is output-oriented, a coalesced segment behaves like a "simple" output. If the coalesced segment is a stop, as in the case of D-effect, it will not be voiced, even if one of its corresponding input segments is a fricative. Compare tableau (41):

(41)

	*Voi/Stop	ICC[voi]	*Voi/Fric	Max[voi]
a. /na-í-**d**-Ø-seh/ (=36b)				
=> [nahí**dz**eh]		*		
[nahí**dz**eh][13] [voi]	*!			*
b. /lé-**d**-Ø-xe/ (=36d)				
=> [lé**y**e**g**e]		*		
[léye**g**e] [voi]	*!			*
c. /ná-ʔede-ne-na-**d**-Ø-táh/ (=37b)				
=> náʔedenata[14]		*		
náʔedena**d**a [voi]	*!			*

To sum up, OT uses the background phonology of Slave to account for the fact that the D-effect produces only voiceless stops. No constraints specific to coalescence are proposed in this section. While some of the constraints are not "pretty", e.g., ICC[voi]stop and ICC[voi]fric, they are all required independently, in order to account for the unique behavior of Slave stops and fricatives in general.

So far, I have accounted for the place, manner and laryngeal features of a coalesced segment. Most of the facts simply fell out from the background phonology of Slave. In the next section of the analysis I turn to the last feature involved in the D-effect, nasality.

7. Nasality

The only phenomenon still to be accounted for is coalescence involving nasals. Two examples are given in (42).

(42) a. /-k'e-na-go-de-**d**-Ø-**ne**h/ —> [gok'eagoda**de**] '3 explored by talking'

b. /**d**-Ø-**me**/ —> [(ʔeðéh) **ehbe**] '(the hide) is strung on a frame' (R 1989:445)

We can observe that when *d* meets a nasal, the nasality is lost, and the output is a—less marked—oral stop. Furthermore, the more marked place feature is kept as usual.

The markedness-as-faithfulness hierarchy for place is responsible for choosing the output place feature. The outcome in terms of nasality can be captured by the ranking Max[-nas] >> Max[+nas]. Tableau (43) illustrates this:

(43)

	Max[-nas]	Max[dors]/ [lab]	Max[+nas]	Max[cor]
a. $d_1 + n_2$				
=> d_{12}			*	
n_{12}	*!			
b. $d_1 + m_2$				
=> b_{12}			*	*
m_{12}	*!			*
d_{12}		*!	*	
n_{12}	*!	*!		

While tableau (43) yields the correct outputs, there is something unsatisfactory about this analysis. Note that it hinges on the use of the feature [-nas]. However, nasality is usually assumed to be a privative feature (e.g., Steriade 1995): [nas] corresponds to the lowering of the velum and airflow through the nasal cavity; the absence of [nas] indicates that no such articulatory movement has taken place and that the articulation is oral. I have no independent justification for the feature [-nas], other than to make the analysis work.

The question, then, is whether there is any other way to explain the orality of the output. Gnanadesikan (1995) proposes to derive the loss of nasality from syllable structure constraints. She proposes a universal hierarchy which forces the choice of the better (less sonorous) onset:

(44) μ/V >> μ/Glide >> >> μ/Approx >> μ/Nasal >> μ/Fric >> μ/Stop

If Max[nas] is interspersed in this hierarchy immediately below μ/Nasal, the coalesced segment has to be oral, violating Max[nas] under duress of obeying μ/Nasal. While at first this seems like an ingenious solution to account for the loss of nasality in coalescence, it makes the wrong predictions elsewhere. Max[nas] >> μ/Nasal effectively rules out *all* nasal onsets in the language. However, nasal onsets are attested in Slave as well as in child language:

(45) a.	**ná.da.ne.ʔį**	'3 whispers'	(R 1989:447)
b.	**nih.me**	' you (sg) boil object'	(Fort Liard Slavey, R 1989:473)
c.	fi.te.**n**ʌ	'container'	(Gnanadesikan 1995:11)

Gnanadesikan does not explain this contradiction. To me, this looks like another case of emergence of the unmarked (unmarked onsets) in coalescence, but certainly we have not found the formal means to ban nasal onsets in coalescence only.

One last possibility is that this pattern has to do with the representation of nasals in Athapaskan languages in general. To begin with, there are few stems which have an underlying nasal. Furthermore, those stems can be phonetically realized as nasals, prenasalized stops or oral stops, as in (46).

(46) -**n**ɛh/-**nd**ɛh/-**d**ɛh 'talk (imperf.)' (Slave, R 1993:325)

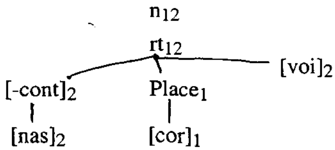
And finally, nasals are the only segments which show a high degree of cross-linguistic variation in the D-effect. *d+n* can result in *d*, as in Slavey, but it can also result in *n* (Sarcee/Tsuut'ina), in ^{d}n (Carrier) and in *n'* (Navajo) (Howren 1971).

All these facts indicate that there is some variation or uncertainty in the interpretation of nasals. For example, Rice (1993) suggests that nasal consonants do not have [nas] underlyingly, but that [nas] may be inserted by default. If this assumption is true, the variable interpretations of nasal stops are not surprising.

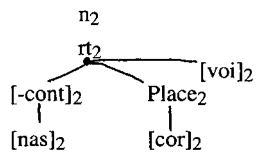
Following this line of reasoning, we can speculate that the output of *d+n* is *d* in Slave in order to maintain stronger faithfulness to both input segments. Note that an output *n* would not give a clear indication that it is a coalesced segment. It could either have the representation in (47a) or that in (47b)[15]:

(47) coalesced:

a.

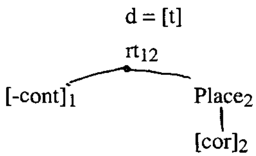


b. not coalesced:



In light of this ambiguity, and given the freedom in the pronunciation of nasals, speakers of Slave may just prefer an oral articulation, where there is no such ambiguity:

(48)



Because of its orality, *d* is not identical to only one input segment (this is even clearer in the case of *d+m —>b* with the place feature $[labial]_2$) and is certain not to violate Max. It cannot be interpreted as deletion of input *d*, while *n* can.

This is an informal explanation, based on the motivation for coalescence to satisfy Max. If it is accurate, it provides strong evidence that the D-effect is indeed coalescence, even in the cases of *d* + stop. However, there is no straightforward way to represent this informal explanation in OT (or any other theory, for that matter).

In summary, coalescence of *d* plus a nasal involves the markedness-as-faithfulness hierarchy for place. No clear account for the loss of nasality has been found. The formal solutions make the wrong predictions or have to resort to uncommon representations, and the intuitive idea that the loss of nasality may be due to faithfulness cannot be represented formally.

Clearly, the representation of nasals in Athapaskan and their behavior in the D-effect needs more work.

8. Conclusion

This paper has presented an OT account of the D-effect in Slave, a Northern Athapaskan language. It has provided broad empirical coverage of the phenomenon of coalescence within the language and beyond, and has shed light on the nature of the process.

As to the nature of the process, the present analysis of the D-effect found that coalescence results from the interaction of faithfulness and markedness constraints. In particular, coalescence is a strategy to obey markedness as well as segmental faithfulness, and featural faithfulness as much as possible. In terms of constraints, this means that markedness , segmental faithfulness and featural faithfulness are high-ranked. The tradeoff is that Linearity or Uniformity are low-ranked: the linear sequence of the input is not recoverable.

This background of constraints predicts that the D-effect is always coalescence, even if the output looks like deletion. I argued that apparent deletion is in fact vacuous coalescence, and that the deletion analysis (for example, L&R 1994, 1995) is in fact impossible, given the OT constraints. This is desirable, since then the D-effect finds a uniform explanation which provides insight into its function.

The function of the D-effect and of coalescence in general is to maintain as much of the input as possible. With Max always satisfied, this is played out at the featural level: as many features as possible of both input segments are maintained. The language's background phonology and general, well-motivated markedness hierarchies determine how many and which features are maintained. Specific constraints, referring to morphological information, are not needed. This simple account can be extended beyond the D-effect, for example to coalescence in child language, something previous analyses have not achieved.

Besides providing a better understanding of the nature and the "inner workings" of coalescence, the study of coalescence raised some points of theoretical interest. For example, coalescence can yield emergence of the unmarked whenever there is a hierarchy Max[$F_{unmarked}$]

>> Max[F_{marked}], as in the choice of stops over fricatives. Usually, emergence of the unmarked involves faithfulness to different domains, in coalescence it involves computation over two inputs. Other interesting points are the special status of nasals, which needs further study, and the asymmetry between place and manner/stricture in terms of markedness and faithfulness. The further study of coalescence in Athapaskan and other languages is certain to shed more light on these questions.

Notes

* I thank Suzanne Urbanczyk for her encouragement, generous sharing of ideas, and enthousiasm. Without her, this paper would not exist. All errors and inadequacies are my own.

1 There is one other in-depth treatment of coalescence in Athapaskan: Causley 1996. Unfortunately, this work is not available to me at the time of writing.

2 The one exception to this is Sarcee/Tsuut'ina, where the D-effect is only caused by the classifier (Cook 1984).

3 Indices are used to show correspondence relations. Segments with the same index are correspondents of each other. Note that correspondents do not have to share all features.

4 Pater uses the more general constraint "Linearity" (cf. McCarthy & Prince, to appear).

5 While my analysis would also work in the aperture theory of Steriade (to appear), I am not using this framework. For reasons, see section 4, footnote 7.

6 If we were to use Ident[F] ("Correspondents are identical in their specification for F.", e.g., Pater to appear), there would be a violation from the output to the input: *dʒ* , a contour segment, is in correspondence with two non-contour segments, incurring one violation each of Ident[-cont] and Ident[+cont]. For this reason, Pater splits Ident[F] into IdentI-O[F] (similar to Max[F]) and IdentO-I[F] (similar to Dep[F]). Full coalescence violates only IdentO-I[F] (but not Dep[F]!), so this constraint is low-ranking.

However, I find using the Ident constraints problematic because one of them is *always* violated, even in cases of full coalescence. This does not capture the intuition that full coalescence maintains all features and is therefore perfectly faithful at the featural level—as opposed to partial coalescence, where certain (input) features are lost. Max[F] and Dep[F] capture this intuition better, since they only show violations in cases of true coalescence.

For another account of coalescence which prefers Ident constraints, see Gnanadesikan (1995).

7 The fact that affricates are more marked than stops provides evidence against Steriade's (to appear) aperture theory. In aperture theory, stops and affricates have equally complex representations, consisting of a closure and a release node:

(i) a. stops: A_0A_{max}

b. affricates: A_0A_f

These representations wrongly predict that stops and affricates are equal in markedness. To get out of this dilemma, Steriade assumes that for stops, "releases are projected from underlying representations which are mere closures" (p. 208) by a Release Projection rule. However, this solution is not available in OT, which is a purely output-oriented representational theory.

For this reason, I am not using aperture theory in my analysis.

8 The output is still [t'], not [t], because the laryngeal feature [cg] is also maintained (cf. section 3 on full coalescence).

9 The patterning of stops is probably the same in all environments, but since I have only checked what happens in stem-initial position, I do not want to make such an unsubstantiated generalization.

With fricatives, there is a complication. In (initial position of) noun-stems, they are voiceless word-initially and voiced if preceded by any segment. Rice (1993) derives this difference between verb and noun stems from a morpheme [+voice], which intervenes between noun stem and prefix, but not between verb stem and prefix.

10 Also, in order to get the aspirated and glottalized stop phonemes, the following rankings must be assumed: Max[cg] >> *[cg] and Max[sg] >> *[sg].

11 Notice that Dep[voi] must also be low-ranking.

12 A third possiblity is to split ICC[voi] rather than *Voi/Obs. The relevant ranking would be ICC[voi]fric >> *Voi/Obs >> ICC[voi]stop >> Max[voi]. It is beyond the scope of this paper to determine which of these alternatives is the correct one. They all yield identical results in the analysis of the D-effect.

13 As is common in the Athapaskan literature, I am assuming that affricates are part of the stop series, cf. (2) in section 1.1. Thus, they are sensitive to *Voi/Stop rather than to *Voi/Fric.

14 Not inlcuded in this tableau are the constraints Max[cg] and Max[sg] (cf. footnote 10), which ensure that these distinctive laryngeal features of stops are maintained in coalescence.

15 Note that I also make the assumption that [-cont] dominates [nas]. Such an assumption is uncommon, but in the spirit of Rice (1987) who suggests that in Slave, the manner features are dominated by a manner node.

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