An optimality theory account of the D-effect in Ahtna

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The D-effect is a well-studied phonological alternation in Dene languages and occurs when the D- classifier prefix precedes a consonant-initial verb stem. This paper analyzes the D-effect in Ahtna using the framework of Optimality Theory. In this paper, it is demonstrated that in Ahtna coalescence and syllable structure are used to preserve the input segments and their features in the output. It is demonstrated that a pattern that at first glance appears to be deletion, is another form of coalescence known as 'vacuous coalescence.' In Ahtna, full coalescence being the fusion of two segments without loss of features occurs when the resulting segment is permitted in the inventory of Ahtna. If this is not possible, then Ahtna uses syllabification and vacuous coalescence to preserve the segments. This analysis further adds data to the prediction of the D-effect in Ahtna for the patterns found in the language.
Keywords: D-effect; Dene languages; coalescence; Optimality Theory

1 Introduction

The D-effect is a well-studied alternation in Dene languages (Wilhelm, 2000). It occurs when /t-/ from the D- classifier prefix meets a consonant-initial verb stem. As demonstrated by the following data set (1), in Ahtna the D-effect is shown to have five different alternations. Ahtna is a Dene language spoken in the Copper River area of Alaska with about 80 speakers (University of Alaska Fairbanks, n.d.). The first alternation as shown in (1a) is the formation of an affricate, (1b) demonstrates the formation of a glottalized stop, the formation of a complex onset is exemplified by (1c), syllabifying the /t-/ as the coda of the preceding syllable is displayed in (1d), and finally, (1e) has previously been analyzed as deletion, but this paper analyzes it as actually another form of fusion. All the data presented in this paper comes from the Ahtna Athabaskan Dictionary (Kari, 1990) and presented using the International Phonetic Alphabet (IPA).

(1)	a.	/tɐ-**t-z**ɛn/	[tɐ.**t͡s**ɛn]	'it is dark coloured'
	b.	/nɐʔi-**t-ʔ**ɐɐn/	[nɐ.ʔi.**t'**ɐːn]	'it was found'
	c.	/naʔɪ-**t-ɣ**ɐɐ/	[na.ʔɪ.**tɣ**ɐː]	'he returned'
	d.	/ɐ-**t-n**ɐɐ/	[**ɐt.n**ɐː]	'he is working'
	e.	/tɐ-**t-tɬ'**ɛt͡s'/	[tɐ.**t͡ɬ'**ɛt͡s']	'it is blue'

The D-effect occurs to reduce a medial consonant cluster formed by the D-classifier prefix attaching to a stem-initial consonant to maintain as much of the input as possible. According to Wilhelm (2000), the D-effect occurs for the output to be segmentally faithful, while having to satisfy markedness and syllable structure constraints.

Previous analyses have conflicted with regard to the D-effect. Howren (1971) proposed a general rule for the D-effect stating that it is always coalescence, never deletion. LaMontagne and Rice (1994, 1995) completed an Optimality Theory analysis of the D-effect across many Indigenous languages and concluded that depending on the language, there are different processes, including coalescence, deletion, syllabification as rhyme, and epenthesis. However, Wilhelm (2000) conducted an Optimality Theory analysis of the D-effect in Slave and found support for Howren's (1971) original analysis of the D-effect. Wilhelm (2000) concluded that the D-effect is only coalescence, with the apparent deletion being 'vacuous coalescence,' which will be discussed further.

This paper will analyze the Ahtna D-effect in the framework of Optimality Theory (Prince & Smolensky, 1993). This paper will show how the five patterns exemplified in (1) are forms of coalescence or using syllable structure to preserve the segments. What at first glance appears to be deletion in (1e) is to be a form of coalescence known as 'vacuous coalescence.' In Ahtna, full coalescence being the fusion of two segments without loss of features occurs when the resulting segment is permitted in the inventory of Ahtna. If this is not possible, then Ahtna uses syllabification and vacuous coalescence to preserve the segments. This analysis further adds to the prediction of the D-effect in Ahtna for the patterns found in the language.

2 Optimality Theory analysis

2.1 Ahtna syllable and morphological structure

A discussion of the structure of Dene language syllables and morphemes is integral in discussing the Ahtna D-effect. In Ahtna, as well as other Dene languages, medial consonant clusters do not usually arise due to syllable structure (Wilhelm, 2000). Most prefixes in Dene languages have the form (C)V, with most stems having the form CV(C). The only exceptions to this form of prefixes are the classifiers. This includes the D- classifier with the form (C), and the 1PL subject agreement prefix, which has the form (VC), resulting in an input of …*V<u>CC</u>VC* (Wilhelm, 2005). The /t-/ is sourced from the D-classifier, which is among the group of derivational classifier prefixes which appear closest to the verb (Wilhelm, 2005). Different Dene languages resolve this medial consonant cluster in a variety of ways, with Ahtna using full coalescence, keeping both consonants at the cost of allowing codas or complex onsets, or by vacuous coalescence.

2.2 Full coalescence

Coalescence is the fusion of two input segments into one output segment and occurs when (syllable) markedness constraints and segmental faithfulness are highly ranked (McCarthy & Prince, 1995). Coalescence is a strategy that aims to maintain an unmarked (syllable) structure without the need for deleting or inserting a segment. Coalescence can be motivated by any markedness constraint, along with the faithfulness constraints DEP and MAX. Full coalescence is the fusion of two segments without the loss of features. In Ahtna, full coalescence occurs when the resulting output segment of coalescence is permitted in the inventory of Ahtna. The output segment of full coalescence corresponds to both input segments and obeys featural faithfulness (Wilhelm, 2000). There are two cases of full coalescence for the D-effect in Ahtna, which occur when the /t-/ precedes a stem-initial coronal fricative or a glottal stop.

2.2.1 Full coalescence with coronal fricative

The first pattern of coalescence to be analyzed is fusion forming an affricate. When the /t-/ from the D- classifier prefix precedes a coronal fricative, the segments coalesce by forming an affricate. The following dataset (2) provides the data from Ahtna showing this pattern of coalescence. It should be noted that the curved line above [ts] and throughout this analysis indicate an affricate which is one segment.

(2)	a.	/st^{h}ɐnɪnɛs-**t-z**ɛt/	[st^{h}ɐ.nɪ.nɛs.**t͡s**ɛt]	‘he became lonely’
		/nɐt^{h}ɛs-**t-z**æʔ/	[nɐ.t^{h}ɛs.**t͡s**æʔ]	‘he belched’
		/tɐ-**t-z**ɛn/	[tɐ.**t͡s**ɛn]	‘it is dark coloured’
	b.	/ɣɛnɐz-**t-ɬ**ɐɐɬ/	[ɣɛ.nɐz.**t͡ɬ**ɐ:ɬ]	‘he dreamt of him’
		/ɣɪz-**t-ɬ**æts/	[ɣɪz.**t͡ɬ**æt͡s]	‘he cooked it’
		/t^{h}ɛz-**t-ɬ**ɛn/	[t^{h}ɛz.**t͡ɬ**ɛn]	‘it is flowing swiftly’

The constraints that motivate coalescence contain some well-known and frequently used constraints as well some constraints that should be defined specifically for this paper. The well-known constraints include MAX (3) and DEP (4) as outlined by McCarthy & Prince (1995), which ban deletion of segments or insertion of segments, respectively. The constraints NOCODA (5) and *COMPLEXONSET (6), as described by Prince & Smolensky (1993), which penalize codas and complex onsets, are also required.

(3) MAXIMALITY (MAX) (McCarthy & Prince, 1995)
Every segment of the input has a correspondent in the output.

(4) DEPENDENCE (DEP) (McCarthy & Prince, 1995)
Every segment of the output has a correspondent in the input.

(5) NOCODA (Prince & Smolensky, 1993)
Syllables do not have codas.

(6) *COMPLEXONSET (Prince & Smolensky, 1993)
Syllables do not have complex onsets.

The key constraint that needs to be outlined for this analysis of coalescence is UNIFORMITY. This is a faithfulness constraint that penalizes segmental coalescence when a segment in the output has multiple corresponding segments in the input. UNIFORMITY is outlined below in (7).

(7) UNIFORMITY (“No coalescence”) (McCarthy & Prince, 1995)
No element of S_2 has multiple correspondents in S_1.

The example of /tɐ-$\mathbf{t_1}$-$\mathbf{z_2}$ɛn/ → [tɐ.$\mathbf{\widehat{ts}_{12}}$ɛn] from the dataset provides an illustration of full coalescence where two segments fuse to form an affricate. Using the diagram shown below in (8), it is observed that the output segment [t͡s] includes the features of both input segments /t-/ and /z/. To form the output of the [t͡s], the [cont] feature from both input segments are included, the [-cont] of the stop and the [+cont] of the fricative also fuse, which allows for the output of an affricate. The Place features of both input segments match as [coronal] and are both represented in the [t͡s]. The subscripts used in the following diagram (8) and in the tableaux to follow, identify and help to track the segments which are involved in coalescence and the features associated with these segments.

(8)

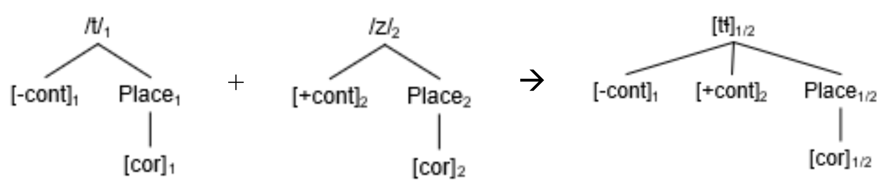


Tableau (9) provides the constraint rankings which are relevant for the parsing of /t-/ before a stem-initial coronal fricative which coalesce into an affricate.

(9)

/ tɐ-**t₁-z₂**ɛn /	DEP	MAX	NOCODA	*COMPLEXONSET	UNIFORMITY
→a. tɐ.**t͡s₁₂**ɛn			*		*!
b. tɐ.**t₁z₂**ɛn			*	*!	
c. tɐ**t₁.z₂**ɛn			**!		
d. tɐ.**z₂**ɛn		*!	*		
e. tɐ.**t₁**ɛn		*!	*		
f. tɐ.**t₁ə.z₂**ɛn	*!		*		

The tableau in (9) compares the winning candidate [tɐ.**t͡s₁₂**ɛn] with some losing candidates. The optimal output [tɐ.**t͡s₁₂**ɛn] violates UNIFORMITY because the affricate [t͡s₁₂] has multiple corresponding segments in the input which was demonstrated in the diagram (8). The losing candidates obey UNIFORMITY, but at the expense of violating other constraints. Since UNIFORMITY is violated by the winning candidate and not by the losers, for the optimal output to be selected, the other relevant constraints must dominate UNIFORMITY. Candidate (9b) is not selected since a complex onset is formed, meaning *COMPLEXONSET is fatally violated. Each of the candidates in (9) violates NOCODA. One violation comes from the word-final coda consonant [n] in the final syllable. However, candidate (9c) *[tɐ**t₁.z₂**ɛn] has a second fatal violation of NOCODA from the /t-/ being parsed as a coda. Both candidates *[tɐ.**z₂**ɛn] and *[tɐ.**t₁**ɛn] fatally violate MAX because they delete one of the input segments. Finally, candidate (9f) *[tɐ.**t₁ə.z₂**ɛn] is not optimal because it inserts a schwa between the input segments, thereby fatally violating DEP.

2.2.2 Full coalescence with glottal stop

The next pattern of coalescence in the Ahtna D-effect to be analyzed is the formation of a glottalized stop. When the /t-/ from the D- classifier prefix precedes a glottal stop, the segments coalesce to form a glottalized alveolar stop. The Ahtna data in (10) illustrate this pattern.

(10)	/nɐʔɪ-**t-ʔ**ɐɐn/	[nɐ.ʔɪ.**t'**ɐːn]	'it was found'
	/nɪɬʁɐdɛ-**t-ʔ**ɐɐn/	[nɪɬ.ʁɐ.dɛ.**t'**ɐːn]	'they are joined'
	/q'ɛʔɪ-**t-ʔ**ɐtʰ/	[q'ɛ.ʔɪ.**t'**ɐtʰ]	'it came loose'

Along with the constraints outlined previously, an additional constraint is needed to analyze this pattern of coalescence. This constraint is MAX[cg] (11) which penalizes outputs that delete the constricted glottis (cg) feature from an input segment and prevents an output that loses the [cg] feature from the glottal stop.

(11) MAX[cg] (Howe & Pulleyblank, 2001)
Every segment of the input with the feature [constricted glottis] has a correspondent in the output.

The example /nɐʔɪ-**t-ʔ**ɐɐn/ → [nɐ.ʔɪ.**t'**ɐ:n] from the dataset in (10) demonstrates the full coalescence of the /t-/ and glottal stop to form a glottalized alveolar stop. The feature tree diagram (12) illustrates the preservation of the input features in the output features. The glottal stop is analyzed as having no place node, so the output segment of $[t']_{12}$ contains all the features of the input segments, thus making it represent full coalescence.

(12)
Input *Output*

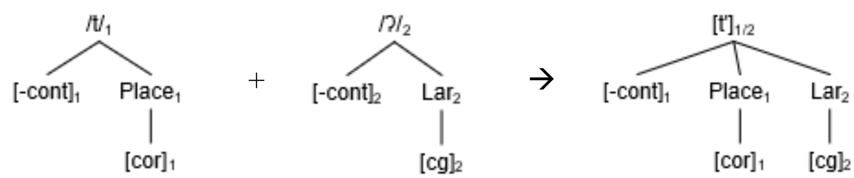


Tableau (13) provides the constraint rankings demonstrating the optimal candidate with the losing candidates which are relevant for the parsing of /t/ before a stem-initial glottal stop into a glottalized alveolar stop. The optimal candidate is [nɐ.ʔɪ.$\mathbf{t'_{1,2}}$ɐ:n] which violates UNIFORMITY since the output segment $[t'_{1,2}]$ has two corresponding segments in the input. The losing candidates (13b-f) demonstrate the same fatal violations as represented previously in the tableau (9) showing full coalescence forming an affricate. The losing candidate (13g) *[nɐ.ʔɪ.$\mathbf{t_{1,2}}$ɐ:n] also violates UNIFORMITY with the output segment $[t_{1,2}]$ having two corresponding input segments. However, *[nɐ.ʔɪ.$\mathbf{t_{1,2}}$ɐ:n] also fatally violates MAX[cg] because the constricted glottis feature of the /ʔ/ is not preserved in the output. For the winning candidate [nɐ.ʔɪ.$\mathbf{t'_{1,2}}$ɐ:n] to be selected, UNIFORMITY must be dominated by MAX[cg].

(13)

/ nɐʔɪ-**t**₁-**ʔ**₂ɐɐn /	Dep	Max	Max[cg]	NoCoda	*ComplexOnset	Uniformity
→ a. nɐ.ʔɪ.**t'**$_{1,2}$ɐːn				*		*
b. nɐ.ʔɪ.**t**$_1$**ʔ**$_2$ɐːn				*	*!	
c. nɐ.ʔɪ**t**$_1$.**ʔ**$_2$ɐːn				**!		
d. nɐ.ʔɪ.**ʔ**$_2$ɐːn		*!		*		
e. nɐ.ʔɪ.**t**$_1$ɐːn		*!		*		
f. nɐ.ʔɪ.**t**$_1$**ə.ʔ**$_2$ɐːn	*!			*		
g. nɐ.ʔɪ.**t**$_{12}$ɐːn			*!	*		*

2.3 Lack of coalescence

If full coalescence of the two input segments would result in a segment that is not found in the inventory of Ahtna, then the syllable structure is adjusted to preserve the input segments and their features. When /t-/ precedes non-coronal stops, fricatives or /n/, or vacuous coalescence occurs when the /t-/ precedes an alveolar stop or affricate.

2.3.1 Complex onset with non-coronal fricative

The first of these patterns to be analyzed is the combining of the /t/ with a stem-initial non-coronal fricative to form a complex onset. The evidence for this pattern comes from the Athabaskan Ahtna Dictionary where the syllable boundaries are identified and repeated below (Kari, 1990). All features of the input are preserved and segmental faithfulness is also achieved. The data in (14) illustrates this pattern found in Ahtna.

(14)	a.	/naʔɪ-**t-ɣ**ɐɐ/	[na.ʔɪ.**tɣ**ɐː]	'he returned'
		/ʔʊnɛ**t-ɣ**ɐɐn/	[ʔʊ.nɛ.**tɣ**ɐ;n]	'he is shy'
		/tnɛs**t-ɣ**ɐɐɣʔ/	[tnɛs.**tɣ**ɐːɣʔ]	'it got toasted'
	b.	/ʁɐ-**t-ʁ**ɐɐnʔ/	[ʁɐ.**tʁ**ɐːnʔ]	'It became moldy'
		/nɐ-**t-ʁ**ɐɐs/	[nɐ.**tʁ**ɐːs]	'It is rough'
		/ɐ-**t-ʁ**ɔl/	[ɐ.**tʁ**ɔl]	'It was scraped'

The phonological inventory of Ahtna only includes coronal affricates (Kari, 1990). This is the reason that coronal fricatives form affricates with /t-/, whereas the non-coronal fricatives do not coalesce to form affricates when preceded by the /t-/ in the D-effect. Non-coronal affricates are ruled out by the constraint

*AFFRIC[dors],[lab] (15) which penalizes non-coronal affricates.

(15) *AFFRIC[dors],[lab]
Do not have non-coronal affricates.

Tableau (16) provides the constraint rankings which is relevant for the optimal parsing of /t/ before a stem-initial non-coronal fricative into a complex onset. The tableau compares the optimal candidate to possible losing candidates.

(16)

/ ʁɐ-**t**$_1$-**ʁ**$_2$ɐɐnʔ /	DEP	MAX	*AFFRIC[dors],[lab]	NOCODA	*COMPLEXONSET	UNIFORMITY
→ a. ʁɐ.**t**$_1$**ʁ**$_2$ɐːnʔ				*	*	
b. ʁɐ**t**$_1$.**ʁ**$_2$ɐːnʔ				**!		
c. ʁɐ.**ʁ**$_2$ɐːnʔ		*!		*		
d. ʁɐ.**t**$_1$ɐːnʔ		*!		*		
e. ʁɐ.**t**$_1$ə.**ʁ**$_2$ɐːnʔ	*!			*		
f. ʁɐ.**t͡ʁ**$_{12}$ɐːnʔ			*!	*		*

Each of the candidates in this tableau violates NOCODA due to the word-final coda. Tableau (16) shows the optimal candidate to be [ʁɐ.**t**$_1$**ʁ**$_2$ɐːnʔ] which violates *COMPLEXONSET due to the /t-/ and /ʁ/ forming a complex onset. The losing candidate *[ʁɐ**t**$_1$.**ʁ**$_2$ɐːnʔ] obeys *COMPLEXONSET, but at the expense of parsing the /t-/ as a coda, which fatally violates the markedness constraint NOCODA. Both candidates (16c) and (16d) are ruled out since they delete an input segment, thereby fatally violating MAX. The candidate *[ʁɐ.**t**$_1$ə.**ʁ**$_2$ɐːnʔ] fatally violates DEP due to the insertion of a schwa. Finally, *[ʁɐ.**t͡ʁ**$_{12}$ɐːnʔ] is ruled out due to the formation of a non-coronal affricate by coalescence, making this candidate fatally violate *AFFRIC[dors],[lab]. Since the winning candidate [ʁɐ.**t**$_1$**ʁ**$_2$ɐːnʔ] violates *COMPLEXONSET, for the winning candidate to be selected, *COMPLEXONSET must be dominated by NOCODA, MAX, DEP and *AFFRIC[dors],[lab].

2.3.2 Coda followed by a non-coronal stop or /n/

The other pattern that is related to syllable structure for the D-effect in Ahtna is syllabifying the /t-/ as a preceding coda, thus preserving all features of both input segments. When the /t-/ from the D- classifier prefix precedes a non-coronal stop or /n/, the /t/ gets syllabified as the coda of the preceding syllable, with the stem-initial consonant as the onset of the following syllable. The following dataset (17) provides the data from Ahtna showing this syllabification pattern.

(17) a. Labial Stops

/q^{h}u-**t-p**ɐʔ/	[q^{h}u**t.p**ɐʔ]	‘it became twilight’
/tɪ-**t-p**æts/	[tɪ**t.p**æts]	‘it turned tan’

b. Dorsal Stops

/tɛs-**t-k**ɛth/	[tɛs**t**.**k**ɛt^{h}]	‘it is smoky’
/ʊq’ɛk’ɪ-**t-q**ɛz/	[ʊ.q’ɛ.k’ɪ**t.q**ɛz]	‘it wore apart’
/dʁɔs ʔɪ-**t-q^{h}**ɐɣ/	[dʁɔs ʔɪ**t.q^{h}**ɐɣ]	‘he is celebrating’
/tŋɛ-**t-q’**ɐɐn/	[tŋɛ**t.q’**ɐːn]	‘it is angled’

c. Nasal Stops

/ɐ-**t-n**ɐɐ/	[ɐ**t.n**ɐː]	‘he is working’
/nɐ-**t-n**ɛst-nɪɪ/	[nɐ**t.n**ɛst.nɪː]	‘it (motor) started’

Two additional constraints are required to analyze the pattern illustrated by this dataset. The first constraint is *[-cont][-cont]ONSET (18) which prevents a cluster of two [-cont] consonants in the onset of a syllable. This is required to prevent an onset cluster formed by the /t-/ and stem initial non-coronal stop or /n/. The other relevant constraint is MAX[nasal] (19) which penalizes outputs that delete the [nasal] feature from an input segment. This constraint is required to prevent an optimal output where the coalesced segment would be missing any positive or negative [+/-nasal] feature from the input.

(18) *[-cont][-cont]ONSET
A consonant cluster of two non-continuants is not permitted in the onset of a syllable.

(19) MAX[nasal]
If the feature [+/-nasal] is found in the input, then there is a corresponding feature in the output.

Tableau (20) provides the constraint rankings with the other losing candidates that are relevant for parsing /t/ before a stem-initial non-coronal stop or /n/, comparing the optimal candidate to the possible losing candidates.

(20)

/ ɐ-**t**$_1$-**n**$_2$ɐɐ /	DEP	MAX	MAX[nasal]	*[-cont][-cont]ONSET	NOCODA	*COMPLEXONSET	UNIFORMITY
→ a. ɐ**t**$_1$.**n**$_2$ɐː					*		
b. ɐ.**n**$_2$ɐː		*!					
c. ɐ.**t**$_1$**ə.n**$_2$ɐː	*!						
d. ɐ.**t**$_1$**n**$_2$ɐː				*!		*	
e. ɐ**t**$_{12}$ɐː			*!				*
f. ɐ**n**$_{1,2}$ɐː			*!				*

Tableau (20) shows the optimal candidate to be [ɐ**t**$_1$.**n**$_2$ɐː] which violates NOCODA since the /t-/ is parsed as the coda of the preceding syllable. Candidates (20b) and (20c) obey NOCODA at the expense of deleting or epenthesizing a segment, thereby fatally violating MAX and DEP respectfully. NOCODA is obeyed by *[ɐ.**t**$_1$**n**$_2$ɐː] but fatally violates *[-cont][-cont]ONSET by having the /t-/ and /n/ form a complex onset. The constraint MAX[nasal] is violated by both *[ɐ**t**$_{12}$ɐː] and *[ɐ**n**$_{1,2}$ɐː] due to the [nasal] feature being deleted from one of the input segments since [$t_{1,2}$] and [$n_{1,2}$] cannot have both a [+nasal] and [-nasal] feature. Although *[ɐ**n**$_{1,2}$ɐː] at first glance appears to satisfy MAX[nasal] since it has a [+nasal] segment, it actually violates it. This is because as noted by the subscripts, it is a coalesced segment, meaning it fuses the features of the two input segments. Since the output of *[ɐ**n**$_{1,2}$ɐː] does not include the [-nasal] feature of the /t-/, MAX[nasal] is violated. Since the optimal output [ɐ**t**$_1$.**n**$_2$ɐː] violates NOCODA, in order for this candidate to be selected as the optimal candidate NOCODA must be dominated by MAX, DEP, *[-cont][-cont]ONSET, and MAX[nasal].

2.4 Vacuous Coalescence

The final pattern to be analyzed is vacuous coalescence. In full coalescence, no features are lost, whereas in vacuous coalescence the output segment contains features from both input segments, but some features are lost (Wilhelm, 2000). Vacuous coalescence can be mistaken for deletion in the D-effect, but better accounts for the patterns of the D-effect than deletion.

When the /t-/ from the D- classifier prefix precedes an alveolar stop or affricate, the segments coalesce to the form of the stem initial segment, with features of both input segments. (21) provides the data from Ahtna showing this pattern.

(21) a. Coronal Stop

/ɪnɐnɛs-**t-tʰ**ɐɐn/	[ɪ.nɐ.nɛs.**tʰ**ɐ:n]	'he helped him'
/tʰɛs-**t-t**uus/	[tʰɛs.**t**u:s]	'he started to crawl'
/tɐnɐ-**t-t'**uut'/	[tɐ.nɐ.**t'**u:t']	'it (tea) is strong'

b. Coronal Affricate

/tɐ-**t-t͡ɬ'**ɛt͡s'/	[tɐ.**t͡ɬ'**ɛt͡s']	'it is blue'
/hʷnɪ-**t-t͡s**æχ/	[hʷnɪ.**t͡s**æχ]	'the snow became soft'
/nɐɐ-**t-t͡s**hɪɪtl'/	[nɐ:.**t͡s**hɪ:tl']	'it snowed'
/sʔɛɬ qhʊɬ-**t-t͡l**hɛt/	[sʔɛɬ qhʊɬ.**t͡l**hɛt]	'he caused crisis for me'

No additional constraints are required to analyze this data. Tableau (22) provides the constraint rankings with the other losing candidates which are relevant for the optimal parsing of /t/ before a stem-initial coronal stop or affricate.

(22)

/ tɐ-**t₁-t͡ɬ'₂**ɛt͡s'/	DEP	MAX	*[-cont][-cont]ONSET	NOCODA	*COMPLEXONSET	UNIFORMITY
→ a. tɐ.**t͡ɬ'₁,₂** ɛt͡s'				*		*
b. tɐ.**t₁t͡ɬ'₂**ɛt͡s'			*!	*	*	
c. tɐ.**t͡ɬ'₂**ɛt͡s'		*!		*		
d. tɐ.**t₁**ɛt͡s'		*!		*		
e. tɐ.**t₁ə.t͡ɬ'₂**ɛt͡s'	*!			*		
f. tɐ**t₁.t͡ɬ'₂**ɛt͡s'				**!		

In tableau (22), each of the candidates received a NOCODA violation due the word-final coda [t͡s']. The optimal candidate for tableau (22) is [tɐ.**t͡ɬ'₁,₂**ɛt͡s'] which violates UNIFORMITY due to the /t₁-/ and /tɬ'₂/ fusing to form [tɬ'₁,₂]. The second candidate is ruled out due to *[tɐ.**t₁t͡ɬ'₂**ɛt͡s'] fatally violating the constraint *[-cont][-cont]ONSET by the cluster of two [-cont] segments in the onset of a syllable. Candidates (22c) and (22d) both fatally violate MAX by deleting one of the input segments in order to satisfy UNIFORMITY. *[tɐ.**t₁ə.t͡ɬ'₂**ɛt͡s'] also obeys UNIFORMITY but inserts a schwa, thereby fatally violating DEP. Finally, candidate (22f) *[tɐ**t₁.t͡ɬ'₂**ɛt͡s'] is not the optimal candidate since it receives a second and fatal violation to NOCODA due to the /t-/ being syllabified as the coda of the preceding syllable. In order for the optimal candidate [tɐ.**t͡ɬ'₁,₂** ɛt͡s'] to be selected, the constraints *[-cont][-cont]ONSET, MAX, DEP, and NOCODA must dominate UNIFORMITY. This ranking is both demonstrated by this dataset, as well as being supported by the datasets showing full coalescence.

2.5 Overall constraint ranking

The overall constraint ranking is provided below in (23) to represent the findings found from the analysis of the D-effect in Ahtna. DEP, MAX, MAX[cg], MAX[nasal], and *[-cont][-cont]ONSET are unranked with respect to each other, and dominate NOCODA, which dominates *COMPLEXONSET; they all dominate UNIFORMITY which is the key constraint for favouring coalescence.

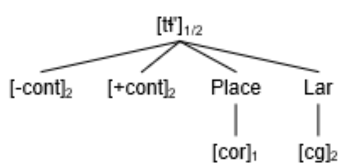
(23) DEP, MAX, MAX [cg], MAX [nasal], *[-cont][-cont]ONSET >> NOCODA >> * COMPLEXONSET >> UNIFORMITY

3 Discussion

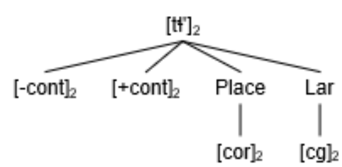
The OT analysis outlined for the D-effect in Ahtna supports previous reports of the D-effect that it always involves coalescence, never deletion (Howren, 1971; Wheeler, 2005; Wilhelm, 2000). The ranking of MAX >> UNIFORMITY is the main motivator for coalescence over deletion. The patterns outlined in the datasets (2, 10, 14, 17) also support LaMontagne & Rice's (1994, 1995) analyses of Ahtna involving coalescence. Where the current analysis differs significantly from the analysis by LaMontagne & Rice (1994, 1995) is with regards to the pattern they analyzed as deletion. The current analysis finds greater support for vacuous coalescence over the analysis of deletion. Due to its subtlety, vacuous coalescence can be misanalyzed as deletion. The subtle difference is illustrated as follows in (24) by these diagrams using the example from the Ahtna dataset (21) for the form /tɐ-**t_1-t͡ɬ'$_2$**ɛt͡s'/ → [tɐ.**t͡ɬ'$_{1,2}$**ɛt͡s']. Previous analyses of this data found in (21) have concluded that this pattern is deletion (LaMontagne & Rice, 1994, 1995; Kari, 1990).

(24) /t_1-/ + / t͡ɬ'$_2$/ → [t͡ɬ'$_{1,2}$]

a. *vacuous coalescence*



b. *deletion*



The subtle and formal difference between these two representations is that (24a) has features of both input segments, while (24b) does not. As seen in this illustration, because the output in (24a) has features from both input segments (the [cont] feature from [t͡ɬ'$_2$] and the Place feature from the [t_1]), it is in correspondence with both segments, and represents a coalesced segment. This contrasts with (24b) where the output is not in correspondence with the input of /t-$_1$/ as there are no features from its input, so (24b) represents deletion. LaMontagne & Rice (1994, 1995) did not make the distinction between (24a) and (24b), and simply assumed deletion whenever the output looks identical to only one of the input segments. Whenever the output looks identical to only one of the segments, it is theoretically possible for this in fact to be a form of coalescence rather than deletion. In fact, the analysis of vacuous coalescence is more coherent as an analysis than one involving deletion.

It is impossible to rule out vacuous coalescence as exemplified by (24a) with the ranking of MAX >> UNIFORMITY as seen in the overall constraint ranking (23) which motivates coalescence in the first place. For deletion to produce the optimal candidate for /tɐ-**t$_1$-t͡ɬ'$_2$**ɛt͡s'/, the opposite ranking of MAX and UNIFORMITY would be necessary. This opposing rankings of these constraints within one language creates a ranking paradox. If the D-effect were sometimes coalescence and sometimes deletion, there would be no uniform motivation for it. For these reasons, this analysis argues that the D-effect involves vacuous coalescence rather than deletion. In summary, in Ahtna, if coalescence can be used to form a segment found in the language, then coalescence is used. If coalescence is not possible due to the phonological inventory, then Ahtna uses syllable structure by incorporating segments into either the coda or the onset to preserve the features of the input segments.

4 Conclusion

This paper analyzed how Ahtna accounts for the D-effect and the alternation patterns that arise using Optimality Theory. This analysis provided evidence in support of the D-effect being coalescence, as the pattern that was previously evaluated as deletion can be analyzed to be vacuous coalescence. Coalescence is a strategy used to obey markedness and segmental faithfulness, as well as featural faithfulness as much as possible. In Ahtna, the alternations of the /t/ from the D-classifier prefix include coalescence forming an affricate or glottalized stop, syllabifying the two segments as a complex onset or the /t-/ as a preceding coda, and vacuous coalescence. Future development in the study of the Dene D-effect could investigate coalescence for the D-effect in the Koyukon- and Hupa-type Dene languages. The aim would be to provide further evidence for coalescence in the D-effect in other languages.

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