Wichita Consonant Cluster Resolution and the Nature of Phonotactics*

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Abstract

Consonant clusters in Wichita (Caddoan; Oklahoma) resolve via a wide variety of processes. Three of them are examined in-depth in this paper: affrication, deletion, and fortition. These are examined to compare two competing theories of phonotactics: one based on syllable structure and one based on the local phonetics. The analyses based on these theories are shown to be comparable in their coverage of the alternations themselves, but make different predictions about other aspects of Wichita’s phonological system. A comparison of these predictions shows that the analysis based on local phonetics offers better empirical coverage of the Wichita data.

1 Introduction

As Mithun (1999, 370) notes, the Caddoan languages “offer a number of points of special interest, with their complex phonological processes (especially Caddo and Wichita) and elaborate morphological structure.” This paper will investigation some of these phonological processes—specifically, the interaction of consonants—in one of the above languages, Wichita. Due to Wichita’s morphological structure, pairs of consonants frequently come into contact across morpheme boundaries, and when they do, the consonants often interact. The chart in Table 1 (following Rood (1996, 585)) shows the results when they do.¹ ²

The resolution chart in Table 1 reveals at least nine different types of phonological processes—the pair of consonants may surface unchanged (henceforth “faithfulness”) or one or both may undergo one of the following processes: affrication, fortition, deletion, debuccalization, coalescence, compensatory lengthening, metathesis, and tonogenesis. Some of these processes only affect one cell and, in some cells, two of these processes affect the outcome. Some examples of these processes are given in (1) below, as well as the major classes that undergo them.

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¹I want to acknowledge several people who made this work possible: David Rood, for all his work in describing Wichita, introducing me to the language, for eagerly answering all my questions, and for his comments on this paper; Arto Anttila and Paul Kiparsky, for their assistance and guidance in helping this QP take shape; Arnold Zwicky, for talking about Wichita earlier in my graduate career and teaching me valuable lessons about writing clearly; Edward Flemming, for introducing me to the Licensing-by-Cue approach; the members of my QP committee; the participants of the Stanford Phonology Workshop; Anya Lunden, for her LATEX assistance; and, finally, Judith Aissen, for her gift of Rood (1976), which has once again been a valuable asset. The usual disclaimers apply.

²Table 1 uses the conventionalized Americanist transcription for Wichita – henceforth “orthography.”

These interactions are, in the limiting case, restricted to morphologically derived environments, although, as the discussion below will show, many have a broader distribution.
| Cluster-initial | t | k | k^w | ? | c | s | r | w | y | h |
|-----------------|---|---|-----|---|---|---|---|---|---|---|---|
| t               | ct | ck | ck^w | c? | cc | c | c | ck^w | ch |
| k               | st | k | ?k^w | k? | :c | ks | rh | k^w | h | kh |
| ?               | t  | k | k^w | ? | c | s | r | w |   |   |
| c               | ct | ck | ck^w | c? | cc | cs | c | ck^w | ch/cs |
| s               | st | sk | sk^w | s? | sc | ss | ss | sk^w | ss | sh/ss |
| r               | c  | hk | hk^w | r? | nc | c | nn | hk^w | rh |
| h               | t  | k | k^w | ? | c | s | r/t:r | hw | h  |
| y               | t  | k | y |   | r |   |   | :y |

Table 1: Resolution of Wichita Consonant Clusters

(1) Process | Example(s) | Major Class(es) Effected
---|---|---
Faithfulness | /k + s/ → [ks], /s + k/ → [sk], Cluster-initial s and c
Affrication | /t + t/ → [ck], /t + k/ → [ck] Cluster-initial t
Fortition | /s + w/ → [sk^w], /c + w/ → [ck^w] Cluster-final w
Deletion | /? + t/ → [t], /? + k/ → [k] Cluster-final ?
Debuccalization | /r + k/ → [hk], /r + k^w/ → [hk^w] Some Cluster-initial r
Coalescence | /k + w/ → [k^w], /t + s/ → [t^w]
Compensatory Lengthening | /k + t^w/ → [:t]^w]
Metathesis | /k + r/ → [rh]
Tonogenesis | /h + u/ → [?t] Cluster-initial h and y

One of the two goals of this paper will be to make sense of (some of) the interactions in this chart. To do so, I will employ the general framework of Optimality Theory (OT) (Prince and Smolensky, 1993/2004). In the process, I will illustrate how Optimality-Theoretic constraints can easily capture alternations and phonotactics all within the same system, thus eliminating the need to posit both what amount to morpheme structure constraints and completely unrelated phonological rules, as is done in the earlier rule-based analysis of Wichita phonology (Rood, 1975, 1976).

The second and more in-depth issue to be examined in this paper deals with the nature of phonotactics. The precise question of this paper is what licenses consonants to be adjacent to other consonants, though this question is relevant to a larger issue, long standing in generative phonology: what is the role of prosodic units in phonology (see Blevins (1995) for an overview to the aspect of the controversy relevant to this paper, the role of the syllable).

Presently, there seem to be roughly two schools of thought on the nature of phonotactic licensing among phonologists. The first holds that certain segments are licensed by particular prosodic positions. This line of research stems from Itô (1986), and the idea of this program is summed up by the Prosodic Licensing Principle: “All phonological units must be prosodically licensed, i.e., belong to higher prosodic structure (modulo extraprosodicity)” (Itô, 1986, 2). Under the Strict Layering Hypothesis, a central part of Prosodic Licensing, there is the following dominance relation: prosodic words → feet → syllables → onsets, nuclei, and codas → segments. Thus, to be in line with the Prosodic Licensing Principle, possible consonant clusters must be licensed through conditions on the onsets and codas immediately dominating them. Although Itô’s original work pre-dated OT, this kind of analysis has been straightforwardly imported into the newer framework (as Prince and Smolensky (1993/2004)’s original explication of OT shows).

The second view, represented by work within OT by the Licensing-by-Cue program (Hume, 1998; Côté, 2000; Steriade, 2001; Anttila et al., in prep.) and outside OT by Blevins (2004), is that syllable structure is
inconsequential for phonotactics, and instead, clusters are licensed depending on the sequence they are in. I will refer to this view as the sequential view. The proponents of this view have grounded their constraints in the perceptual qualities in and around the relevant segments. In particular, this hypothesis on grounding can be summarized with the following, paraphrasing Flemming (2005): the presence of a particular sound in a particular environment is licensed by the availability of perceptual cues for that segment in that environment.

In this paper, I will examine the above theories of phonotactics within the context of affrication, deletion, and fortition in Wichita, and I will argue that the facts in Wichita support an analysis within the latter viewpoint. First, I will argue for particular sequential constraints, grounded in the perceptability of particular environments. Second, I will show that an analysis based on these constraints offers better empirical coverage of the phonological data of Wichita, both within these three alternations and in predictions generated from, but extending beyond, these alternations.

To enable such a cross-theoretic comparison, the discussion below will provide both a sequential analysis and a syllable-based analysis of this data. Building up these analyses will be the task of the sections 3–7. Then, in section 8, I will compare the ability of the two analyses to account for the Wichita data, especially with respect to phonological data beyond these alternations. Here, I will argue, based on this comparison, that a sequential analysis should be preferred. Section 9 then will finish the paper with some concluding comments. This will include comments on a larger issue that this research raises: what is the role of prosody in phonology? However, before getting into the details of these analyses and their implications, let me begin with brief discussions of the Wichita language, of its phonetic inventories, and a few other analytical preliminaries.

2 Preliminaries

2.1 About Wichita

As mentioned above, Wichita is a member of the Caddoan language family, a small family of languages spoken by some of the indigenous inhabitants of the central regions of what is now the United States of America. The language itself is moribund, with fewer than 10 people with some knowledge of the language alive today. These remaining (semi-)speakers live in south central Oklahoma. Historically, the Wichita ranged from southern Kansas (where Coronado encountered them in the 16th century) to central Texas. This range can be roughly approximated by the cities bearing the name of the tribe or a subpart thereof: Wichita, Kansas to Waco, Texas—the Waco being a band within the Wichita tribe.

Wichita is a part of the Northern Caddoan subbranch of the Caddoan family; thus, it is a sibling to Kitsai (extinct since the 1940s, but spoken historically in Texas), Pawnee (historically spoken in Nebraska), and Arikara (historically spoken in South Dakota). The Northern Caddoan group is more distantly related to Caddo, the language for which the family is named. Caddo was historically spoken in an area that included eastern Texas, southern Arkansas, and northern Louisiana. None of the Caddoan languages is particularly viable at the present.

Unsurprisingly, some of the same processes that I will discuss below for Wichita also occur in other (mainly Northern) Caddoan languages, often with interesting variations. Although intra-family comparison is not the point of this paper, I will briefly mention comparable phenomena in the other Caddoan languages, to the extent the literature has mentioned them.

The Caddoan family is possibly related to both the Iroquoian and Siouan languages, the three families comprising what is called the Macro-Siouan stock. As of 1999, this relationship remained a possibility, though not demonstrated (see discussion in Mithun (1999, 305) and references cited therein). Even if this relationship proves to be false, the Caddoan languages are still typologically similar to the Iroquoian languages in many ways: both language families have complex polysynthetic morphologies and have phonological systems with unusual segmental inventories. In fact, let us now turn to precisely this latter topic,
2.2 The Consonants of Wichita

In this section I outline the segmental phonology of consonants in Wichita. In doing so, I will follow existing discussions of Wichita phonology, both the SPE-style analysis in Rood (1975) and the discussions in the respective grammatical descriptions (Rood, 1976, 1996), as well as my own observations from forms given in the latter two sources and observations from David Rood (p.c.).

The consonantal inventory is given in Table 2. This inventory is striking in two regards. First, it is quite small. Second, it lacks true labial sounds, an absence that extends into the vocal domain, as surface [u] is absent, and surface [o:] almost always—if not always—derives from either /awa/ or /iwa./

The slash between the two sonorants is due to the fact that these two phones are in complementary distribution. The coronal nasal, [n], appears in initial singletons; next to the coronals [t], [tʰ], and [s]; and in the geminate version of this consonant, [nː]. The coronal tap, [r], is found everywhere else: intervocally, word-finally, and in clusters with glottals, [rh, rʔ]. Despite their allophonic status, these two phones will be represented in writing by distinct symbols, following the established conventions for writing Wichita.

One final comment regarding Table 2: although [h] is classified as an approximant in the above chart, there is nothing phonetically unusual about the sound. However, as the alternation in -rC- clusters discussed in §B.1 will show, [h] is better regarded as an approximant than a fricative.

Moving to other basic consonantal facts beyond Table 2, Wichita permits only two “true” geminates: [sː] and [nː] (conventionally written {ss} and {nn}). However, Wichita also permits two “quasi”-geminates, “quasi” in the sense that they do not involve a held single segment, but involve multiple articulations. The first “quasi”-geminate is [tʰː] (written {cs}), a [t] with a held frication burst. The second “quasi”-geminate is [tʰtʰ] {cc}, merely a sequence of two affricates, each one having a release burst.

2.3 Analytical Preliminaries

The facts given above provide a starting point for an OT analysis, since, following insights dating back to Kisseberth (1970), constraints within an OT grammar account for distributional facts and alternations. Thus, from the above discussion of the basics of Wichita phonology, it seems reasonable to posit high-

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3In the conventional orthography used by David Rood in his descriptions, following Americanist practices, /tʰ/ is written {c}, /j/ is written {y}, and [r] is written {r}. Throughout this work, all examples will be in this “orthography,” but I will conduct the phonological discussion largely in IPA characters given in Table 2.

4There is, however, an underlying /u/ that absolutely neutralizes to [i], but behaves different from /i/. So, the surface vocalic segments in Wichita are [i, e, a, o], while the underlying vocalic segments are /i, e, a, u/. Also, relevant to the vocalic domain is that [i], [e], and [a] all can have three degrees of length: short (no symbol), long (.), and superlong (:), although I suspect the latter might only be found in morphologically derived environments. Vowels can also have high (V) or low (no symbol) tone.
ranking constraints against [n] intervocally, word-finally, and next to glottals\(^5\) to capture the alternation between [n] and [r] noted above.

Additionally, the absence of true (held) geminates outside of [s:] and [n:] necessitates that the analysis have high-ranking constraints against other geminates. I propose *[-Cont]GEMINATE, a constraint against non-continuant geminates, and *APPROX-GEMINATE, a constraint against approximate geminates. These seem to be reasonably natural constraints, because non-continuants are harder to hold than continuants and approximant geminates may be too confusable with long vowels to be licensed.\(^6\) However, the precise formulation of these constraints is ultimately tangential to the present purposes; the more important notion is that there are some high ranking constraints barring these sequences, and, thus, they will not be candidates under consideration in the in-depth investigation in sections 3–7.

The data in Table 1 also give further basic and high ranking constraints from which to begin the analysis. Although the table shows that Wichita uses a large number of different resolution strategies, one notable absence from the chart is epenthesis: no vowels are inserted to resolve any of these clusters and, unless one counts the insertions from affrication and fortition as epenthesis, no consonants are inserted either. This suggests a high-ranking DEP constraint (McCarthy and Prince, 1995) militating against epenthesis. Furthermore, Table 1 also suggests one final undominated constraint. As the cells of the chart show, all of the resolutions are comprised of just one or two consonants. And when a sequence of three underlying consonants comes in contact, the resolution is to just two consonants (see the discussion in Rood (1976, 239–240)\(^7\)). Thus, in Wichita, the generalization is that there are no sequences of three consonants in a row in derived environments: hence the constraint *CCC.\(^8\) As with the geminate constraints above, because DEP and *CCC are highly ranked, they serve to eliminate candidates from consideration in the examination further below.

With these high-ranking constraints established, one final bit of preliminary business remains. Due to the fact that the analysis will importantly use manner and place features for the various sounds, I want to precisely lay out what specifications I am assuming for these sounds. These specifications don’t seem (to me) to be terribly controversial (compare these with the features discussed in Clements and Hume (1995)), but, in the interest of explicitness, I give them here. Note, however, I don’t assume that sounds must have a unique manner or place feature, although most will under my categorization below.

Given in (2) are the manner specifications for the consonants of Wichita:

(2)

<table>
<thead>
<tr>
<th>manner</th>
<th>t, k, t(^*$), k(^w), ?</th>
</tr>
</thead>
<tbody>
<tr>
<td>[plosive]</td>
<td>t, k, t(^*$), k(^w), ?</td>
</tr>
<tr>
<td>[fricative]</td>
<td>s</td>
</tr>
<tr>
<td>[resonant]</td>
<td>n, r, j, w, h</td>
</tr>
<tr>
<td>[sonorant]</td>
<td>n, r, j, w</td>
</tr>
</tbody>
</table>

Given in (3) are the place specifications:

(3)

<table>
<thead>
<tr>
<th>place</th>
<th>t, t(^*$), s, n, r, j</th>
</tr>
</thead>
<tbody>
<tr>
<td>[coronal]</td>
<td>t, t(^*$), s, n, r, j</td>
</tr>
<tr>
<td>[dorsal]</td>
<td>k, k(^w), w, h, ?</td>
</tr>
<tr>
<td>[labial]</td>
<td>k(^w), w</td>
</tr>
</tbody>
</table>

With these preliminaries out of the way, let us begin the investigation of particular consonant cluster interactions.

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\(^5\) These won’t be formalized here, since these are orthogonal to the focal point of this paper, consonant cluster resolution.

\(^6\) These geminates also suffer from the same problems that other C-glide clusters face in Wichita. See the discussion in §5 and §7.3.

\(^7\) For completeness, I add the caveat that one of the two consonants can be geminate [s:].

\(^8\) Like many of the constraints discussed in this analysis, *CCC is immune to prosodic boundaries.
3 Affrication

3.1 Basics

The first phonological process I want to discuss is affrication, a process that affects cluster-initial, but morpheme-final /t/. In this alternation /t/ becomes [tʰ] in pre-consonantal position within derived environments. These environments and the resulting surface clusters are shown in the cells of Table 3, a subpart of Table 1.

<table>
<thead>
<tr>
<th>Cluster-initial</th>
<th>t</th>
<th>k</th>
<th>kʷ</th>
<th>?</th>
<th>tʰ</th>
<th>s</th>
<th>r</th>
<th>w</th>
<th>y</th>
<th>h</th>
</tr>
</thead>
<tbody>
<tr>
<td>t</td>
<td>tʰ</td>
<td>tʰk</td>
<td>tʰkʷ</td>
<td>tʰʔ</td>
<td>tʰtʰ</td>
<td>tʰʔ</td>
<td>tʰ</td>
<td>tʰ</td>
<td>tʰkʰ</td>
<td>tʰh</td>
</tr>
</tbody>
</table>

Table 3: Resolutions of -tC- Clusters

As a result of this alternation, the contrast between /t/ and /tʰ/ (=c) is neutralized in this particular environment. Given below in (4) are some examples of affrication. As the examples in (4) show, affrication is quite common with the affix -t- ‘1st person agent.’ However, as (4c) reveals, the kinds of alternations noted in Table 3 above can also be found with /t/-final stems.

(4) a. tacʔiː:s
   ta- t- ?iː:s
   IND- 1A- see
   ‘I saw him.’ (Rood, 1976, 217)

b. tackaʔac
   ta- t- kaʔac- s
   IND- 1A- eat- IMPF
   ‘I ate it.’ (Rood, 1976, 237)

c. tactarʔaːc
   ta- t- tarʔaːt- s
   IND- 1A- turn.around- IMPF
   ‘I turned it around.’ (Rood, 1976, 237)

However, the process of affrication is not just restricted to these alternations. In fact, the phone [t] is not found word-finally in Wichita. Judging from the cognates in the other Northern Caddoan languages, Proto-Northern Caddoan *t affricated at the word-edge in Wichita, as shown by the sample cognate sets in (5).

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9I refer to this as ‘agent’ because Wichita is an active-stative language. Also, unlike many languages, Wichita lacks affixes that are portmanteau realizations of person and number features; rather person and number are expressed through separate (and non-adjacent) affixes. The affix featured in (4) is just a person affix.

10Glosses largely follow the Leipzig Glossing Rules, see http://www.eva.mpg.de/lingua/files/morpheme.html. Some changes or additions: AOR = aorist, COLL = collective, IMPF = imperfect, INFER = inferential, QUOT = quotative, O = object affix, PAT.PL = patients are plural, SP.ACT.PL = speech act participants (i.e. local pronouns) are plural.

11Perhaps this would be better regarded as stem-edge effect, given the presence of some affixes in some of the forms.

12The process of affrication in morphologically-derived environments also occurs in Pawnee, but before a much more limited set of consonants: t, s, and c. Additionally, the /s/ and /c/ in this alternation “harden” to [t] in conjunction with affrication (Parks, 1976, 42–43). I do not know if there is affrication in Arikara; affrication appears to be absent in Caddo.
Given these facts, an analysis of affrication must account for both the alternation as well as the phonotactic distribution. I look to present an analysis that can do this in the section below.

### 3.2 An Analysis

Given in this section is a sequential analysis for affrication in Wichita. This will require positing four constraints. The first is the markedness constraint given in (6) below.

\[(6) \text{tV: The phone [t] must be followed by a vowel (cf. } t \rightarrow V \text{ in Côté (2000, 154))}\]

This constraint has both motivation within Wichita and outside it. The Wichita-internal motivation is precisely the facts that I discussed above: [t] neither appears before consonants nor at the end of words. Thus, it would appear that [t] is only licensed in Wichita if a vowel follows it.\[^{14}\]

The Wichita-external motivation comes from both cross-linguistic patterns and general phonetic tendencies. The cross-linguistic evidence comes from patterns involving [t] in non-Caddoan languages. Côté (2000, 46–54), in positing a similar constraint to (6), motivates it based on cross-linguistic facts, largely from Attic Greek. I largely follow her discussion below.

In Attic Greek, there are several phenomena that support the tV constraint. First, as a distributional fact, all obstruent-obstruent clusters, both word-initially and word-medially, have a coronal for their second member. Furthermore, in obstruent-obstruent clusters where one would expect a coronal stop for the first member (due to other parts of the paradigm), the stop often deletes. In some cases, however, where there are two stops in a row, the first stop fricativizes to [s]. This pattern of the coronal stops word-internally parallels Wichita word-internal affrication. Attic Greek also parallels the Wichita word-final facts in that the coronal stops are not allowed word-finally (they delete in Greek), while other coronals are (in Greek, [n, r, s] are allowed (Smyth, 1956, 33); in Wichita, [t, s, n, r]).

As Côté goes on to point out, similar facts hold word-internally for Latin, although Latin differs from Attic Greek in some cases, because Latin repairs using assimilation, not out-and-out deletion. Latin also differs from Attic Greek word-finally: coronal stops are permitted. Côté also notes two other languages that show that coronal stops need a following vowel. One is Tagalog (original discussion in Blust (1979)), where the process of metathesis applies to -tC- clusters, rendering them -Ct-. The other is the Turkic language, Yakut (also known as Sakha) (original discussion in Wetzels (1989)), where -[coronal]C- clusters apparently also assimilate to the C.

Additionally, having such a constraint is supported by the phonetics of coronal stops, as Kang (1999) notes. As Kang shows, coronal place is importantly cued by the transitions of the second formant of the

\[^{13}\]The transcriptions of these words have been normalized to follow Americanist conventions. I do not know why the Wichita word, kitak\(^w\)ac, ‘otter’ lacks the long [a:] that appears in the forms of the other languages. Taylor takes some of these examples from early wordlists—this word is not found more modern Wichita—so I suspect that in this case the transcriber may not have heard the length.

\[^{14}\]This isn’t entirely correct because there is morpheme-internal [th] within stems. However, this generalization in text does seem to be true at the word and phrase level, and could be accounted for by adopting some sort of stratal account for the presence of [th]. See further discussion in §8.1.4.
surrounding vowels in and out of the consonant. These transitions are clear in CV sequences, but considerably weakened in VC sequences. The lack of cues makes coronal consonants vulnerable to masking by further consonants. This, of course, is creates special problems in stops, since they lack other internal cues to make them heard. Thus, it is not unreasonable to think that there is a phonetic basis for tV constraint above. Overall, both cross-linguistic and the phonetic facts provide a strong reason for positing a constraint like tV to account for unattested -tC- clusters in Wichita.

The remaining constraints involved with the analysis of affrication are all faithfulness constraints that limit the ability of an underlying segment to change to fix violations of the above structure. These three constraints will be drawn from the standard Optimality-Theoretic view on restrictions of this kind, Correspondence Theory (McCarthy and Prince, 1995).

The second constraint needed for the analysis is defined in (7).

\[(7) \text{MAX-C (abbreviated label: MAX): Don’t delete consonants present in input.}\]

This constraint is motivated by the fact that within the affrication alternation, there is no deletion. However, although deletion is generally dispreferred in Wichita’s consonant cluster interactions, it is not absent, as §4 will show. Thus, as further alternations are considered, the constraints concerning deletion will be refined. However, the general MAX-C constraint is sufficient for the affrication part of the analysis.

The third constraint is defined in (8).

\[(8) \text{IDENT (ID): In input segments with a corresponding output segment, keep the feature specifications in the output the same as the input.}\]

This constraint prevents gratuitous changes to a segment’s features; in effect, prohibiting strange alternations like /t/ → [b]. Much like MAX-C above, it will be further refined as the analysis proceeds.

The first refinement is given in (9).

\[(9) \text{IDENT(manner) (ID-man): In input segments with a corresponding output segment, keep the manner feature specification in the output the same as the input.}\]

This constraint, a more specific version of (8), restricts the gratuitous changes from happening within a certain subset of a segment’s features – the manner features, for which I gave the specifications in (2). Within the affrication analysis, this constraint only allows /t/ to become [t] or [ts]; that is, the constraint does not allow a change in /t/’s manner feature, [plosive]. This prevents Wichita’s /t/ from undergoing fricativization to [s] (as /t/ sometimes does in Attic Greek) or any other more serious lenition process.

With these four constraints, let us turn to how they interact to give the desired results. Given in (10) is an example of such an interaction, a tableau of the form from example (4c), tat'ar?at't, ‘I turned it around,’ which shows the interaction of /t + t/.

\[(10) \text{Input: /ta + t + t} \_2 \text{ar?at's+t + s/} \text{tV, MAX, ID-(man), IDENT}\]

\begin{tabular}{|l|c|c|c|}
\hline
\text{Input: /ta + t + t} \_2 \text{ar?at's+t + s/} & \text{tV} & \text{MAX} & \text{ID-(man)} & \text{IDENT} \\
\hline
\text{a. tat} \\_ \text{t} \text{ar?at's} & ✗ & ✗ & ✗ & ✗ \text{*} \\
\text{b. tat} \text{t} \_1, \_2 \text{ar?at's} & ✗ & ✗ & ✗ & ✗ \text{**} \\
\text{c. tat's} \text{ar?at's} & ✗ & ✗ & ✗ & ✗ \text{**} \\
\text{d. tat} \text{t} \_2 \text{ar?at's} & ✗ & ✗ & ✗ & ✗ \text{**} \\
\text{e. tat} \text{t} \_2 \text{ar?at's} & ✗ & ✗ & ✗ & ✗ \text{**} \\
\hline
\end{tabular}

I assume, following the insights of Deguchi (2001), that alternations like /t + t/ → t and /t + t/ → t are in fact instances of coalescence and not deletion. See section A.2 for more on these clusters.

The subscripts 1 and 2 are provided to show the correspondence between the input and the output. Thus, instances of X\textsubscript{1,2} are coalescence and while X\textsubscript{1} or X\textsubscript{2} indicates deletion. When an output retains both input segments, the subscripts will be absent. I follow these conventions throughout the paper.
This example straightforwardly shows the mechanics of the analysis. The markedness constraint TV rules out the fully faithful candidate, candidate (e), *tattar?at^s. The faithfulness constraints then rule out the remaining unattested fix-up strategies. MAX-C rules out the candidate with deletion, candidate (d); IDENT(manner) rules out the case of fricativization of the first /t/, as in candidate (c); and IDENT rules out candidate (b), which changes both relevant segments.

The same sort of result is obtained with affrication in clusters other than /t + t/. The tableau in (11) shows the interaction of a different -tC- cluster, /t + k/, exemplified by the form from (4b), tat^ska?at^s, ‘I ate it.’

<table>
<thead>
<tr>
<th>(11)</th>
<th>Input: /ta + t1 + k2al?at^s + s/</th>
<th>TV</th>
<th>MAX</th>
<th>ID-(man)</th>
<th>IDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ☞</td>
<td>ta[t^sk]a?at^s:</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>ta[t^1,2]a?at^s:</td>
<td></td>
<td></td>
<td>**!</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>ta[sk]a?at^s:</td>
<td></td>
<td>**!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>ta[k^2]a?at^s:</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>ta[t^1]a?at^s:</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td>ta[k]a?at^s:</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In (11), the constraints work almost exactly in the same fashion as in (10); one slight difference is that the MAX-C constraint eliminates deletion of either input segment (candidates d and e).

Both (10) and (11) also provide a ranking argument: the constraint TV must outrank IDENT. This ranking argument comes from the comparison of forms like ta[t^sk]a?at^s: and *ta[tk]a?at^s:. Both forms violate just one constraint (ta[t^sk]a?at^s:, IDENT and *ta[tk]a?at^s:, TV); but only the form with affrication is attested. Thus TV must be the worst constraint to violate.

None of the other constraints can be crucially ranked from the affrication data. The order in which they are presented in the above tableaux is a bit arbitrary (but actually follows the ranking from a more complete analysis of the Wichita data). However, this motivates us to consider further consonant cluster resolutions to see how they may inform this emerging analysis.

4 Deletion

4.1 Basics

Like affrication, deletion involves a cluster-initial, but morpeme-final segment: ?. The nature of the process is quite simple; ? deletes before another consonant, as Table 4 shows.

<table>
<thead>
<tr>
<th>Cluster-final</th>
<th>t</th>
<th>k</th>
<th>k^w</th>
<th>?</th>
<th>t^s</th>
<th>s</th>
<th>r</th>
<th>w</th>
<th>y</th>
<th>h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster-initial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>?</td>
<td>t</td>
<td>k</td>
<td>k^w</td>
<td>?</td>
<td>t^s</td>
<td>s</td>
<td>r</td>
<td>w</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Resolutions of -?C- Clusters

Across the Northern Caddoan family, this rule, as it applies to the glottal stop, appears to be unique. However, there is a similar process in Pawnee that Parks (1976, 38–39) calls laryngeal loss, where [h] is deleted before consonants.

Glottal stop deletion in Wichita is exemplified in (12)–(14). Like affrication, word-internal ?-deletion is restricted to a just few affixes, having the requisite phonological shape. These include hi?-, ‘non-singular agent’\(^{17}\) shown in (12) and a?:?, ‘quotative’, shown in (13).

\(^{17}\)It is glossed in (12) as dual, its ‘base’ meaning.
(12)  hito:ris
    hi?- ti-   war-  s
    DU- IND.3- go.DU- IMPF
    ‘They two are going.’ (Rood, 1976, 187)

(13)  a:kiriwa:c?árasca:hi
    a?-  ki  Riwa:c  ?aras- ca-  re:hi
    QUOT- AOR- big- meat- surface- put.PL.OBJ
    ‘He put the big quantity of meat on top.’ (Rood, 1976, 266)

However, the environment for deletion can also straddle word boundaries. This is shown by the example
given in (14). The second line gives the forms of the words in isolation; the top line gives the forms of
the words in continuous speech. Note that there are three instances of ظ-deletion in this example:
\[ \text{wéra} \rightarrow \text{wéra}, \text{wickhé}: \rightarrow \text{wickhé}: , \text{and wa} \rightarrow \text{wa}. \]

(14)  wéra  tac  kwickhé:  wa  ri?:wah.
    wéra?  tac  wickhé?:  wa?  ni?:wah.
    INFER big very already it.being.long
    ‘It must have been a very long way.’ (Rood, 1976, 205, 238)

Example (14) also shows that several other processes can occur between words. Fortition, the topic for §5,
occurs between the words \(\text{tac} \) and \(\text{wickhé}:\) and the intervocalic lenition of /n/ to [r], discussed in passing in
§2.3, occurs between \(\text{wa}\) and \(\text{ni?:wah}\).

4.2 Expanding the Sequential Analysis

How might the sequential analysis account for the alternations given in Table 4 and demonstrated in (12)–
(14)? As in the discussion of affrication, I begin first with the markedness constraint that rules out ظ-clusters and then move to discuss the faithfulness constraints that “fix up” the marked structures.

To rule out sequences of ظC, we could try and generalize the tV constraint from the affrication analysis. However, because there is not a close parallel in the phonotactics between ظ and /t/—namely, ظ appears
word-finally, in contrast to /t/—I take a different analytical tack. Instead, I propose the constraint in (15):

(15)  [+glottal] \rightarrow \text{release} (\text{Glott} \rightarrow \text{Rel}): Glottal segments need to have audible releases

Although I intend this to be generally applicable to both ظ and [h], which both are restricted as initial
members of consonant clusters in Wichita,\(^{18}\) I will focus on motivating this constraint for the segment
involved with the deletion process under discussion here, the glottal stop.

Like tV, [+glottal] \rightarrow \text{release} is phonetically motivated. Glottal stops, without any oral articulation, are
difficult to perceive. This perception problem becomes worse if there is no release burst, as glottal stops do
not have other salient cues such as the formant transitions discussed for /t/. Thus, it seems that if glottal stops
are licensed at all, they should be licensed in positions where a release burst could be perceived by listeners;
that is utterance-finally and pre-vocally. Otherwise, it may be difficult to ever know that a glottal stop is
there.

Also, this constraint seems to be motivated from Wichita data beyond the alternation. Interestingly, there
is an asymmetry in the appearance of glottal stops in consonant clusters. Although the glottal stop is absent
from the initial position of clusters,\(^{19}\) it is found widely in the final position of two-member consonant
clusters. The list in (16) shows the various combinations I found just by looking at the dictionary and
examples within Rood (1976).\(^{20}\)

\(^{18}\)The sound [h] does appear initially in some clusters, unlike ظ.

\(^{19}\)Alternatively, the glottal stop might only be absent from the initial position of derived consonant clusters.

\(^{20}\)It is not clear to me whether the absence of ظ is an accidental or principled gap.
Thus, this asymmetry also suggests the release of glottal stops is important, as embodied in the constraint in (15). It is also possible that, like tV, this constraint may also be typologically well-motivated, too, although at present, I am not aware of any studies that have looked closely at the distribution of glottal stop.

Having dealt with the important markedness constraint in ?-deletion, I turn now to the relevant faithfulness constraints. This alternation, since it involves deletion, requires a revision to the existing faithfulness constraints; otherwise the presently high ranking MAX-C prevents candidates with deleted segments from being optimal, contrary to the attested outputs given in Table 4.

To head off this problem, I propose that a second constraint from the MAX family is in play here and it actually ranks above the general MAX-C constraint. A definition for this constraint is given below in (17):

(17) MAX-oralC [MAX-oral]: Don’t delete segments with an oral place of articulation (i.e. one that involves an articulator articulating in the oral cavity)

The effect of this constraint is that it doesn’t care about deletion of a glottal stop (or a glottal approximant), allowing candidates with glottal stop deletion to pass onto and interact with the lower-ranked constraints. We can see its effect, along with the effect of [+glottal] → release, in the tableau in (18), which gives the constraint interaction for the form, hito:ris, ‘They two are going,’ from example (12).

As (18) shows, [+glottal] → release rules out the most fully faithful candidate, candidate (d), since the glottal stop does not have a release in the position before the [t]. Moving up list of candidates, candidate (c), which deleted the input [t], incurs a fatal violation of MAX-oralC and is thus eliminated. The remaining two candidates, (a) and (b), tie with one violation each of MAX-C, but the optimal (and attested) candidate is selected by IDENT(manner), which prefers the faithful output of [t] over the lenited [s].

This constraint interaction also produces a ranking argument. In the pairwise comparison of candidate (a), hito:ris, and candidate (d), *hi?to:ris, one sees that both only violate one constraint. However, since hito:ris is attested and *hi?to:ris is not, this reveals that [+glottal] → release (which *hi?to:ris violates) must crucially outrank MAX-C (which hito:ris violates).

5 Fortition

5.1 Basics

In contrast to the previous two alternation types, fortition involves a cluster-final and morpheme-initial consonant. As shown in Table 5, most cluster-final underlying /w/’s become the corresponding plosive, [kʷ]. Two of the few remaining clusters – /hw/ and /kw/ – remain faithful, with some coalescence in the latter, while the third, /t/w/, undergoes the deletion process already discussed.

This process is, in fact, not found only in Wichita, but also in related Pawnee (Parks, 1976, 50–52). The crucial difference between Wichita and Pawnee is that in Pawnee, /w/ becomes [p], not [kʷ], since the latter segment doesn’t exist in Pawnee. However, it is possible and, in my estimation, highly likely that these two alternations were, once upon a time, one and the same, since all instances of Proto-Caddoan *p are w initially or kʷ medially in Wichita, but remain p in Pawnee (see cognate chart in Taylor (1963, 125)).
Table 5: Resolution of -Cw- Clusters

<table>
<thead>
<tr>
<th>Cluster-initial</th>
<th>Cluster-final</th>
</tr>
</thead>
<tbody>
<tr>
<td>t</td>
<td>tʰkw</td>
</tr>
<tr>
<td>k</td>
<td>kw</td>
</tr>
<tr>
<td>?</td>
<td>w</td>
</tr>
<tr>
<td>tʰ</td>
<td>tʰkw</td>
</tr>
<tr>
<td>s</td>
<td>skw</td>
</tr>
<tr>
<td>r</td>
<td>hw</td>
</tr>
<tr>
<td>h</td>
<td>hw</td>
</tr>
</tbody>
</table>

There is also fortition of /w/ to [p] in Caddo (Melnar, 2004, 197–200), although it doesn’t occur in the same position (it occurs word-initially only); therefore, it could be that this is an independent development.

Because fortition in Wichita is a cluster-final alternation, the affected segments are all root-initial segments, so unlike the previous alternations, w-fortition can occur with a potentially open class of morphs. This alternation is exemplified by the root, -wa, ‘go’ in (19) and (20), and by the root, -wi, ‘stand upright,’ in (21).

(19) ıskʷa
    i- s- wa
    IMP- 2A- go
    ‘Go!’ (Rood, 1976, 236)

(20) ıkʷa
    i- t- wa
    IMP- 1A- go
    ‘Let me go.’ (Rood, 1976, 236)

(21) ıthkʷi
    ti- r- wi
    IND.3- COLL- stand.upright
    ‘They are standing upright.’ (Rood, 1976, 236)

Finally, as (14) showed, fortition also occurs across word boundaries, as in the two-word expression tac wickhéʔ, which became tac kwickhé:\.

5.2 Expanding the Sequential Analysis Further

To capture the fortition facts, further constraints must be added, though without altering the results previously achieved. Once again, I will discuss the markedness addition first before moving on to the faithfulness addition.

The markedness constraint relevant for the fortition domain is as in (22):

(22) *C-glide: Sequences of a consonant plus a glide are ill-formed

Outside the fortition process, the Wichita-internal motivation for this constraint is that there are no instances of C + glide sequences, aside from kʷ, which I have been and will continue to treat as a unitary segment, and the sequence hw, which I will treat as being permitted due to a higher ranking AGREE constraint, which I will not formalize, but discuss a possible phonetic motivation behind it further below.
I turn next to some cross-linguistic motivation. Although it seems that there are not many other languages where such a constraint has a clear motivation (i.e., a language without general constraints against glides or consonant clusters), there is a possible example from Lakhota. Lakhota has a large number of word-internal clusters including stop-stop (e.g. *tk*), stop-fricative (e.g. *ps*), fricative-stop (e.g. *st*), obstruent-nasal/lateral (e.g. *sn*) and nasal-nasal (e.g. *mn*) (Albright, 2004). Interestingly, glides in Lakhota generally do not appear to occur in word-internal consonant clusters, though they can appear in word-initially by themselves. Examination of data in Albright (2004), Shaw (1980), and Williamson (1902/1992) indicates that all the exceptions are, as in Wichita, velar-[w] clusters.

These facts are consistent with a perceptual grounding to this constraint. The idea is that glides following most consonants are not terribly well-cued. Between the formant transitions out of (and bursts of) the preceding consonants and the formant transition into the following vowels, the cues for the glides “get lost in the shuffle,” and are easy to misperceive as being absent. Ideally, this should be corroborated by more detailed phonetic studies. I am presently not aware of any studies that have looked at this, or any of the other aspects of the ideas I present above.

However, akin to the case of place in nasals (see discussion in Blevins (2004, 118)), if a glide is preceded by a consonant with a similar place of articulation, the cues for the glide improve, so it can be licensed (hence the AGREE constraint above). Thus, under this later scenario, [w] need not undergo fortition after [k] and [h], but rather can remain faithful, since it is well-cued as is.

It is quite possible that the constraint defined in (22) is actually a specific instance of a more general constraint in Wichita, *C-sonorant, as Wichita does not have sequences of -Cn- or -CR-, either. These additional data suggest a more general phonetic hypothesis regarding these restrictions on consonants followed by sonorants: all the sonorants are acoustically complex, having vowel-like formants (and in the case of [n], anti-formants). Given this complexity, it seems plausible that the sonorant segments receive the best cues in environments where there isn’t a consonant preceding the sonorant, so that the consonant doesn’t impede the complex cues. Thus, sonorants might be disallowed post-vocically in some instances, as is the case in Wichita.

However, since the main concern here is the alternation with /w/, I will just use the *C-glide constraint given above. For further consideration of *C-sonorant, see the discussion in §A.2.

Turning now to the faithfulness constraint, the fortition data necessitates an additional member of the IDENT family, IDENT(place), defined below in (23):

\[
\text{IDENT}(\text{place}) [\text{ID-pl}]: \text{If an input segment has an output correspondent, don’t change the place feature of a segment between the input and output.}
\]

This constraint keeps alternations from changing place of articulation; thus, changes to /w/ must keep the [labial] feature of /w/, as it does when /w/ becomes [kw] in fortition. However, this constraint isn’t specific to labials; it enforces place stability in all alternations. However, thus far, the forms considered above with IDENT(place) violations have been subsumed by violations of IDENT. However, as the fortition examples show, this cannot always be done. I turn to these kinds of interactions and to demonstrate, in detail, how the analysis of fortition works in the tableaux in (24) and (25).

The tableau in (24) gives the constraint interaction involved in generating the form from (19), *isk*10*a*, ‘Go!’

\[\text{(23)} \quad \text{IDENT}(\text{place}) [\text{ID-pl}]: \text{If an input segment has an output correspondent, don’t change the place feature of a segment between the input and output.}\]

---

21 These all occur initially as well in Lakhota.
22 Ideally, this should be corroborated by more detailed phonetic studies. I am presently not aware of any studies that have looked at this, or any of the other aspects of the ideas I present above.
As the tableau shows, the \textsc{maxoralC} constraint eliminates the candidates with deletion [(h) and (i)], and the newly introduced markedness constraint, \textsc{c-glide}, eliminates the fully faithful candidate, \textit{*iswa}. Then, \textsc{ident(place)} eliminates a whole host of candidates, candidates (c)–(f). Note that it doesn’t matter which segment causes the violation of \textsc{ident(place)}: in candidate (c), \textit{isha}, the violation comes from changing \textit{w} [labial] to \textit{h} [dorsal], while in candidate (f), \textit{ihkw}a, the violation comes from changing \textit{s} [coronal] to \textit{h} [dorsal]. The correct form \textit{iskw}a is a result of \textsc{ident(manner)}, which rules out the last remaining other candidate, candidate (b).

This analysis has posited \textsc{ident} constraints on the two major kinds of articulatory features – place features and manner features. However, as (24) shows, the faithfulness to these respective features is not equal. In fact, Wichita prefers to preserve a place feature over a manner feature. Evidence for this comes from two of the candidates from (24), each of which preserves one major feature. The attested output, \textit{iskw}a, is place-preserving, while the manner-preserving \textit{isha} is not; thus, \textsc{ident(place)} crucially outranks \textsc{ident(manner)}.

A second crucial ranking is also shown by the interaction in (24). Here the pairwise comparison is between candidate (h), \textit{*iswa}, and candidate (a), \textit{iskw}a. \textit{Iswa} is fully faithful, but violates \textsc{c-glide}; \textit{iskw}a violates \textsc{ident(manner)}, but satisfies \textsc{c-glide}. Therefore, because \textit{iskw}a is the attested form, \textsc{c-glide} must outrank \textsc{ident(manner)}.

Although the tableau in (24) demonstrates how the sequential analysis of fortition works, I show that the overall analysis presented here can capture both the fortition data as well as the previous processes. Thus, I next consider the tableau in (25), which shows the interaction with the form from (20), \textit{itwa}, ‘Let me go!’ This form includes a /t + w/ interaction, a sequence that undergoes both affrication and fortition.

---

**Table 24**

<table>
<thead>
<tr>
<th>Input: /is\textsubscript{w}a/</th>
<th>\textsc{maxoral}</th>
<th>\textsc{c-glide}</th>
<th>\textsc{max}</th>
<th>\textsc{id-pl}</th>
<th>\textsc{id-man}</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.  e\textsuperscript{\textbullet}</td>
<td>i[sk\textsuperscript{w}]a</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b.  t\textsuperscript{\textbullet}</td>
<td>i[t\textsuperscript{k}w]a</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>c.</td>
<td>i[sh]a</td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>d.</td>
<td>i[s\textsuperscript{1,2}]a</td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>e.</td>
<td>i[s\textsuperscript{1,2}]a</td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>f.</td>
<td>i[hkw]a</td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>g.</td>
<td>i[sw]a</td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>h.</td>
<td>i[w\textsuperscript{2}]a</td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>i.</td>
<td>i[s\textsuperscript{1}]a</td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
</tr>
</tbody>
</table>

The constraint interaction proceeds much as in (24), except that the fully faithful candidate, candidate (h), \textit{*itwa}, violates two highly ranked markedness constraints, \textsc{tv} and \textsc{c-glide}, instead of just one. The other difference lies in the interaction of the final two candidates, \textit{itwk}a and \textit{iskw}a.\textsuperscript{23} Here the constraint vio-

\textsuperscript{23}As (24) shows, \textit{iskw}a is a permitted string; rather, the asterisk before \textit{iskw}a here refers to the fact that this form is not the grammatical output of \textit{itwa}.
lation pattern is similar to the affrication pattern seen in (10), where the remaining two constraints tie on IDENT(place) and the outcome is decided (in favor of $it^\k^w a$) by IDENT(manner).

The tableau in (25) provides evidence for one last crucial ranking of constraints: $^\circ$C-glide $\gg$ IDENT(manner). As (25) shows, the attested form, $it^\k^w a$, violates IDENT(manner). The candidate of comparison is candidate (e), $^*it^*wa$, which violates $^\circ$C-glide. However, since candidate (a) is attested, IDENT(manner) must be the lesser constraint to violate, and must be lower ranked.

6 Sequential Analysis Summary

Having gone through all the processes under close consideration in this paper, I want to summarize the first account of these processes, the sequential analysis.

The general characteristic of this analysis is that markedness constraints all make reference to particular sequences. Furthermore, these markedness constraints – tV, [+glottal] → release, and $^\circ$C-glide – were all shown to be grounded in the phonetic tendencies surrounding these particular sequences of sounds. In particular, they require consonant clusters to contain perceptually well-cued segments. This phonetic grounding has some further support from similar phenomena in other language families across the world, suggesting that none of these alternations is motivated by truly Wichita- or Caddoan-specific constraints.

From this in-depth examination of the sequential analysis, the following ranking in (26) was obtained:

\[
(26) \quad [+\text{glottal}] \rightarrow \text{release} \\
\begin{array}{cccccccc}
\text{MAX-oralC} & \text{MAX-C} & \text{tV} & ^\circ\text{C-glide} \\
\text{IDENT}(\text{place}) & \text{IDENT}(\text{manner}) & \text{IDENT} \\
\end{array}
\]

As (26) shows, most of the constraints interact to produce a ranking. However, in a few cases, most notably between [+glottal] → release and most of the second line of constraints, there is not enough interaction to determine a ranking. Thus, (26) shows no line for ranking relationships that cannot be determined.

In addition to capturing the affrication, deletion, and fortition alternations, this ranking can also straightforwardly capture the numerous cases of faithfulness, the dominant strategy in the resolution of clusters beginning with /t$^\circ$/ and /s/, shown in Table 6.

<table>
<thead>
<tr>
<th>Cluster-initial</th>
<th>t</th>
<th>k</th>
<th>k$^w$</th>
<th>?</th>
<th>t$^e$</th>
<th>s</th>
<th>r</th>
<th>w</th>
<th>y</th>
<th>h</th>
</tr>
</thead>
<tbody>
<tr>
<td>t$^e$</td>
<td>t$^e$t</td>
<td>t$^e$k</td>
<td>t$^e$k$^w$</td>
<td>t$^e$?</td>
<td>t$^e$t$^e$</td>
<td>t$^e$</td>
<td>t$^e$k$^w$</td>
<td>t$^e$h/t$^e$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>s</td>
<td>st</td>
<td>sk</td>
<td>sk$^w$</td>
<td>s$^?$</td>
<td>st$^e$</td>
<td>s:</td>
<td>s:</td>
<td>sk$^w$</td>
<td>s:</td>
<td>sh/s:</td>
</tr>
</tbody>
</table>

Table 6: Resolution of -sC- and -t$^e$C- Clusters

An example of a faithful interaction is given in (27). Here the contact occurs because of the adjacency of the affix -s-, ‘2nd person agent,’ and the affix -ki-, ‘1st person object.’ As expected from Table 6, the /s + k/ contact resolves to [sk].
This interaction is predicted by the sequential analysis as the tableau in (28) shows.24

Thus, the sequential analysis offers impressive empirical coverage, handling not only the cases of affrication, -?-deletion, w-fortition, but also cases of faithfulness found within -sC- and -tC- clusters. The present empirical coverage is shown in Table 7. The grayed-out cells represent alternations captured by the sequential analysis.25

Yet the question remains how it stands up to alternative views of these facts. I begin consider this question in the next section, and start by showing that there is a feasible alternative account of the alternations using a syllable structure-based approach.

7 A Syllable Structure Analysis

In contrast to the sequential approach, there is an alternative interpretation of the data, where the attested patterns are not the direct result of constraints on sequences, but rather are the result of constraints placed on what syllable structure positions—onsets and codas—can license. In particular, this section will discuss a syllable account predicated on the idea that certain segments, even if they are unmarked otherwise, can

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24I am not sure why the tone appears on the long a; for convenience, I assume it is part of the underlying representation, but future work should investigate whether such an assumption is actually warranted.

25An expansion of the sequential analysis to include the remaining obstruent + C clusters and some of the rC clusters is given in the appendices.
become marked in certain syllable positions. Because this syllable structure analysis is just a different theory of markedness compared to the sequential analysis, I will import the faithfulness constraints from the first analysis without any further discussion.

As in the sections above on the sequential analysis, I will again discuss each of the three processes—affrication, deletion, and fortition—and consider the relevant details for implementing the above idea. In considering the syllable boundaries, I will give my best guesses at the syllabifications, based on syllabifications given by Rood (1996, 582). Per graphical convention in phonetics and phonology, syllable boundaries will be marked by periods.

7.1 Affrication

Affrication, as discussed in §2, occurs in Wichita both in pre-consonantal position as well as word-finally. Taking the pre-consonantal position to be a syllable-final one, then the generalization seems pretty clear: [t] is not permitted in the coda position of a syllable. This suggests the following constraint, akin to a similar constraint – the conjoined constraint *[t] & *[CODA – proposed in previous work on affrication in Wichita by Deguchi (2001).

\[(29) \quad *\text{Coda/t}: \text{Don’t have } [t] \text{ in the codas of syllables}\]

In addition to having the same Wichita-internal motivation as the tV constraint, it also serves the same function in the analysis; it eliminates the marked configuration [t.C] and sets in the motion the need to have the affrication “repair.” The tableau in (30) illustrates just this kind of constraint interaction, again using the form from (4c), ta[.t]ar?a:t, ‘I turned it around.’

\[(30)\]

<table>
<thead>
<tr>
<th>Input: /ta + t_1 + t_2 ar?a:t + s/</th>
<th>*Coda/t</th>
<th>MAX-oral</th>
<th>ID-man</th>
<th>IDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ta[t].t]ar?a:t^a</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b. ta[t_1,t_2]ar?a:t^a</td>
<td></td>
<td></td>
<td></td>
<td>**!</td>
</tr>
<tr>
<td>c. ta[s,t]ar?a:t^a</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>d. ta[t_2]ar?a:t^a</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>e. ta[t,t]ar?a:t^a</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Like tV, *Coda/t rules out the faithful candidate (e). The attested candidate – candidate (a) – is then chosen via the remaining faithfulness constraints, in the same fashion as discussed for the tableau in (10).

Thus, *Coda/t achieves the same kind of result as tV, but through a different means. The rest of the analysis takes the insight from this part of the analysis and extends it to the other cases.

7.2 Deletion

Under the syllable-based view, if the bad coda [t]’s are ruled out by *Coda/t, then why not extend it to rule out syllable-final ??. Such an extension is formalized by the constraint defined in (31):

\[(31) \quad *\text{Coda/?}: \text{Don’t have } [?] \text{ in the codas of syllables}\]

Much as *Coda/t had an analogue in the constraint tV from the sequential analysis, *Coda/? likewise has an analogue in [+glottal] → release. Like its analogue, *Coda/? rules out the marked string of [?C], although only when it is syllabified [?C]. The role of *Coda/? in the syllable structure-based analysis of ?-deletion is shown in the tableau in (32), of the form, hito:ris, ‘They two are going.’

\[26\text{Constraints, whatever their ranking, which are not violated by any candidate under consideration, have been omitted throughout this section.}\]
As in (30), once the high ranking markedness constraint, *Coda/? in this case, has eliminated the fully faithful candidate (candidate (d)), the various faithfulness constraints ultimately select the attested output, just as in the tableau in (18).

Although *Coda/t and *Coda/? may seem, at first glance, disjoint—there is no commonly-discussed natural class of sounds that is just the set \{[t], [?]\}—there is an interesting connection between the two of the them: [t] and [?] are generally considered the most unmarked stops (see Paradis and Prunet (1991) for discussion of coronals; Lombardi (2002) for glottals). In particular, generalizing over these two constraints, it appears that unmarked segments are, informally, too unmarked to appear in weak positions such as codas. Formally, this insight could be captured though local conjunction between a harmonic scale of prosodic prominence (where codas would be ranked at the lower end) and a harmonic scale of place (as proposed by Lombardi (2002)), although I won’t delve into the details of such a formalization here.

The line of thinking outlined above does bring to light an important difference between the syllable-based analysis under discussion here and the sequential analysis. In the syllable-based analysis, the markedness is grounded in typological observation of what appears to be cross-linguistically marked; whereas, in the sequential analysis, the constraints against these segments is grounded in phonetics, and thus, the markedness is a consequence of acoustics.

7.3 Fortition

Although the syllable-based analysis has gotten a lot of mileage, thus far, out of restrictions in codas, this particular kind of restriction cannot be easily extended to account for the cases of w-fortition. However, this is likely a welcome result, since strengthening processes (like /w/ → [kw]) are, in the very least, preferred in stronger positions (Zoll (1998); Smith (2002), among others), which are typically thought not to be codas. Yet, at a higher level, the general analytical move of restricting particular classes of segments from particular syllable positions can be applied to w-fortition. In this case, the restriction is in the onset, as formalized in (33):

(33)   *ONSET/GLIDE: Don’t have glides in the onsets of syllables

This constraint is one of the many members of the *ONSET/X family (Smith, 2003), a modified version of the *MARGIN/X family of Prince and Smolensky (1993/2004). The universal hierarchy embodied in the *ONSET/X family is predicated on the idea that onsets prefer low sonority segments to maximize the onset’s distinctiveness from the high sonority nucleus. So, in fact, *ONSET/GLIDE is the highest ranked member of this universal subhierarchy, since onsets with glides have the highest sonority of any kind of consonantal onset. To capture further restrictions on other kinds of sonorants in Wichita, further members of the subhierarchy, like *ONSET/RHOTIC and *ONSET/NASAL would be needed. However, since they don’t figure in the analysis of fortition, they will not be discussed further here.

As has been a re-occurring theme in this section, in terms of functionality in the actual analysis, there is a great similarity between *ONSET/GLIDE and its sequential analogue, *C-glide. As in the other syllabic sub-analyses, *ONSET/GLIDE rules out the fully faithful candidate, and then the remaining faithfulness

\(^{27}\)This same selection by faithfulness constraints also occurs in the corresponding tableaux, (10) and (18), of the sequential analysis.
constraints interact to produce the attested example. An interaction illustrating this is given in (34), using the form *iskw*a, ‘Go!’ from (19).

(34)  

<table>
<thead>
<tr>
<th>Input: /is\w2a/</th>
<th>MAX-oral</th>
<th>*ONSET/GLIDE</th>
<th>ID-pl</th>
<th>ID-man</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. *</td>
<td>i[s,k]a</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>b. i[t,k]a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. i[s,h]a</td>
<td></td>
<td></td>
<td></td>
<td>!</td>
</tr>
<tr>
<td>d. i[s1.2]a</td>
<td></td>
<td></td>
<td></td>
<td>!</td>
</tr>
<tr>
<td>e. i[s.s]a</td>
<td></td>
<td></td>
<td></td>
<td>!</td>
</tr>
<tr>
<td>f. i[h,k]a</td>
<td></td>
<td></td>
<td></td>
<td>!</td>
</tr>
<tr>
<td>g. i[s.w]a</td>
<td></td>
<td></td>
<td></td>
<td>!</td>
</tr>
<tr>
<td>h. i[w2]a</td>
<td></td>
<td></td>
<td></td>
<td>!</td>
</tr>
<tr>
<td>i. i[s1]a</td>
<td></td>
<td></td>
<td></td>
<td>!</td>
</tr>
</tbody>
</table>

Thus, w-fortition shows that a syllable-based approach has to account for the Wichita data by positing constraints about the licensing in syllable onsets, in addition to syllable codas.

7.4 Summary of the Syllable Analysis

This section has shown the viability of a second approach to Wichita consonant clusters, where the markedness constraints restrict the licensing potentials of onset and coda constituents within syllables. This is a straightforward extension of Itô’s Prosodic Licensing Principle. Furthermore, these licensing factors have been shown to be related to the overall markedness of the segments, relativized to the particular syllable position. In codas, unmarked segments are dispreferred; in onsets, the dispreferred segments are those that are similar to nuclei.

Like the sequential analysis, the syllable-based analysis can likewise capture the case of faithfulness found in the -sC- and -tC- clusters. A tableau showing this is given in (35). Note that this tableau closely matches the violation pattern of the similar tableau, (28), from the sequential analysis.

(35)  

<table>
<thead>
<tr>
<th>Input: /ta + s_1 + k_2i + r:i:k + i:s/</th>
<th>*Coda/t</th>
<th>*Coda/i</th>
<th>MAX-oral</th>
<th>*ONSET/GLIDE</th>
<th>ID-pl</th>
<th>ID-man</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. *</td>
<td>ta[s,k]irá:k?i:s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. t[a]k?i:s</td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. ta[h,k]irá:k?i:s</td>
<td></td>
<td></td>
<td></td>
<td>!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. ta[s1]irá:k?i:s</td>
<td></td>
<td></td>
<td></td>
<td>!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. ta[k2]irá:k?i:s</td>
<td></td>
<td></td>
<td></td>
<td>!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

So, on this point as well, the syllable-based analysis matches the empirical coverage of the sequential analysis.

In the analytical details, the syllable-based analysis has been shown to be quite similar to the sequential analysis. In particular, the constraints on licensing within the syllable—*Coda/t, *Coda/i, and *ONSET/GLIDE—occupy the same highly-ranked position in the syllable-based grammar as their counterparts do in the sequential analysis. Likewise, the imported faithfulness constraints occupy the same mid to low position as they do in the sequential analysis. So, given these similarities, this sets the stage for the next section, which will look to differentiate more clearly between the two analyses and see which offers a better picture of understanding the Wichita phonological system as a whole.
8 Comparison

So, as §7 revealed, both analyses can account for the alternations; in fact, they account for these alternations in a similar way. These analyses, however, make different predictions about other aspects of the system, both Wichita-internally and Wichita-externally. This section will investigate two further important classes of predictions: the phonotactics at the edges of words (with reference to deletion, fortition, and affrication) and, internal to Optimality Theory, what the constraints predict for a factorial typology. I argue, given the Wichita-internal facts, that the sequential analysis is preferable. I additionally offer some thoughts about the two factorial typologies, though the results there seem to be preliminary.

8.1 Differences at the Edges

The first prediction to be investigated involves the edges of words. In general, the two analyses part company at the edges of words. In its unadulterated form, the syllable-based analysis predicts that word-internal consonants, whether in a coda or an onset, will behave just like their edge counterparts. The sequential analysis, for the most part, predicts the opposite: that the word-internal consonants will behave differently from their peripheral counterparts.

8.1.1 Deletion

Within the syllable-based account, the chief markedness constraint for deletion was *Coda/P. In restricting the nature of the coda consonants in Wichita, this constraint makes the prediction that glottal stops should be absent from codas. This, however, is not the case, as shown below in (36)–(38):

(36) k'iri
NEG
‘No!’ Sentence final in (Rood, 1976, 260)

(37) ha?wa
OK
‘OK.’ Sentence final in (Rood, 1976, 263)

(38) hiri
then
‘then.’ Intonation phrase final in (Rood, 1976, 263)

And in fact, beyond these sentence-final examples, numerous more words end in the glottal stop (and even the glottal approximant [h]), at least in their citation form. However, I don’t directly consider them above because, as (14) showed, ?-deletion is a process where the environment can straddle a word-boundary. Due to this, I assume that the final glottal stops of the citation form are deleted under most circumstances. However, even without these additional words, there are still the cases above, so I conclude this prediction of *Coda/? is false.

The sequential analysis avoids this problem because it only targets the perceptually difficult phrase-internal ?C clusters; on this account, because an utterance-final ? is released, it has good enough cues to be licensed.

However, one must consider the possibility that other kinds of constraints are also in play, which could allow us to maintain the syllable-based analysis. To make that discussion clearer, let me first examine the fortition data, and then consider a response from the syllable-based analysis for the problems from both deletion and fortition, since there are similarities between the two.

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28This form shows that ? + w → w is, in the very least, a derived environment effect.
8.1.2 Fortition

The driving force for fortition in the syllable-based analysis is the constraint *ONSET/GLIDE. This, like *Coda?, makes what appears to be an incorrect prediction.

While the phone [w] does not appear after a consonant in Wichita, it does appear word-initially. Numerous nouns (and non-verbal adjectives) begin with [w]. Wac, 'jackrabbit;' wac?ta, 'penis;' wac, 'blood;' waseʔek?ta, 'dog;' and w:yo:, 'cat' are a subset of those given in the -w- section of the dictionary (pp. 289–290) in Rood (1976). Verbal roots also often begin with /w/, but due to the (almost) final position of roots within the verbal morphology, they never surface as the first consonant of the word.

Furthermore, it is not a case that w and kʷ are in complementary distribution. Rather, /w/ contrasts with /kʷ/ in initial position as (39) shows.

\[(39)\quad \text{wi:}c \quad \text{‘man’} \quad \text{(Rood, 1996, 606, 607)}
\]
\[\text{k̂wi:}c \quad \text{‘dull’}\]

This is all a surprise under an analysis with *ONSET/GLIDE, which predicts that the plosive [kʷ] should appear in all these onsets, when, in fact, it is only predictably present in the post-consonantal position. In contrast, this is not surprising at all from the standpoint of *C-glide. Since the constraint targets only [w] in post-consonantal position, [w] is free to appear and contrast with [kʷ] in word-initial position, since the *C-glide says nothing about that position.

8.1.3 Can the Syllable-Based Analysis be Saved?

So, the above two subsections have raised some serious questions for the syllable-based analysis. Yet, in OT, with the possibility of numerous other constraints interacting with these, we need to carefully consider some other options for “fixing” the syllable-based analysis.

One possibility is that there are edge-specific faithfulness constraints preserving final glottal stops and initial w’s. However, this move is suspect for several reasons. Let us first consider the case of faithfulness to the final glottal stops. A positional faithfulness constraint here would need to be faithfulness to an utterance-final position. Yet, positional faithfulness constraints, as a class, are faithful to stronger positions (Beckman, 1998). These can be phonological, such as the first syllable, or morphological, as in faithfulness to the stem or even the root. However, aside from being within the stem or root, the utterance-final position does not seem to be a particularly strong position to be faithful to.

Considering the case of left-edge (given the example in (14), probably utterance-initial) positional faithfulness to [w], this is far less problematic by itself. This does meet the strength desideratum discussed above, and considering the issue with [th] to be discussed below, it may be a move worth making anyway. However, when we consider the two possible constraints together, we find ourselves in an awkward position. There is both a right-edge faithfulness constraint and a left-edge faithfulness constraint; thus, the relevant prosodic phrase (perhaps the utterance) is circumscribed by positional faithfulness constraints, which seems like a conspiracy in and of itself.

Another possibility is to use one or more members of the ALIGN family to misalign some prosodic unit and some grammatical unit. The effect would be to create a representation where the exception clause of the Prosodic Licensing Principle (“modulo extraprosodicity”) could be evoked. In the two cases under consideration here, this would mean that the relevant prosodic unit would end before a utterance-final glottal stop, and that it would begin after an utterance-initial [w]. Again, this suffers from the circumscription problem – the utterance is circumscribed by extraprosodicity, suggesting that something more is going on. Furthermore, there seems to be no independent evidence for such extraprosodicity, although like many underdescribed languages, the prosody of Wichita is not well understood. From the discussion of stress in

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29 Or perhaps this restriction is just in utterance-initial positions.
(Rood, 1996, 582–583), it seems that Wichita stress is a Stress-to-Sonority system, where, in the hierarchy of receiving primary stress, high tone is preferred over long vowels, which, in turn, are preferred over singleton low vowels. Evidence for this pattern is shown in (40), where the primary stress is shown in boldface and the secondary stress is shown by underlining.

(40) nahe:rih  ‘creek’
k?í:ta:ks:ki:ya:k?:a  ‘millet’
kin.ni:tsa:ak:yi:has:ti:  ‘alfalfa’
ti:ka:si:sk:  ‘he has a beard’
ti:ka?:a?ts:  ‘he is eating it’

(Rood, 1996, 582)

As shown in the examples in (40), stress appears on the initial syllable, the antepenultimate syllable, the penultimate syllable, and the final syllable. This suggests that, in principle, stress can range over quite a bit of the word, and that initial and final syllables are not extraprosodic.

Thus, it seems that the problems raised in §8.1.1 and 8.2.1 remain problems for a syllable-based analysis, because the addition of positional faithfulness or alignment constraints does not completely solve the problems of the original syllable-based analysis.

8.1.4 Affrication and Initial Consonant Clusters

Thus far, it has been the case that the syllable-based analysis constraints have had predictions beyond the alternations. However, this section considers a case when the opposite holds: where the sequential analysis makes claims beyond the alternations. How do these predictions bear out?

In dealing with affrication, the relevant markedness constraints were tV and *Coda/t for the sequential and syllable-based accounts, respectively. *Coda/t makes no predictions beyond codas. However, tV, in requiring [t] to be licensed only when a vowel occurs after it, makes predictions even about initial clusters. The prediction is very clearly that [t] should not be present, unless that [t] precedes a vowel.

Despite all the clusters inside words, there are actually few initial clusters allowed in Wichita. However, most of the ones given by Rood (1996, 583) either support the prediction of tV or remain neutral to it. These clusters are [rh], [ks], [kʔ], [tʰh], [kʰ], [tʰkʰ], and [kskʰ]. In particular, the penultimate cluster, [tʰkʰ], fits quite well with tV. If one posited an underlying /t/, under Richness of the Base, tV would force it to surface as it does, as [tʰ]. Furthermore, this cluster, like all the clusters here, has all the non-approximant members well-cued, especially with respect to place of articulation.

Yet, the final cluster that Rood mentions would appear to be problematic for the tV constraint: [th]. Here, the constraint tV would predict that the /t/ should become [tʰ] in this environment, since [h] is not a vowel. However, given the cue-based grounding of the sequential analysis, the reverse question may be the more relevant one: why does the /t/ in /t + h/ (i.e., /th/ across a morpheme boundary) affricate, when the aspiration of the [h] should provide cues for the /t/? The answer here seems to be morphophonological analogy: since all other cases of -tC- (in particular, involving -t-, ‘1st person agent’) involve affrication, the process of affrication “overapplies” with /th/ in derived morphological environments.

Putting aside [th], to capture these high-stridency clusters and the non-appearance of [t] in the syllable-based analysis would require an additional theory. However, the move to another theory would cause the loss of a generalization that the sequential analysis elegantly captures, that the word-internal and word-initial clusters both are driven by phonetically-grounded constraints.

And furthermore, the most likely theory enlisted to aid the syllable-based theory – one that evokes the sonority sequencing principle — has a formidable task here. It is not clear where affricates fall in the

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30This is the idea that phonotactics is driven by a need for segments to rise in sonority to the nucleus and then fall to the margin.
sonority hierarchy, under the standard view of sonority sequencing. Assuming the proposal of Deguchi (2005), affricates are more sonorous than stops. Thus, a cluster like [tʰkh] vacillates in its sonority, going from mid-low to low to mid-high. So, even here, there is slight evidence that a syllable-based account augmented with sonority sequencing still wouldn’t quite get everything correct.

8.1.5 Assessing the Edge Data

As this subsection has shown, the behavior of the segments involved with affrication, deletion, and fortition at the edges is different from the same segments in word- and utterance-internal positions. In considering the two analyses, the sequential analysis does better here. It provides a natural account of the facts surrounding fortition and deletion without circumscribing the relevant constituent with positional markedness constraints or positing what appears to be unmotivated extraprosodicity. The sequential analysis also, in the case of affrication, seems to offer good predictions with regard to initial consonant clusters, thus, tying together phonotactics across the word, while the syllable-based account claims that the two are unrelated.

8.2 Factorial Typologies

Finally, let us consider the broader predictions of these two analyses. Under the standard assumptions of OT, re-ranking the constraints gives the factorial typology – a prediction about the possible range in which languages can vary. On a more practical level, this process of re-ranking constraints provides an indicator of how restricted the analysis is.

Using the OTSoft software package (Hayes et al., 2003), the constraints of each analysis (augmented to account for some of the alternations to be discussed in the appendix) were permuted to provide a factorial typology. From the standpoint of “how many possible languages does this create,” the syllable-based analysis appears to be more restrictive, creating only 400 outputs to the sequential analysis’ 524 different outputs. However, it may be that the syllable-based analysis is too restrictive; it, for instance, never allows [w] to surface from a -Cw- cluster. This seems to me to be a wrong prediction, although I know of no languages where this is inaccurate. However, the sequential analysis makes what strikes me as a weird prediction as well; that /tʰw/ could surface, in some language, as /tʰh/. And it is odd that neither analysis, with the constraints discussed above, predicts the more commonly occurring fricativization pattern. So, it seems that this typology needs to be refined. However, it seems that the sequential analysis could easily provide a constraint that could give the fricativization pattern (OCP-[stop] or similar constraint barring two stops), while such a fix does not seem so easy for the syllable-based analysis.

Doubtlessly, Wichita is at the fringe of the consonant cluster resolution spectrum; Wichita seems to be well over the norm for number of consonant cluster resolution strategies. Thus, it may be too preliminary, without a more extensive empirical base of what occurs in other languages, to properly judge which of the interactions predicted by these two analyses is truly anomalous. However, given some of the results above, there are still further reasons to be suspicious of the syllable-based account.

9 Concluding Comments

In the above eight sections, this paper has focused on the patterns of affrication, fortition, and deletion within Wichita, and the ramifications of these patterns for a theory of why Wichita phonotactic patterns are the way they are. In this investigation, two analyses were considered: one based on local phonetic cues, which I termed the sequential analysis, and one based on conditions on the licension potentials of different syllable positions, which I termed the syllable-based analysis.

The two analyses offer identical coverage in terms of the affrication, ?-deletion, and w-fortition alternations as well as the non-alternation cases of faithfulness. However, as §8 showed, constraints from both
analyses make differing predictions about the rest of the system beyond the alternations; in particular, they make differing predictions regarding the distribution of segments at the edges of words. Upon a closer examination of these predictions, the sequential analysis was shown to directly capture these additional phenomena. Thus, the sequential analysis provides better empirical coverage while limiting its machinery (not needing to circumscribe the edges of utterances with additional constraints). Thus, it seems to be the better analysis to choose.

However, what about the interesting insight of the syllable-based analysis that the unmarked appear to become so unmarked in codas that they disappear (such as when $P$ deletes) and the marked are so marked in onsets that they have to strengthen (such as when $w$ undergoes fortition)? This meta-statement is interesting, but its appeal to purely formal properties does seem to leave some question as to why this should be so. And in a way, the sequential analysis offers a reason why this is so, although without needing to make recourse to syllables. Under the sequential analysis, this is just a consequence of the phonetic nature of the sounds in question. The phones $[t]$ and $[?]$ have particular cues in particular contexts and, in the pre-consonantal contexts that arise in these consonant clusters, the cues for $[t]$ and $[?]$ are not so good. Thus, the nature of these sounds is not some deep, subconscious fact about language, but a consequence of the nature in which the sounds are heard and articulated.

Finally, with the evidence against the licensing-by-prosody view for Wichita, this does raise the question: what exactly is the status of prosody in phonological theory? I think the results of this study are simple and clear: prosody does not seem to be relevant for the tactical arrangement of phones in Wichita. However, I think it is far too premature to dismiss prosody all together, since prosody (not just syllables) has been claimed to be relevant for many other phenomena (stress, prosodic morphology, even some kinds of domain-specific alterations) beyond just the licensing of segments. In fact, it is possible that prosody might have something to contribute to some of the other phonological issues of Wichita not discussed in this paper, including the presence of overlong vowels (see fn. 4) and the iterating secondary stress (as shown in (40)).

Thus, while this investigation of Wichita casts some doubt about the usefulness of prosody in phontactics, the larger issue of the usefulness of prosody—in Wichita and natural language more globally—remains an empirical one. It seems, though, given the insights brought out by this in-depth investigation of a single language that the place of prosody may be more clearly answered if further studies are conducted with depth in individual languages and breadth across languages, to ensure the descriptive adequacy of the data and to further the typological understanding of the phonological systems of natural languages.
A  “Opacity” in tC and cC clusters

Deguchi (2001), in his paper on affrication in Wichita, claims that there is opaque interactions in two classes of clusters that begin with coronal plosives. In this section, I want to argue that both of these are not, in fact, cases of opacity. Furthermore, I show that both of these cases can be easily treated within the sequential analysis I propose in the main body of this paper, with just a few, independently needed, extensions.

A.1 Cs clusters

The first case of “opacity” I want to consider involves a pair of consonant-[s] clusters. As the case for “opacity” is made clearer by the use of “orthography,” I will temporarily shift to c instead of t. This is also made clearer by the rule-based system, so I temporarily shift to that system as well.

The cases under question are /t + s/ → [c] vs. /c + s/ → [cs]. An example of the former is given in (41), where the final t of the root comes into contact with the imperfective suffix, -s.

(41) tactar?a:c
ta- t tar?a:t- s
IND- 1A- turn. around- IMPF
‘I turned it around.’

(42) tacka?acs
ta- t ka?ac- s
IND- 1A- eat- IMPF
‘I ate it.’

From a rule perspective, this appears to be a case of overapplication. Assuming an affrication rule that turns coronal stops into coronal affricates, /ts/ and /cs/ should have derivations like in (43):

(43) /ts/ /cs/
   Affrication  t → c —
   Output     cs  cs

Under “normal circumstances” (i.e., in every other case of affrication) the derivation should stop here. However, to capture the /t + s/ facts, there must be another string specific (and otherwise unmotivated) rule of S-deletion. This step is shown below in (44):

(44) /ts/
    Output from previous derivation  cs
    S-deletion  s → ∅
    Output     c

As Deguchi’s analysis shows, re-capturing this same sort of effect in OT is no less pretty, if not even worse. To affect this, Deguchi uses a constraint that conjoins both a markedness constraint,*s, and a faithfulness constraint, IDENT.

However, these complications are quite unnecessary. Looking at the actual phonetic strings, the resolutions are as in (45):

(45) /ts/ → [tʰ]
    /tʰ}s/ → [tʰː]

Thus, all that is needed is two simple faithfulness constraints, MAX ‘No deletion’ and DEP-µ31 ‘No

---

31 Any constraint barring the insertion of length will do here; I choose DEP-µ as one possibility.
insertion of length.’ This latter constraint, though not discussed in sections 3–7, is needed anyway, because there are no instances of resolution in Wichita where a segment (or perhaps just a consonant) is lengthened. Thus, these two cases are resolved as the following two tableaux show:

(46)

<table>
<thead>
<tr>
<th>Input: /t + s/</th>
<th>DEP-µ, MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. e²⁷ t² e  {c}</td>
<td>*!</td>
</tr>
<tr>
<td>b. t² e  {cs}</td>
<td></td>
</tr>
</tbody>
</table>

(47)

<table>
<thead>
<tr>
<th>Input: /t² + s/</th>
<th>DEP-µ, MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. t² e  {c}</td>
<td>*!</td>
</tr>
<tr>
<td>b. e²⁷ t² e  {cs}</td>
<td></td>
</tr>
</tbody>
</table>

Thus, these data clearly point out the importance of analyzing the phonetic string and not getting confounded by the orthography.

A.2 Cr clusters

The other case of “opacity” that Deguchi discusses is the resolutions of /tr/ and /t²r/, which are both realized as [t²]. Here it seems that there is no confusion about what the sounds are, but I will still argue that there is no actual opacity.

Examples of these alternations are given in (48) and (49) below. The relevant interaction in (48) occurs between -t-, ‘1st person agent,’ and the stem, -re?e-, ‘make;’ the relevant interaction in (49) is between the dative morph, -uc-, and the stem, -riye:s-, ‘child.’

(48) tace?es
   ta- t- re?e- s
   IND- 1 A- make- IMPF
   ‘I made it’
   (Rood, 1976, 237)

(49) a:ʔákiciye:s?akʷa:ri
   a:- a:- ki- uc- riye:s- ?ak- wa:ri
   QUOT- AOR1- AOR2- DAT- child- PAT.PL- tell
   ‘He told his children.’
   (Rood, 1976, 268)

From a derivational point of view, as shown by the rules in (50), this is an instance of counterbleeding opacity.

(50) /tr/ /t²r/

| Affrication | t → t² |
| Output      | t²r    |
| R-deletion  | r → ∅ |
| Output      | t²     |

In his Optimality-Theoretic solution, Deguchi (2001) deals with this, like the -Cs- opacity discussed above, via constraint conjunction. Precisely, he conjoins a markedness constraint, essentially *ONSET/r, and a faithfulness constraint, IDENT. To get his analysis to work, Deguchi makes a key insight, that the process here is actually not deletion, as the rules above suggest it is, but rather coalescence. Once we make that insight, I argue these interactions can be straightforwardly captured using the sequential analysis, and thus are not true cases of opacity.

However, to make the sequential analysis work, we must use the more general version of *C-glide, *C-sonorant, to rule out the fully faithful forms. This constraint was mentioned in passing in §5.2, as
being independently needed in Wichita, because the sequences -Cn- and -Cr- absent in Wichita. With this constraint highly ranked, it forces a form like /tr/ to change. The tableau in (51) shows the constraint interaction for this sequence.

(51)

<table>
<thead>
<tr>
<th>Input: /ta + t_{1} + r_{2}e?es + s/</th>
<th>tV ′ MAX-oral *C-son ID-pl ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. t[t^{1,2}]e?es</td>
<td>*!</td>
</tr>
<tr>
<td>b. ta[t^h]e?es</td>
<td>*!</td>
</tr>
<tr>
<td>c. ta[t^r]e?es</td>
<td>*!</td>
</tr>
<tr>
<td>d. ta[r_{2}]e?es</td>
<td>*!</td>
</tr>
<tr>
<td>e. ta[t_{1}]e?es</td>
<td>*!</td>
</tr>
<tr>
<td>f. ta[th]e?es</td>
<td>*!</td>
</tr>
<tr>
<td>g. ta[tr]e?es</td>
<td>*!</td>
</tr>
</tbody>
</table>

Here the key is that the coalescent candidate, candidate (a), does not incur any violations of IDENT(place), even with the coalescence and affrication, while the “normal” affrication candidate, candidate (c), is ruled out by *C-sonorant.

The tableau for the /t^s + t/ interaction is given below in (52):

(52)

<table>
<thead>
<tr>
<th>Input: .../ut^{s}<em>{1} + r</em>{2}ye:s/...</th>
<th>tV ′ MAX-oral *C-son ID-pl ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ... i[t^{1,2}]ye:s ...</td>
<td>*!</td>
</tr>
<tr>
<td>b. ... i[t^h]ye:s ...</td>
<td>*!</td>
</tr>
<tr>
<td>c. ... i[t^r]ye:s...</td>
<td>*!</td>
</tr>
<tr>
<td>d. ... i[r_{2}]ye:s...</td>
<td>*!</td>
</tr>
<tr>
<td>e. ... i[t_{1}]ye:s...</td>
<td>*!</td>
</tr>
</tbody>
</table>

The pattern here is very much the same as in (51). Again, the coalescent candidate, candidate (a), wins, aided in part by its non-violation of IDENT(place), and the fact that the general markedness constraint, *C-sonorant, eliminates candidate (c), which would otherwise seem like viable competition, given the general pattern of faithfulness among -t\[C\]- clusters.

Thus, Deguchi’s insight of viewing these patterns as coalescence means that these -Cr- alternations can be taken from the opacity pile and placed, along with the affrication, deletion, and fortition cases discussed above, into the regular constraint interaction pile.

B Other Alternations

This next section will discuss three other alternations that are not discussed in the main body of the paper. The following show how the sequential analysis could be extended, and, perhaps more importantly, discuss further problems the Wichita data bring to any analysis.

B.1 rC clusters

The first set of clusters I will discuss in this extended analysis section are the ones labeled -rC- clusters. Recall from §2.1 that [n] and [r] are in complementary distribution. Thus, by the Richness of the Base hypothesis (Prince and Smolensky, 1993/2004), either /n/ or /r/ could be the input’s underlying form. Following the established conventions in the grammatical descriptions of Wichita, I will assume an underlying form of /r/, but I could equally assume /n/ as well.32
The outputs of the /rC/ clusters in Wichita are given in Table 8.

In contrast to the relatively straightforward interactions in instances of -tC-, -t\textsuperscript{C}C-, -sC-, -\textsuperscript{C}C-, and -Cw-clusters, the resolutions of -rC- clusters fall into four different classes. The first two can be captured by a relative simple extension of the analysis presented above, so I will present that analysis here. The latter two are a bit more difficult, so I will just point out some of the issues and leave a more complete analysis for future research.

The first of the -rC- resolutions is that the /r/ is realized as [n] before certain coronals. In /rt\textsuperscript{s}/, the /t\textsuperscript{s}/ remains faithful, resulting in [nt\textsuperscript{s}]. In /rr/, the second /r/ assimilates to the [n] and the result is a geminate, [n:]. An example of this kind of -rC- resolution strategy is given in (53) below, where the key interaction is between -kir-, ‘liquid,’ and -ri-, ‘portative’.\textsuperscript{33}

(53) tatt\textsuperscript{s}as
  ti- a:- ti:sa:s- kir- ri- ?a- s
  IND.3- PREV- medicine- liquid- PORT- come IMPF
  ‘He is bringing (liquid) medicine.’ (Rood, 1996, 592)

Here, as one would expect from Table 8, an /r/ next to another /r/ creates an output of a geminate [n:].

The second kind of -rC- interaction is debuccalization, where the sonorant become the voiceless laryngeal [h]. This occurs before velars and labio-velars, as shown by (54) and (55) below.

(54) tihkitare:s?i
  ti- r- kita- re:(hi)- s- ?i
  IND.3- COLL- top- lie- IMPF- be
  ‘They are lying on top’ (Rood, 1976, 238)

(55) tihk\textsuperscript{w}i
  ti- r- wi
  IND.3- COLL- stand.upright
  ‘They are standing upright.’ (repeats (21))

To account for interactions such as the “nasalization” before coronals and the debuccalization before velars, I propose the constraint in (56):

(56) \texttt{AGREE(place)/RC (AGR-pl)}: Consonants in a resonant-consonant cluster must have the same place feature.

In the case of “nasalization,” \texttt{AGREE(place)} rules out the debuccalization realization, *[hr], paving the way for the geminate [n] to be selected. This constraint interaction is shown in the tableau in (57), a portion of the form from (53). MAX-oralC rules out any instance of consonant deletion (including candidate (c)). However, candidates where coalescence has occurred (such as in candidate (b)) must be ruled out by some

\textsuperscript{32}In fact, both the presence of [r] intervocalically and the presence of [h] before velars in Table 8 suggests that [n] was the historical segment. Under this view, the intervocalic alternation then would be an [n] \rightarrow [r] lenition and the the presence of [h] before velars would be a [n] \rightarrow [n] \rightarrow [h] development.

\textsuperscript{33}This latter morph is attached to stems of verbs of motion to create a verb stem of carrying.
constraint that doesn’t allow long consonants to coalesce. I call this constraint below \( \text{MAX}-\mu \) (‘Don’t delete length’), but its exact definition and ranking in the analysis remain to be worked out.

Further candidates like \( *...\text{ki}[\text{t}n]/a... \) and \( *...\text{ki}[\text{r}]/a... \) are ruled out by higher-ranking constraints independently needed, since such forms are generally phonotactically bad in Wichita. The former would be ruled out by some constraint against consecutive sonorants; the latter would be ruled out by \( *[-\text{Cont}]\text{GEMINATE} \), which I proposed in §2.3, assuming the tap \( r \) is \([-\text{Cont}]\).

In the case of the debuccalization, the above \( \text{AGREE} \) constraint makes it so the optimal candidate is the one where the [dorsal] resonant, \([h]\), is adjacent to the [dorsal] \([k]\). This constraint interaction, with the relevant faithfulness constraints from the existing analysis, is shown in (58), the tableau of a portion of the form from (54). Note the possibility of the realization of an agreeing nasal (as in candidate (e)) is blocked by the high-ranking constraint against the velar nasal, which is not a phone of Wichita.

Another possible candidate, \( *...\text{[nk]/ita}... \), would have the same violation pattern as candidate (d), \( *...\text{[rk]/ita}... \).

However, an interesting outcome of adding these -rC- cluster interactions to the analysis is that it necessitates yet another constraint that refers to a sequence of consonants, \( \text{AGREE}\text{(place)}/\text{RC} \).\(^{34}\) Thus, these -rC- clusters would seem to be further evidence in favor of a sequential approach to consonant cluster resolution in Wichita.

Turning to the other two resolutions of -rC- clusters, the first of them could be seen as a kind of faithfulness: before glottals, the tap allophone appears. This is shown in (59) below, where the relevant interaction occurs between the preverb \( -r- \) and the \( h \) of the incorporated nominal \( -\text{ha:-} \), ‘in.water.’

If this were a case of simple faithfulness, this would be no problem. However, it is confounded a bit by the variation between \([n]\) and \([r]\). Since either phone could be the underlying form, there must be some markedness constraint that forces the output realization to be the tap allophone. While this requires further study, I speculate that such a constraint may involve \([r]\)’s stop-like characteristics. I suggest this connection because I imagine that \([rh]\) and \([r]?\) clusters are phonetically similar to the other stop + glottal consonant clusters, which are quite common in Wichita. However, I leave it to future research to work out the precise details of this aspect of the analysis of consonant clusters in Wichita.

\(^{34}\)This also, presumably, has phonetic grounding.

\(^{35}\)The \( s \) glossed as IMPF might, alternatively, be viewed as a combining suffix for a compound. Same thing could be said for similar \( s \)'s in (54) and (61)
Finally, the fourth -rC- cluster process is the coalescence of the sonorant and two of the coronals: /t/ and /s/. That both /rt/ and /rs/ coalesce is shown nicely by the form in (60). The /r + t/ interaction occurs between the morph -r- and the root -tar-, ‘cut,’ while the /r + s/ interaction occurs between the root -tar- and affix -s, ‘imperfective.’ Both interactions resolve to [t₇] (={c}).

(60) ticac
    ti- r- tar- s
    IND- COLL- cut- IMPF
    ‘He cut them’ (Rood, 1976, 236)

The coalescence of these clusters to [t₇] appears to be a derived environment effect, because, at least, [nt] and [ns] exist elsewhere in Wichita (Rood, 1996, 583). However, I believe these two sequences – [nt] and [ns] – are restricted just to stems, as the sequence [nt] is in the following:

(61) tiʔikhánthirisʔih
    tiʔi- ki-  hanthiri- s- ʔi- h
    this PAST.PTCP.3- be.daylight- IMPF- be- SUBORD.PFTV
    ‘yesterday’ (Rood, 1976, 49)

However, I presently don’t have an understanding of this case of opacity, either within the synchronic system I’m purposing here or diachronically. It is interesting that the /rt/ → [nt] does not occur in this derived environment, while [nt₇] is okay, and within the -kC- system (discussed in the section below), *[t₇] is not the resolution of /kt/, while [t₇] is the resolution of /kt₇/. An idea worth exploring is whether an analysis could come from assimilating this case to the interaction between pre-obstruent length and the length of the obstruent itself that may independently explain the [k] ∼ length alternation. However, this, or an alternative proposal, awaits full investigation and explication in future research.

B.2 kC clusters

The interaction in the -kC- clusters is the most complicated of any one class of cluster-initial consonants. These interactions are given in Table 9.

<table>
<thead>
<tr>
<th>Cluster-initial</th>
<th>t</th>
<th>k</th>
<th>kʷ</th>
<th>?</th>
<th>t₇</th>
<th>s</th>
<th>r</th>
<th>w</th>
<th>y</th>
<th>h</th>
</tr>
</thead>
<tbody>
<tr>
<td>k</td>
<td>st</td>
<td>k</td>
<td>:kʷ</td>
<td>k?</td>
<td>:t₇</td>
<td>ks</td>
<td>rh</td>
<td>kʷ</td>
<td>h</td>
<td>kh</td>
</tr>
</tbody>
</table>

Table 9: Resolution of -kC- Clusters

The processes here are quite varied. They are summarized in the table in (62):  

---

36 An alternative view might be that /t/ and /n/ do contrast in Wichita, though in a very restricted way.
Process | Examples
--- | ---
Faithfulness | /k + s/ → [ks]
 | /k + ?/ → [k?]
 | /k + h/ → [kh]
Coalescence | /k + w/ → [kw]
Fricativization | /k + t/ → [st]
Coalescence with Fricativization | /k + y/ → [h]
Fricativization with Metathesis | /k + t/ → [rh]
Compensatory Lengthening | /k + k\textsuperscript{w} → [:k\textsuperscript{w}]
 | /k + t\textsuperscript{\textit{st}} → [:t\textsuperscript{\textit{st}}]
Degemination | /k + k/ → [k]

The sheer number of resolution processes makes this part of the chart difficult to clearly understand. However, as far as I’m aware, these alternations apply in all environments that have the appropriate /kC/ input. Furthermore, there are some interesting sub-generalizations. First, all the faithful outputs are independently good clusters – they all occur initially (as discussed in §8.1.4). Second, in almost all the cases of non-faithfulness (save degemination), there is lenition. However, in contrast to the behavior of /t/, the lenition is rather severe: often to the point where the underlying /k/ is just realized as length. Third and finally, the instances where this length occurs (i.e. compensatory lengthening) are before [t\textsuperscript{\textit{st}}] and [k\textsuperscript{kw}], the two stops in Wichita with the longest duration. This parallels the common Germanic lengthening pattern where vowels are longer before stops with the longer duration.

However, accounting for this “super-lenition” of /k/ via-à-vis the relatively small lenition (or even, depending on one’s point of view, fortition) of /t/ is a bit tricky. I will discuss some of the issues below, using the alternation of /k + t/ → [st]. Although this is a relatively mild lenition of /k/, this form is similar to the case to /t + t/ → [t\textsuperscript{\textit{st}}], facilitating comparison as well as being a form that won’t necessitate a lot of new markedness constraints.

An example of the /k + t/ → [st] alternation is given below. Here the relevant interaction occurs at the boundary of the morph -ra:k-, ‘speech act participants are plural,’ and the stem -tariyari-, ‘butcher.’

(63) taca:stariyari
ta- t- ra:k- tariyari
IND- 1A- SA_.PL- butcher
‘We (excl.) are butchering’ (Rood, 1976, 238)

Focusing on the interaction illustrated by (63) above, the analysis, as is in the body of this paper, makes the wrong prediction, even if we assume an additional markedness constraint, *kC,\textsuperscript{38} which rules out the fully faithful sequence, [kt]. As the tableau in (64) shows, the existing constraints predict the form with [t\textsuperscript{\textit{st}}] should be the attested one (denoted by √) when, in fact, the actual output is the one with [st] (denoted by △).

<table>
<thead>
<tr>
<th>Input: /k\textsubscript{1}t\textsubscript{2}/</th>
<th>*kC- MAX-oral</th>
<th>ID-pl</th>
<th>ID-man</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>t\textsuperscript{\textit{st}}</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>b.</td>
<td>st</td>
<td>*</td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>k\textsubscript{1}</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>t\textsubscript{2}</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>kt</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{37}Cases like metathesis and compensatory lengthening would.

\textsuperscript{38}This is just a cover constraint. The actual constraint (or constraints) needs to both allow [ks] and [k] + [glottal] strings, while disallowing strings such as *[kt] and *[k\textsubscript{r}], a task that is not trivial.
This problem opens the door for the possibility of understanding these Wichita consonantal interactions even better. Here, I want to suggest three possible avenues to explore. These will again be couched in Optimality Theory, but I believe at least some of them are broad enough that they could be recast in other frameworks.

The first avenue is to suppose that the IDENT(manner) constraint is actually only relevant for coronal consonants. This has some intuitive appeal, because, as the chart in Table 2 showed, there are four different manner contrasts in the coronals – no other place comes close to these many contrasts. The diversity of manner contrasts would seem to make IDENT(manner) more relevant to coronal, as to keep the multitude of coronal contrasts distinct. However, such a constraint preservation view does run into problems in that the case of affrication does not actually preserve a contrast. Also, this kind of constraint runs counter to the idea that constraints should not refer to unmarked segments, such as coronals (Kiparsky, 1994; de Lacy, 2002).

A second idea is that this is evidence for strata: the instances of /k/ belong to a different morphophonological constituent from the instances of /t/, with a different constraint ranking (cf. Kiparsky (2000) and Orgun (1996)). This view does seem to have the necessary morphological correlations; that is, all the morphs that end in /k/ (thus creating a -kC- cluster) are closer to the verb root, and ostensibly a part of the stem. Putting this in terms of the template discussed in Rood (1996), the morph -ra:k-, ‘speech act participant is plural,’ is in slot 13 (an example is shown in (63)), while the morph -?ak- ‘direct or indirect object is plural,’ is in slot 17 or 20, depending on function. An example with this morph in patientive function is shown below in (65):

(65) tac?ak?:s
    ta- t- ?ak- ?i::s
    IND- 1 A- PAT.PL- see
    ‘I saw them.’ (Rood, 1976, 217)

Noun stems with a final -k appear in slot 18. The verb root itself resides in slot 25, so these morphs with /k/ are all much closer to the verb root than the /t/ morph, -t-, ‘first person agent,’ found in slot 4.

However, this difference between the two kinds of stops is rather weak evidence for strata, and seeing as the consonant cluster interactions discussed throughout this paper do not show clear independent evidence for strata, it may be too hasty to consider a strata-based solution. Thus, this second avenue leaves open several interesting empirical questions about the differences between the segments within the Wichita verb and their relationship to the morphology-phonology interface.

A third route would be to say the IDENT(manner) is not the right way to think about the various lenition processes of /t/ and /k/ in consonant clusters. Going this route leaves perhaps the most options of any ideas presented here, but the question that I think may be most profitable is to consider whether the motivations for constraints such as tV (and a better worked out *kC constraint) and their resolutions are in some way linked. If they are (whether in the theory of phonology or the theory of phonological change), this might shed some light on the difference between the resolutions to /k/ and /t/ as well as possibly offering a tighter factorial typology (or more theory-neutrally, the range of possibilities in natural languages) than the one discussed in §8.

B.3 What about hC and yC clusters?

I have yet said nothing about the remaining part of the resolution chart, given in Table 10.

This part of the table is perhaps the most puzzling of the consonant cluster resolution chart, and I will only highlight the problems and give some possible ways in which these problems could be solved.

The mysteries here are twofold. First, it is not clear why /h/ should create a high tone. As Mithun (1999, 24–26) points out, the deletion of h more commonly creates low tone. So, it is a bit bizarre why it should create high tone in Wichita. One guess about this is that, historically, the [h] became length, and then the
high tone was attracted to the newly-created long vowel. However, more comparative work is needed to verify this hypothesis (and perhaps instrumental examinations of existing recordings).

The other mystery has to do with the relationship between /y/ and /h/. In this part of the table, as well as when they are cluster-final, there are some instances where they resolve the same (e.g. /(V)y + t/ and /(V)h + t/ → [ ´Vt]; /s + y/ and /s + h/ → [ss]39). Thus, a second part of the \-hC-/-yC- problem is how to capture that \(h\) and \(y\) are sometimes similar and sometimes different. Thus, a complete analysis of consonant clusters in Wichita also requires an examination of these issues as well.

### C Constraints Discussed

A quick reference of all constraints discussed in this paper and their definitions:

<table>
<thead>
<tr>
<th>Constraint</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>(t)V</td>
<td>The phone [t] must be followed by a vowel</td>
</tr>
<tr>
<td>+glottal (\rightarrow) release</td>
<td>Glottal segments need to have audible releases</td>
</tr>
<tr>
<td>*C-glide</td>
<td>Sequences of a consonant plus a glide are ill-formed</td>
</tr>
<tr>
<td>*C-sonorant</td>
<td>Sequences of a consonant plus a sonorant are ill-formed</td>
</tr>
<tr>
<td>*Coda/t</td>
<td>Don’t have [t] in the codas of syllables</td>
</tr>
<tr>
<td>*Coda/?</td>
<td>Don’t have [?] in the codas of syllables</td>
</tr>
<tr>
<td>*ONSET/GLIDE</td>
<td>Don’t have glides in the onsets of syllables</td>
</tr>
<tr>
<td>MAX-C</td>
<td>Don’t delete consonants present in input.</td>
</tr>
<tr>
<td>MAX-ORALC</td>
<td>Don’t delete segments with an oral place of articulation (i.e. one that involves an articulator articulating in the oral cavity)</td>
</tr>
<tr>
<td>IDENT</td>
<td>In input segments with a corresponding output segment, keep the feature specifications in the output the same as the input.</td>
</tr>
<tr>
<td>IDENT(place)</td>
<td>If an input segment has an output correspondent, don’t change the place feature of a segment between the input and output</td>
</tr>
<tr>
<td>IDENT(manner)</td>
<td>In input segments with a corresponding output segment, keep the manner feature specification in the output the same as the input.</td>
</tr>
<tr>
<td>DEP-(\mu)</td>
<td>Don’t insert a mora ((\approx) Don’t insert length)</td>
</tr>
<tr>
<td>AGREE(place)/RC</td>
<td>Consonants in a resonant-consonant cluster must have the same place feature</td>
</tr>
<tr>
<td>MAX-(\mu)</td>
<td>Don’t delete a mora ((\approx) Don’t delete length)</td>
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### References


\(^{39}\) However, the alternation /s + h/ \(\rightarrow\) [ss] is in free variation with [sh] (David Rood, p.c.).
Anttila, Arto, Fong, Vivienne, Benus, Stefan and Nycz, Jennifer. in prep. Consonant Clusters in Singapore English, manuscript, Stanford University and New York University.


