Phonological evidence for morpho-syntactic structure in Athapaskan[*]

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Abstract

Athapaskan verbal morphology appears to violate the Mirror Principle of Baker (1985) in multiple ways and, thus, the ordering of affixes in these languages has resisted a straightforward analysis. We adopt a new morphological tool of Iterative Root Prefixation (Travis 2011), which allows for a more direct mapping from syntax to morphology in languages of this profile. Apparent violations of affix ordering that remain, namely the puzzling placement of the transitive and causative morphemes, are argued to be explained by overriding phonological constraints.

1 Introduction

In Cinque's (2014) investigation of the relative order of the verbal heads Tense Aspect Modality V, he is able to account for most of the word orders that are found in his cross-linguistically rich dataset. One order, however, proved to be particularly recalcitrant, the order found in Athapaskan languages. The issue is that preverbal order is expected to follow the strict hierarchy of Mood > Tense > Aspect, since any variation in this order should be driven by leftward movement of the verb. In Athapaskan languages, however, the preverbal order of verbal inflectional elements is unexpectedly reversed (see, e.g., Speas (1991a, 1991b), Rice (2000)).[1] Cinque provides a solution which involves a collection

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[1]Comparing different languages in terms of these orders can become fraught due to the cross-linguistic variation in the exact content of these inflectional heads (as well as the inconsistency of labels used by different researchers). We have chosen to use terms such as Tense

of movements that unduly complicate his overall system. He thus concludes that verbal morphology in Athapaskan requires further study. The purpose of this paper is to do just that. We propose that by acknowledging a new type of morphological attachment (Iterative Root Prefixation) and understanding the role that phonology can play in this sort of attachment, we can simplify the mapping of phrase structure to morphology, with a more economical system of movement rules.

We begin our investigation by examining a cluster of issues that arise when probing the verbal morphology of Navajo (section 2). We then turn (in section 3) to review two accounts, Speas (1991b) and Harley (2011). We argue that both accounts face empirical and theoretical challenges. In brief, neither is able to account for the idiomatic properties of a certain set of adverbial morphemes and both, we claim, employ overly powerful morphological devices. We therefore turn to two other accounts, one created by combining and modifying ideas of Speas and Harley, which we call the Morphological Merger (MM) account, and another from Travis (2011), which we call the Iterative Root Prefixation (IRP) account. We show that MM, while more constrained than the two accounts discussed earlier, is unable to explain the placement of the same set of adverbial morphemes. IRP, while accounting for the adverbial morphemes, also faces challenges, namely the unexpected placement of the transitive and causative morphemes, leaving MM and IRP on an equal footing. We propose, however, that a solution to the problem of the transitive and causative morphemes lies in phonology (section 4). For the phonological discussion, we turn to two other Athapaskan languages, Tsilhqút'ín (also known as Chilcotin) and Witsuwit'en. Importantly, though, the phonological characteristics pertinent to our discussion of the transitive and causative morphemes also hold true of Navajo and other Athapaskan languages. We argue that there is a conspiracy between the shapes of these affixes and the prosodic constraints of Athapaskan which, together, evade the requirements of IRP concerning affix placement.

2   The issues

The Mirror Principle of Baker (1985) captures the fact that morpheme order reflects the hierarchy of syntactic heads. We will show, in this section, how Athapaskan verbal morphology creates certain problems for the Mirror Principle, with the aim of eventually providing an analysis without comprising the economy of existing syntactic systems. We begin by presenting the order of morphemes and highlighting the problematic issues that arise from this order,

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and Aspect in this paper even though it has been argued that a term such as Tense does not accurately reflect the Athapaskan facts. We do this because (a) these terms are familiar and allow for the necessary cross-linguistic comparison and (b) they are used in the syntactic literature that we engage. Crucially, exact labels are not the issue of this paper. What is at the heart of the paper is the observation that prefixes closer to the verbal root have scope over the prefixes to their left. Rice (2000: 4) states in discussing Positions 1-8: "in Athapaskan languages morphemes of greater scope appear to the right of morphemes within their scope".

using the verbal template adapted from Speas (1990) in (1) for Navajo; see Rice (2000) for a detailed cross-Athapaskan comparison of the verbal template.[2]

We draw particular attention to the disjunct/conjunct labels in the top row, the arrows in the bottom row, the shading of Positions 1, 6, 9, and ROOT, and the boxed positions of 6 and 9. The details and importance of each of these are addressed below.[3]

(1)   Navajo verbal template

DISJUNCT			CONJUNCT						ROOT
1	2	3	4	5	6	7	8	9	ROOT
ADV	ITER	DIST PL	DIR OBJ	DEIC SUBJ	ADV	MODE	SUBJ	VOICE/ TRANS	
←								→	

The distinction between the disjunct and conjunct morphemes is both semantic and phonological. Rice (2000: 34) characterizes the disjunct morphemes (Positions 1-3) as having 'well-defined lexical meanings' and varying more in their syllabic and segmental shapes. In contrast, the conjunct morphemes (Positions 4-9) are more functional in their semantics and phonologically quite restricted. In spite of these differences, we adopt the view, following Li (1946) and Kari (1976), that the template represents one syntactic word in Athapaskan languages, which corresponds to a single phonological domain.[4]

Beyond the conjunct *vs.* disjunct distinction, there are three observations from semantics that should inform our determination of the appropriate syntactic structure which will feed the morpho-phonological component.[5] First, as mentioned earlier, the morphemes are the reverse of what is expected with respect to their position in relation to the ROOT (indicated by the arrows in the bottom row of (1)). This observation is presented with the most breadth and depth in Rice (2000). To illustrate, Position 2, which encodes the aspectual notion of iterativity, is further from the ROOT than Position 7, mode, which encodes something like tense, contradicting Cinque's aforementioned universal

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[2]Similar but more detailed discussion of issues that arise in finding a syntactic account for the order of morphemes in the Athapaskan verbal system can be found in Speas (1990) and Travis (1992, 2010, 2011) for Navajo, and in Rice (2000) for the Athapaskan language family more generally. See also Crippen (2019) for the distantly-related Tlingit.

[3]We only use the notion of root, and not stem, in this paper as it has the clearest syntactic status. The root represents the monomorphemic lexical material in the lowest head of the verbal extended projection as in Grimshaw (2000). The Athapaskan root takes on different shapes depending on certain aspect/mode morphemes (see Young and Morgan (1972: 41ff) for their description of the Navajo verb stem). While we do not discuss this issue, we assume that because this morphology affects the shape of the root, the position in which it is realized does not give us any information about where it appears in the syntactic tree. This issue is discussed with respect to position 9 in section 4.2.

[4]We are operating under the assumption that words are, for the most part, complex heads. Further, we are only entertaining syntactic accounts that share this assumption. For a different viewpoint see, for example, Rice (2000), who argues that Athapaskan verbs are syntactic phrases.

[5]We are working within the Distributed Morphology framework of Halle and Marantz (1993), where morphological structure is determined for the most part by syntactic structure.

order of Tense>Aspect>Verb. Position 9 has special problems, which we leave aside for now, as this position will be the focus of this paper.[6]

Second, Positions 1, 6, 9, and ROOT (the shaded cells in (1)) in some cases reflect idiomatic semantics. For example, the translation for 'pray' is comprised of morphemes that spread across 1, 6, and ROOT – so_1 ... di_6 ... zin_{ROOT}, where each morpheme does not carry meaning on its own (example from Navajo, taken from Speas (1990: 208)).[7] The material in these positions may have a discernible meaning, but often is simply idiosyncratically specified. For example, Position 1 contains material similar to particles in English expressions such as *stand up* and *look up*. We also include Position 9 in this inventory of idiomatic affixes, as indicated by the shading. The affixes in this position, termed classifiers in much of the traditional literature, often correlate with semantic notions such as transitivity, causation, middle/reflexivization. However, the existence and shape of these morphemes are sometimes not predictable from the resulting semantics (see, e.g., Rice 2000: 128).

The third observation is that both Position 6 and Position 9 (indicated by frameboxes in (1)) appear to have semantic properties that, from a syntactician's point of view, are v-like. As already mentioned, Position 6, often labelled as an adverb, may not have clear semantic input to the verbal form. When it does contribute, however, it might add meaning about manner or the beginning of an event. For example, manner of the action may have to do with stomach/food/oral noise as in verbs that mean 'belch' or 'say'. Alternatively, this morpheme might have something to do with the beginning of an event such as inchoative, or have the effect of iteration over the whole event. The first type of meaning shows similarities with the 'manner tags' of Hale and Keyser (1993: 90). The second type of meaning indicates the beginning, existence, or number of the event. We hypothesize, following Hale and Keyser, that both of these have meanings that we might want to relate to v. But Position 9 also encodes semantics that have traditionally been linked with v, such as causativity and transitivity.

Much of our discussion will centre on Positions 6 and 9. We will show that syntactic accounts diverge depending on which of these two is fixed as being in v. In the end, we will argue that they are, in fact, a reflection of an articulated v, where 6 is v, introducing an event variable, and 9 is EXTARG, determining

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[6]Note that Position 5, Deictic Subject, might seem misplaced, but the morphological material in this position is quite different from the other position for subject agreement, Position 8. We set aside a longer discussion of this but simply note that Position 5 has a much reduced inventory of morphemes, typically just third person, or first person plural, and has uses such as in impersonal constructions or impersonal passives. For this reason, we, along with others, assume that Position 5 is much lower in the hierarchy than Position 8, and is in the thematic domain of the ROOT. For example, Hargus (2007: 42) writes: "The subjects of the pronominal zone, or outer subjects [Position 5], are also all attested as thematic and derivational prefixes. In contrast, the inner subject prefixes [Position 8] have exclusively inflectional functions."

[7]Note that Position 1 is a disjunct prefix and Position 6 a conjunct prefix. We mentioned in the text that the former usually have well-defined lexical meanings, but, as we see in this example, this is not always the case for Position 1. Further, Position 6, a conjunct prefix, does not contain the sort of inflectional material that would be expected of a functional morpheme. It is this sort of mismatch that a syntactic account should strive to explain.

the nature or existence of an external argument (see Pylkkanen (2008)), and that their respective positions in the verbal template can be explained through an interaction of syntactic and phonological processes. More specifically, we will argue that the material in Position 9 is *syntactically* located between Positions 6 and 7 and that prosodic constraints explain its final location adjacent to the ROOT.

3 Previous syntactic accounts

In this section, we briefly present some of the syntactic analyses in the literature on Athapaskan, concentrating on Navajo, to highlight the difficulty of capturing all observations in one account without complicating the system of movement rules. We have chosen to focus on Navajo as this language has been at the centre of the debate on how to syntactically represent the morpheme order of the verbal complex in this language family.

3.1 Speas

Speas (1991b) posits the account for Navajo sketched in (2). To generate the desired morpheme order, she starts with a head-final tree and the appropriate hierarchy of morphemes, then proposes iterative lowering of morphemes via suffixation, followed by lowering and prefixation of the complex head that has been created. The tree is given below where O is Object (Positions 4 and 5),[8] A is Aspect (Position 6), T is Tense (Position 7), and S is Subject (Position 8).[9]

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[8]Speas (1991b: 188), citing Sandoval and Jelinek (1989) and Willie (1989), collapses Positions 4 and 5 into one position.

[9]In Speas (1990), Position 6 was labelled Adverb. We have matched her labels to positions to the best of our abilities.

(2)   Speas (1991b) tree
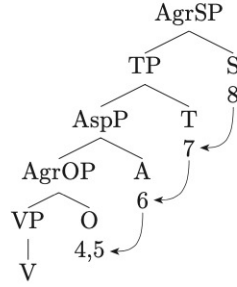
a. Merged order   b. Post lowering and affixation

AgrSP
TP   S
           8
AspP   T
           7
AgrOP   A
          6
VP   O
 | 4,5
V

AgrSP
TP   S
AspP   ~T~
                 ~T~ S
AgrOP   A
                A   ~T~
VP   O   ~T~ S
 |
 V   O   A
      A   T
           T   S

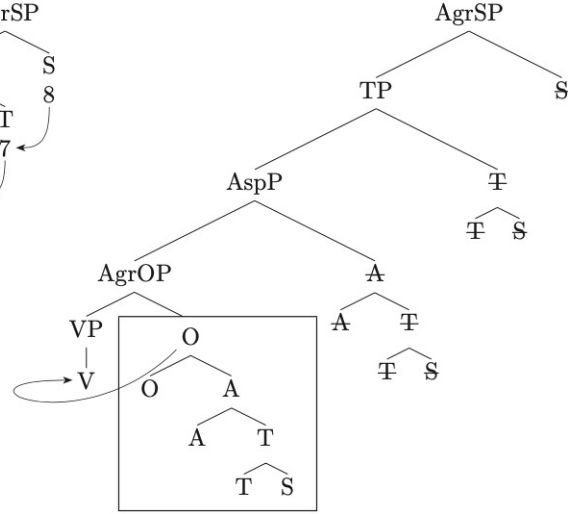There are several observations that this analysis fails to account for. First, it does not address the location of the disjunct prefixes (Positions 1-3). Second, it cannot capture why 1, 6, ROOT can convey idiosyncratic lexical information. Third, it places Position 6 within the inflectional domain, which is not intuitive given both its idiosyncratic meaning and, when the meaning is transparent, its non-inflectional (adverbial) nature. Finally, it does not deal with Position 9 at all.[10] There are two problems from a theory-internal perspective. First, the structure is head-final which is a problem for those who espouse Kayne's anti-symmetry hypothesis (Kayne 1994), as we do, and, second, it proposes rampant lowering, mixing both suffixation and prefixation. Neither of these processes is ruled out on theoretical grounds, but they are not, to our mind, ideal.

3.2   Harley

Harley (2011) presents the problem of Navajo through an example with a subset of morphemes (Positions 1, 4, 6, 7, 8, 9, ROOT) only. She accounts for the semantics of Position 9 by identifying it as *v*. Position 4 is related to the object. Position 1 is analyzed as a particle generated lower in the structure. Elements in Positions 6-8 are generated above *v*, in the inflectional domain. The result of

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[10]One can amend the account to include Position 9, either by placing it in a very low position preceding (and already attached to?) the V or in a very high position so that it would lower and suffix to the S. Both of these amendments come with their own difficulties.

this base-generated structure is shown in the head-final tree below.[11]

(3)   Harley (2011) tree
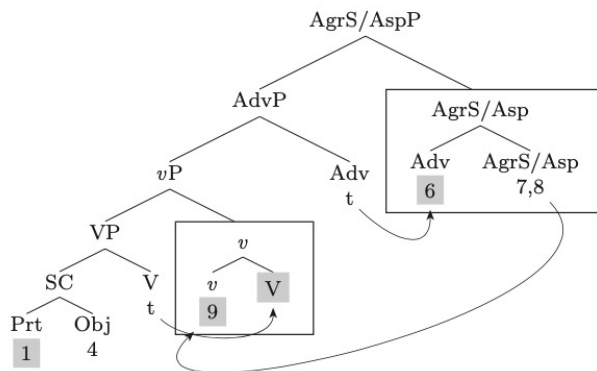
What is needed to achieve the final order of morphemes is (i) two cases of head movement (V to v suffixation and Adv to AgrS/Asp prefixation) followed by (ii) Local Dislocation (Embick and Noyer 2007) of the Adv+AgrS/Asp complex with the v+V complex, and finally, (iii) morphological merger of all of the morphemes to form one word.

Issues with this account are that the structure is crucially head final; the idiosyncratic nature of Position 6 is not accounted for;[12] Position 6 is in the inflectional domain, which would not be expected given its role as indicating manner; and most strikingly, the use of two head movement rules (one feeding suffixation, the other prefixation), followed by local dislocation, followed by morphological merger, appears uncharacteristically complex. While this complexity could be supported by the observation that such systems are seemingly rare, one could also argue that any order could be generated within such a powerful movement system.

3.3 Morphological Merger

In this section, we discuss a third possible account that avoids some but not all of the issues in the two previous accounts.[13] We label this account Morphologi-

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[11]SC refers to a small clause where the material in Prt is predicated of the object, similar to a particle construction in English such as *I put the book down*. Again, we have matched the labels to the relevant positions as we understand them. The shaded heads indicate the idiosyncratic material highlighted in the template in (1).

[12]Harley points out that the material in Position 1 is idiosyncratic in the way that German particles are idiosyncratic.

[13]This account is the result of a joint effort by members of the McGill/UQAM Word Structure Research Group (*Groupe de recherche sur le mot*), in particular Tom Leu, Heather Newell, and Máire Noonan. McDonough (2000) proposes a bipartite structure for the Navajo verb where a compound is formed between two domains, an inflectional domain (Positions 4-8) and a verbal domain (9+ROOT). In some ways, without the underlying syntactic structure,

cal Merger (MM), as the position of the ROOT at the end of the word is achieved through morphological merger (see, e.g., Marantz (1988)). Two advantages of this analysis are that the underlying structure is head-initial, and that there is only one instance of head movement followed by one instance of morphological merger. It also, as with Harley's account, has Position 9 as v. The syntactic hierarchy reflects the semantic hierarchy, and then this order is reversed preverbally by having head movement not start with the lexical head V, but rather with the first head c-commanding v. The result is that morphemes 1-8 form a complex head in that order, which then merges with the material in v and V, which have remained in situ. Note that we have simply numbered the positions and their projections here as the main point is to present the mechanisms that reverse the order.

(4) Output (MM account)
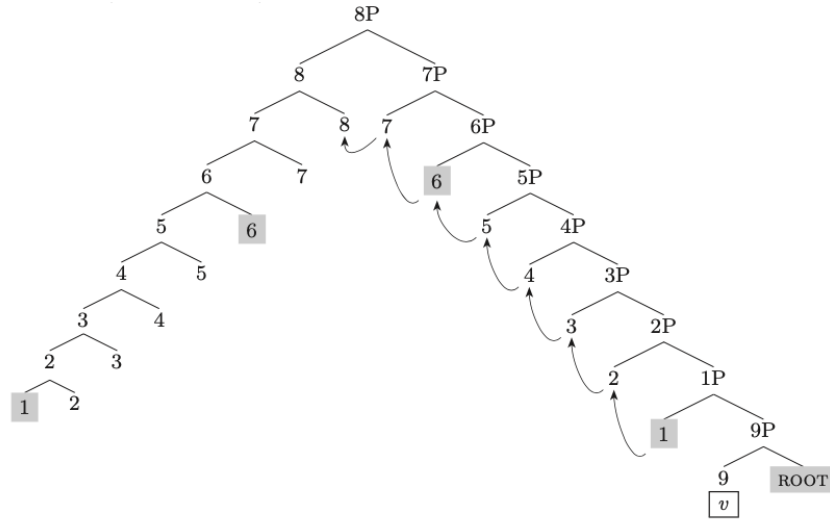
There are issues, however, with this analysis. First, by having Positions 1-3 generated in a particle position, Harley was able to distinguish between the disjunct (1-3) and conjunct (4-9) prefixes. This tree, however, makes no such distinction.[14] Second, this tree is left with the problem of the idiomatic behaviour of Positions 1 and 6, which are clearly in the inflectional domain above

the results of her account are similar to the MM account. Montoya (2017) further develops McDonough's account into a tripartite structure. Hale (2001) also proposes a bipartite analysis but accounts for morpheme order using a combination of syntax (heads *vs.* phrases) and phonology (a phonological skeleton which is filled in with the prefixal heads).

[14]Travis (2010) proposes that the disjunct prefixes are all adjuncts, and as adjuncts, they are spelled out separately from the rest of the structure (in independent phases) consistent with their different phonological behaviour (see Piggott and Travis (2013) for a similar analysis of adjuncts in Ojibwe). This solution to the conjunct/disjunct distinction could presumably be added to any of the syntactic analyses we discuss.

v. Finally, we suggest that such an analysis predicts that Positions 1-8 should spell out as a phonological word that would be merged with the phonological word created by *v* and ROOT, forming a higher phonological word. In other words, we would expect there to be a 'hard' (i.e., PWd) edge between Positions 8 and 9. We will see, in section 4.3, that this prediction is not borne out.

3.4   Travis

The last account we present involves a reworking of Travis (1992, 2010, 2011). We call this the Iterative Root Prefixation (IRP) account for reasons that will become clear shortly. In this account, the starting point is the identification of Position 6, and not Position 9, as *v*. Positions 7 and 8, tense/mode and subject agreement, respectively, are generated above this node, in the inflectional domain. There is another inflectional domain within the *v*P, which houses Positions 1-5.[15] Head movement, as shown in (5), creates the structure in (6). Note that unlike the MM account, here, the movement begins with the lexical category V at the base of the tree. Further, we will point out that, inexplicably, Position 9 is included with the V in this movement.[16]

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[15]As the goal of this paper is to address the contribution of phonology to a morpho-syntactic problem, we leave some syntactic details aside. See Travis (2010) for more argumentation for a similar syntactic structure, in particular, for an inflectional domain within the *v*P.

[16]As mentioned in fn. 14, Travis (2010) assumes that Positions 1-3 are late adjuncts spelled out in separate phases. For expository purposes, we have simply made them part of the more complex tree.

(5)   Head movement (IRP account)

8P
8 AGRS
7P
7 T
6P
6 v
5P
5 DEIC.SUBJ
4P
4 AGRO
3P
3 ASP.MOD
2P
2 ASP.MOD
1P
1 DIR.PRT
9+ROOTP
9+ ROOT

(6)   Output (IRP account)

8P
8
7P
7
8
7
6P
6
7
6
5P
5
6
5
4P
4
5
4
3P
3
4
3
2P
2
3
2
1P
1
2
1
9+ROOTP
9+ ROOT
1
9+ ROOT
9+ ROOT
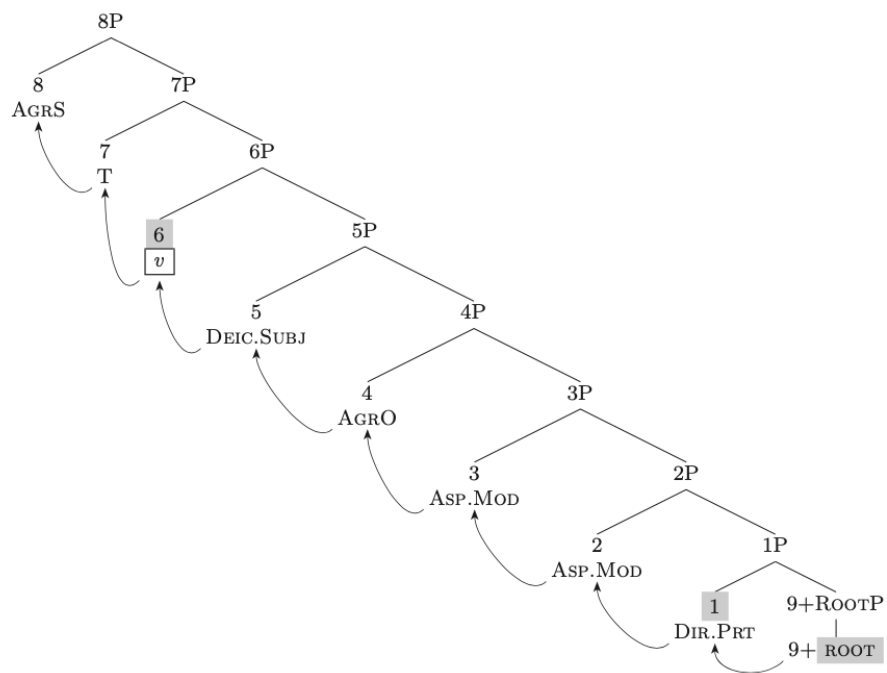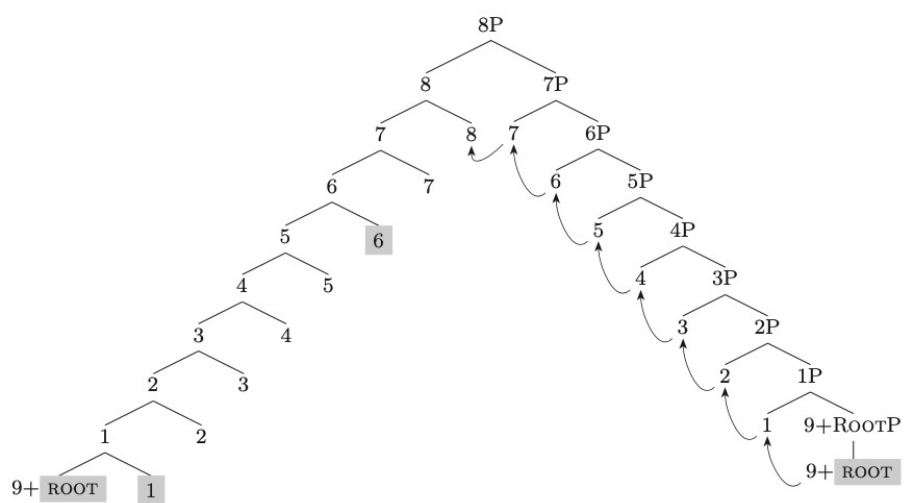
The morpheme order produced by this tree and subsequent head movement has the problem that the 9+ROOT complex is at the beginning rather than at the end of the sequence. This order, however, is changed through Iterative Root Prefixation, which proceeds as follows. At each branch within the complex head, a computation occurs that prefixes the affix not to the left edge of the complex material to which it attaches, but rather, directly to the left edge of the ROOT. We first give a flavour of how the process works, in (7).[17]

(7)   Iterative Root Prefixation

a.   [9+ROOT] + **1** →   IRP   → [**1** + 9+ROOT]
b.   [1 + 9+ROOT]] + **2** →   IRP   → [1 + [**2** + 9+ROOT]]]
c.   [1 + [2 + 9+ROOT]]] + **3** →   IRP   → [1 + [2 + [**3** + 9+ROOT]]]]
d.   [1 + [2 + [3 + 9+ROOT]]]] + **4** →   IRP   → [1 + [2 + [3 + [**4** + 9+ROOT]]]]]
e.   ...

Crucially, morphemes 2,3,4 attach directly to the ROOT, in effect, tucking in under the material previously prefixed, pushing that material further to the left (borrowing and adapting Richards' (1997, 2001) process of tucking in).

Since the starting point of this account is the mapping of the material in Position 6 with v, having 6 in the inflectional domain, a problem for the three previous analyses, is no longer an issue. Further, if Position 1 is treated in a similar fashion to English particles,[18] having Positions 1,6,ROOT as containing idiosyncratic material is no longer a problem.

3.5   Remaining problems

A serious challenge remains for the IRP account, however. While Position 6 is taken care of through its identification with v, the other v-like position, Position 9, is left unaccounted for. In fact, it isn't given any analysis and is simply treated as a sub-part of the ROOT.[19] It is this issue that we pass on to be accounted for by the phonological component of the grammar. Before turning to phonology, however, we speculate where in the template, from a semantic point of view, we would expect the material in Position 9 to appear. Position 9 encodes transitivity (voice) and causation. As noted earlier, Hale and Keyser (1993) have utilized v (or more accurately, the V that selects a VP) to introduce the notion of cause, to add an external argument, and as a host for manner tags that involve the agent or initiator of an event. Position 9 assumes the function of cause (and adds the external argument), while Position 6 encodes manner of the action.

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[17]Note that Speas (1990) presents a phonological account of affix placement, where affixes are infixed at certain phonological boundaries. Her account is similar to the IRP in that affixes are not attached to the left edge of the previously constructed material. It is dissimilar, however, in that her account targets several different phonological environments while the IRP iteratively refers to the same edge.

[18]In Travis (2010), following ideas of Newell (2005), it was assumed that this material was late-adjoined to Inner Aspect. This analysis is not without problems, however, leading Newell to propose a different account in Newell (this volume). Again, we leave some of the syntactic issues aside.

[19]There are though precedents for this; see McDonough (2000).

Given that both Position 6 and Position 9 have v-like properties, we might expect them to be adjacent. Accordingly, we suggest that the material in Position 9 is between the heads of Positions 6 and 7 in the structure, a position that we will eventually label 6.5. For expository purposes, we identify Position 6 as v and Position 9 as ExtArg.[20]

(8)   Articulated v

```
                    TP
                    |
                    T′
                  /    \
                T      ExtArgP
                7         |
                       ExtArg′
                       /      \
                  ExtArg       vP
                6.5 (a.k.a. 9)  |
                               v′
                              /  \
                             v    XP
                             6
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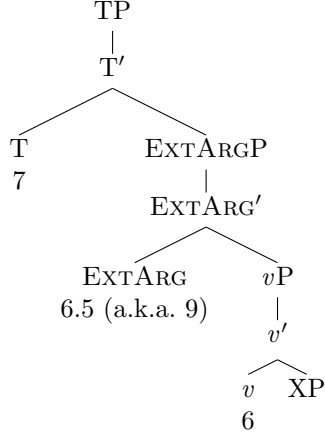
With this structure in mind, we turn to explore how phonology can inform our understanding of the syntactic underpinnings of the Athapaskan verbal template, including resolving the puzzling location of Position 9.

4   Phonological properties

In this section, we propose that the phonological properties of prefixes within the Athapaskan verb can add to our understanding of syntax–morphology anomalies. We shift our attention first to Tsilhqút'ín. It is distinctive among Athapaskan languages in containing a particular phonological process, vowel pharyngealization, that will help to establish which morphemes preceding the ROOT fall within the domain of the word. We then compare Tsilhqút'ín and Witsuwit'en, where the shapes that Position 9 affixes take differ. Taken together, these two languages will allow us to explain the apparent misplacement of Position 9 and, given certain assumptions concerning domains of spell-out and the phonological effects of bracketing, arbitrate between the MM and IRP accounts.

4.1   The word domain, with a focus on Tsilhqút'ín

In all of the syntactic accounts of the Athapaskan verb discussed in section 3, whatever processes were used to combine the morphemes, there is general

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[20]We acknowledge that the exact merge position of Position 9 is difficult to determine as it might be just above or just below Position 6. Our main point, however, remains: phonological requirements obscure the syntactic hierarchy.

agreement that the end result is phonologically a word.[21] In this section, we use Tsilhqút'ín vowel pharyngealization to confirm this assumption, drawing on generalizations from Krauss (1975) and Cook (1983, 1993, 2013). While this process does not arbitrate between the MM and IRP accounts – this will require that we look inside the phonological word (§4.3) – it establishes what the maximal phonological word (PWd_{max}) is in Athapaskan. By focusing on harmony, we seek to add to the existing literature that uses segmental and prosodic processes to define the left and right edges of this domain (see, e.g., Kari (1976) on Navajo, cf. McDonough (2003); Andrews (1988) and Cook (2013) on Tsilhqút'ín; Hargus (1988) on Sekani; Rice (1989, 1993) on Slave; Gordon and Luna (2002) on Hupa; Alderete and Bob (2005) on Tahltan; Hargus (2007) on Witsuwit'en).

In the consonant chart in (9) (adapted from Cook (1983)), two types of segments are identified in the top row. There are those labelled SA that participate in sibilant assimilation, namely the plain and pharyngealized coronals (the latter marked by an underdot),[22] and those labelled Phar that trigger pharyngealization (or 'flattening') of neighbouring vowels. The pharyngealized coronals (SA Phar) trigger flattening across the entire word; the uvulars target adjacent vowels only and, thus, this process will largely be set aside.

(9)   Tsilhqút'ín consonants

			SA	SA Phar			Phar		Phar	
p	t	tɬ	ts	ṭṣ	tš	k	q	k^w	q^w	
b	d	dl	dz	dẓ	dž	g	ɢ	g^w	$ɢ^w$	
	t'	tɬ'	ts'	ṭṣ'	tš'	k'	q'	$k^{w'}$	$q^{w'}$	ʔ
	n̥	ɬ	s	ṣ	š		χ	x^w	$χ^w$	h
m	n	l	z	ẓ	y		ɣ	w	$ɣ^w$	

The impact on vowel quality is shown in (10) (from Cook (1983)). (/i/ surfaces as [əi] when preceded by a pharyngealized consonant and as [e] when followed by a pharyngealized consonant.)

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[21]There is less agreement on whether or not it is morphosyntactically a word. For example, one of the goals of Rice (2000) is to argue that the verb is a morphosyntactic phrase. We take the view that the verb is not a phrase but a complex head.

[22]Many other Athapaskan languages also have sibilant assimilation, but in these languages (including Navajo), the alternation is typically between the S series and the Š series in (9) (Cook 1993, Hansson 2001). As these languages do not have pharyngealized coronals, sibilant assimilation does not trigger an effect on vowels. We return to the significance of this shortly.

(10) Tsilhqút'ín vowels

			Phar		
i		u	əi/e		o
ɪ		ʊ	əɪ		ɔ
	ɛ			ə	
	æ			ɑ	

We begin with some discussion of sibilant assimilation, as its interaction with vowel pharyngealization will inform our understanding of the latter process and, hence, of PWd_{max}. The examples in (11) show that in sibilant assimilation, all participating segments agree with the rightmost sibilant (S or Ṣ) in the word.[23] In (11a), the rightmost sibilant, /s/ in the ROOT, turns the pharyngealized sibilant, /ṣ/ in the mode prefix, into its non-pharyngealized counterpart. Conversely, in (11b), the rightmost sibilant is pharyngealized, /ṣ/ in the ROOT, which turns the sibilant in the 1SG prefix, /s/, into its pharyngealized counterpart.[24]

(11) a. ɬæ ## ṣɛ-7 s-8 Ø-9 tšis
          NEG   MODE 1SG VOI/TR ROOT
          'I did not fry it.'   [ɬæ sɛstšis]
          (Cook 1987: 56)   **Rightmost S**

      b. tɛ-6 ɣɛ-7 s-8 Ø-9 tšʊṣ
          ADV MODE 1SG VOI/TR ROOT
          'I will handle it (cloth).'   [tɑṣtšɔṣ]
          (Krauss 1975: 11)   **Rightmost Ṣ**

A comparison of the vowels in the underlying and surface forms of the example in (11b) shows that the pharyngealized sibilants additionally trigger vowel pharyngealization. Unlike sibilant assimilation, pharyngealization spreads to vowels bidirectionally: the examples in (12a) and (12b) show leftward and rightward spreading, respectively, and establish that the adverb and mode prefixes (phonologically fused in the surface form in (12a)) are in the same domain as the ROOT.

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[23] In much of the earlier literature on Tsilhqút'ín, morpheme boundaries and labels are not provided. These have been inserted to the best of our abilities. In addition, tone is not marked on any examples, as most are drawn from work that predates a solid understanding of tone in the Tsilhqút'ín verbal complex. A systematic examination of this topic appears in Cook (1989, 2013).

[24] We have indicated the templatic positions of each prefix with a subscript, but a comment is in order. We are basing this on the Navajo template in (1) to provide continuity in the paper. We are aware, though, that labels can vary substantially depending on a variety of things (e.g., language, researcher). These details, however, should not affect the main point of this paper. All that is required for our purposes is that the semantic scope of the prefixes goes from right to left and that the material in Position 9, which encodes transitivity, appears out of place in this context.

(12) a. tɛ-$_6$ γɛ-$_7$ s-$_8$ Ø-$_9$ tšʊṣ
ADV MODE 1SG VOI/TR ROOT
'I will handle it (cloth).'   [taṣtšəṣ]
(Krauss 1975: 11)   **Leftward spread**

b. ṣɛ-$_7$ Ø-$_8$ Ø-$_9$ dæh
MODE 3SG VOI/TR ROOT
'He sat.'   [ṣədɑh]
(Krauss 1975: 30)   **Rightward spread**

The example in (13) shows further that all of the conjunct prefixes fall within this domain, as all of the vowels contained within them, along with the vowel in the ROOT, surface as pharyngealized.[25],[26]

(13) yɛ-$_4$ dɛ-$_6$ tɛ-$_6$ ṣɛ-$_7$ Ø-$_8$ Ø-$_9$ γæṣ
DIR.OBJ ADV ADV MODE 3SG VOI/TR ROOT
'He starts to gnaw it.'   [yədətezγɑṣ]
(Krauss 1975: 18)

However, unlike sibilant assimilation in Navajo, which does not spread past the conjunct prefixes (McDonough 2000, 2003), the Tsilhqút'ín data in (14) reveal that the phonological domain under consideration is even larger: pharyngealization triggered by SA Phar goes beyond the conjunct prefixes to include the disjunct prefixes as well. In (14a), for instance, /u/ in the Event prefix is realized as pharyngealized [ə] rather than as non-pharyngealized [ɛ] (with labialization surfacing on the preceding consonant), and in (14b), /æ/ in the Iterative prefix surfaces as [ɑ].[27]

(14) a. gu$_2$ # dɛ-$_6$ tɛ-$_6$ ṣɛ-$_7$ Ø-$_8$ Ø-$_9$ k'æn̥
EVENT   ADV ADV MODE 3SG VOI/TR ROOT
'A forest fire has started.'   [gʷədəteẓk'æn̥]
(Cook 1977: 262)

b. næ$_2$ # sɛ-$_4$ nɛ-$_6$ γɛ-$_7$ ɛn-$_8$ l-$_9$ tṣɛnṣ
ITER   1SG.OBJ ADV MODE 2SG VOI/TR ROOT
'You are hitting me.'   [naṣənɑγəĩltṣə̃ṣ]
(Cook 1987: 56)

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[25] Cook (1989: 142) observes that two Position 6 prefixes can co-occur, as we see in (13) and (14a).

[26] /ṣ/ in the mode prefix in (13), as well as in (14a), voices to [ẓ] when in intervocalic position and preceded by a conjunct prefix (Cook 1989, 2013; see also Andrews 1988). This is then bled by vowel deletion (Cook 2013), which is responsible for [ẓ] ultimately appearing in coda position adjacent to the ROOT.

[27] The hiatus that arises from morpheme concatenation in (14b) is resolved through raising (/ɛ/+/ɛ/ → /i/) (Cook 1989, 2013); in this example, the vowel is then pharyngealized (to [əi]) following /γ/. More generally, vowels in hiatus are not tolerated in Tsilhqút'ín. Finally, /ɛ/ is lowered and pharyngealized (to [ɑ]) before /γ/ (Cook 2013: 188). These processes will be evident throughout the paper.

In both cases in (14), pharyngealization in the disjunct domain has been acquired from a pharyngealized segment in the conjunct+ROOT domain to its right, suggesting that both conjunct and disjunct prefixes belong to a single phonological domain. Before we can conclude this definitively, however, we must ensure that vowel pharyngealization is bounded by this larger domain. The examples in (15) show that this is indeed the case: when a vowel is adjacent to a pharyngealized consonant across a word boundary, the vowel does not surface as pharyngealized.

(15)   a.   dɛl   ## ṣɛ-$_7$ id-$_8$ Ø-$_9$ liṇ
              blood   MODE 1PL VOI/TR ROOT
              'We got bloody.'   [dɛl ṣəidliṇ]
              (Krauss 1975: 9)   *[dəl ṣəidliṇ]

        b.   bɛ-   tšænɣ ## gu$_2$ # Ø-$_8$ Ø-$_9$ ẓun
              3POSS belly   EVENT   3SG VOI/TR ROOT
              'He is hungry (lit. his belly, it event root)'   [bɛtšɑ̃ goẓon]
              (Krauss 1975: 8)   *[bətšɑ̃ goẓon]

In (15a), /ṣ/ at the left edge of the mode prefix does not turn /ɛ/ in /dɛl/ into its pharyngealized counterpart. In (15b), /ɣ/ at the right edge of /bɛ-tšænɣ/ pharyngealizes the preceding vowel (/æ/ becomes [ɑ]), and then deletes. Although pharyngealization triggered by a uvular would not be expected to target /ɛ/ in the first syllable of /bɛ-tšænɣ/, we would nonetheless expect this vowel to surface as pharyngealized due to the following pharyngealized sibilant, /ẓ/ in the verbal ROOT, if pharyngealization crossed words. This, however, is not the case.

We can now address the structure of the phonological domains at play. It is evident from the data in (14) and (15) that the ROOT, conjunct prefixes and disjunct prefixes together form a single phonological word (see also Alderete and Bob (2005) on Tahltan, Hargus (2007) on Witsuwit'en; cf. Rice (1993) on Slave). As mentioned earlier, we label this domain PWd$_{max}$. This is because we assume that PWd$_{max}$ itself contains a lower PWd, the domain formed by the ROOT and conjunct prefixes (Positions 4-9). We do not consider the conjunct prefixes to form a domain independent from and compounded to the ROOT in Tsilhqút'ín because sibilant assimilation does not apply across true compound boundaries in this language (e.g., [[tsá]$_{PWd}$[ẑéẑ]$_{PWd}$]$_{PWd}$, *[[tŝá]$_{PWd}$[ẑéẑ]$_{PWd}$]$_{PWd}$ 'beaver skin' (Cook 2013: 39) (Ŝ = pharyngealized coronal)). This structure has, though, been motivated for other Athapaskan languages (e.g., Slave (Rice 1993), Witsuwit'en (Hargus 2007)). Nevertheless, because the ROOT is virtually always stressed in Athapaskan (Rice and Hargus (2005); but see McDonough (2003) on Navajo), we suggest that it forms a foot unto itself, following Tuttle (1998) for the Minto and Salcha dialects of Tanana and Alderete and Bob (2005) for Tahltan. This status will also serve to license the rich segmental profile that the ROOT displays (see, e.g., Rice and Hargus (2005)).[28]

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[28]Concerning Tsilhqút'ín, the literature does not mention that roots are stressed. However,

We turn finally to the disjunct prefixes. Recall that these prefixes are phonologically less constrained than the conjunct prefixes (e.g., Rice (2000)), suggesting, as above, that the former are not contained within the lower PWd that organizes the latter. In combination with Rice's (1993) observation that there is much more variation in the order of disjunct prefixes across Athapaskan languages, this motivated Travis (2010) to analyze these morphemes as late adjuncts spelled out in separate phases (see fn. 14). Under the assumption that separate phases that organize bound material correspond to an adjunction structure in the phonology, this, along with their distinct phonological profile, suggests that the disjunct prefixes are proclitics (see, e.g., Cook (2013: 200)), each adjoined to the lower PWd formed by the conjunct prefixes and ROOT.[29] The full structure we propose is in (16).

(16)   Structure of PWd_{max}
        [1 [2 [3 [4-9 [ROOT]$_{\text{Foot}}$]$_{\text{PWd}}$]$_{\text{PWd}}$]$_{\text{PWd}}$]$_{\text{PWd}}$

Returning specifically to Tsilhqút'ín, the data thus far examined confirm that both the conjunct and disjunct prefixes fall within the domain of vowel pharyngealization and that the process is indeed bounded by PWd_{max}. The example in (17) also indicates that sibilant assimilation is bounded by this same domain.

(17)   sɛ.u₁   # sɛ-₇   ɛn-₈ ɬ-₉   tsæn
        1SG.TO   MODE 2SG VOI/TR ROOT
        'You listened to me.'   [sosõĩɬtsɑn]
        (Krauss 1975: 56)

Thus, one may question why we could not have relied on sibilant assimilation alone to establish the edges of PWd_{max}, given that this process occurs widely throughout the Athapaskan family (Rice and Hargus 2005). One reason is that the domain of sibilant assimilation varies across languages. In some, agreement is only observed within the ROOT (see Rice and Hargus (2005) on Sekani), as was the case in Proto-Athapaskan-Eyak (Krauss 1964); in others, agreement is confined to the conjunct domain (see McDonough (2000, 2003) on Navajo). A

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tone (marked high/unmarked low) is contrastive within roots, which may suggest the presence of a foot. Tone is also contrastive on some prefixes, and in these cases, high tone spreads rightward to the ROOT (Cook 1989), which could indicate that it needs to be licensed by the foot. We point out as well that, in some Athapaskan languages, the left edge of the foot may not align with the left edge of the ROOT but may instead include an adjacent prefix; see Rice (1990) on the Hare dialect of Slave and our analysis of D-effect constructions in Witsuwit'en in §4.2.2.

[29]It may be that in some languages the disjunct prefixes each form their own PWd internal to PWd_{max}, which will enable them to be independently stressed (see Rice (1993) on Slave). In Tsilhqút'ín, we do not think that this analysis holds because, as mentioned earlier, sibilant assimilation does not apply across true compound boundaries. We thus leave open the possibility that Athapaskan languages differ in this respect. We also point out that, for some languages, the disjunct and conjunct prefixes have been proposed to form one phonological domain, as these two types of prefixes form a single domain for stress assignment (e.g., Alderete and Bob (2005) on Tahltan; Hargus (2007) on Witsuwit'en).

second reason is that, in some languages, sibilant assimilation applies gradiently, especially when trigger and target are at some distance from each other, with considerable variation within and across speakers (see Sapir and Hoijer (1967), Young and Morgan (1972), McDonough (2000), Berkson (2013) on Navajo; and Cook (1989, 2013) on Tsilhqút'ín). This, along with the segmental composition of certain prefixes means that, even in languages where sibilant assimilation targets disjunct prefixes, the process may not definitively establish the left edge of PWd_{max}. Vowel pharyngealization, by contrast, is less gradient as it spreads over shorter distances; it also targets all vowels, regardless of their quality. This process, which is innovative in Tsilhqút'ín (Cook 1993, Hargus 2010), thus enables us to establish with certainty which morphemes fall within the domain of the word.

Finally, since the output of sibilant assimilation in Tsilhqút'ín impacts whether the vowels in a word will be pharyngealized or not, both processes must apply non-cyclically after all prefixes have entered the derivation and PWd_{max} has therefore been built. Recall that it is the rightmost sibilant in the word that determines the (non)pharyngealized quality of all sibilants to its left. Because the rightmost sibilant could be available early in the derivation (e.g., in the ROOT in the examples in (11)) or it could be available late (e.g., in Position 8, underlined in /tɛ-ṣɛ-s̱-gæy/ → [tɛzɛsgæy] 'I started to walk' (Krauss 1975: 15)), the entire word must have been built in order to achieve the correct output.

Although the phonological processes we have discussed inform us about the structure of the Athapaskan word, they do not arbitrate between the MM and IRP accounts, as both will appropriately build the lower PWd and PWd_{max} domains. As we will see below, however, the accounts differ in the internal structure of the lower PWd: MM predicts there to be a hard edge between Positions 8 and 9, but correctly situates the latter position adjacent to the ROOT; IRP does not predict there to be any hard edges in the span between Position 4 and the ROOT, but it incorrectly predicts that Position 9 will appear between Positions 6 and 7. We first show, in section 4.2, how the phonology can explain why Position 9 appears adjacent to the ROOT, thereby resolving that problem for IRP. We then turn, in section 4.3, to show how other phonological processes in Tsilhqút'ín support the absence of a hard edge between Positions 8 and 9, contra MM. Taken together, we thus conclude that the phonology supports the bracketed structure of the IRP account over the MM account.

4.2 The Phonology of Position 9

In this section, we focus on the unexpected location of the material in Position 9 for the IRP account. We will henceforth refer to this position as 6.5, as per (8), to more accurately reflect its syntactic properties. We argue that its linear position adjacent to the ROOT can be phonologically explained. In brief, when Position 6.5 morphemes enter the derivation, they will be prosodically bound to the left edge of the ROOT such that the boundary between them and the ROOT will not be visible to prefixes that enter the derivation after this point.

Before detailing our analysis, we briefly sketch the necessary formal mech-

anisms we employ at the level of the syllable. We adopt many of the premises of Government Phonology (GP) (Kaye, Lowenstamm and Vergnaud 1990), a theory of grammar that strives to capture cross-linguistic generalizations on syllabification by appealing to universal principles and parametrically-limited options on phonotactics and constituent size. Well-formedness constraints on constituency are rigidly adhered to, within and across languages, which means that outputs are often more abstract than they appear: left-edge clusters that do not respect the phonotactic profile of branching onsets may be given a coda-onset analysis; right-edge clusters may be similarly analyzed; and clusters in any position may be interrupted by an empty nucleus. In addition to regulating constituent well-formedness, GP also regulates interconstituent well-formedness (syllable contact) through governing relations that express a dependency relation between heads (onsets) and preceding codas (complements). Interconstituent Government will play a central role in our analysis of the unexpected location of the morphemes that occupy Position 6.5. More generally, the benefits that a restrictive theory such as GP provides will be evident at various points in the paper.

4.2.1 Tsilhqút'ín and Navajo

In (18), we list the morphemes that occupy Position 6.5, along with their semantic contributions. The underlying shapes that these morphemes take seem to be consistent across Athapaskan. There is, however, family-internal variation in their surface realization, notably for /d/, which we return to shortly.

(18)   Position 6.5 (formerly Position 9)
      Ø   transitive, intransitive
      ł   causative
      l, d   middle/reflexive, passive

Our analysis for languages like Tsilhqút'ín and Navajo stems from the particular shapes of the morphemes that occupy Position 6.5 combined with the fact that roots are virtually always consonant-initial.[30] As single consonants, the morphemes in Position 6.5 are defective: without a vowel, they cannot project their own syllable. Effectively, then, they strive to be syllabified as codas immediately preceding the ROOT, although we will see that this fails in the case of /d/.

The data from Tsilhqút'ín in (19) show that when Position 6.5 is either /l/ or /ł/, it successfully surfaces in coda position. The result is an optimal phonotactic profile: a high-sonority continuant in coda followed by a consonant of lower or equal sonority in onset position.[31] Notably, there is no epenthetic

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[30]In Tsilhqút'ín, roots are always consonant-initial (Cook 2013). There are, though, a handful of vowel-initial roots in Navajo (McDonough 2000, Hale 2001); in these cases, Position 6.5 affixes are syllabified in onset position, and are thus bound to the ROOT in a similar manner as we detail below for /d/.

[31]Athapaskan consonants fall into two broad sonority classes: low sonority stops/affricates (top three rows in (9)) and high sonority continuants (bottom two rows in (9)). This differ-

vowel that appears between Position 6.5 and the ROOT, even though closed syllables are rarely observed upstream of this ROOT-adjacent position.

(19) a. γε-7   id-8 l-6.5   ʔʷεɬ
         MODE 1PL VOI/TR ROOT
         'We are swimming.'   [γəilʔʷεɬ]
         (Cook 1983: 127)

     b. sε-4   Ø-8 ɬ-6.5   γʷεs
         1SG.OBJ 3SG VOI/TR ROOT
         'He is tickling me'   [sεɬγʷəs]
         (Krauss 1975: 39)

When the affix is /d/, as in the Tsilhqút'ín examples in (20), it cannot be syllabified in coda; as a stop, it is too low in sonority, meaning that the resulting phonotactic profile would be ill-formed: a low sonority stop would be followed by an onset of equal or higher sonority. In the latter case, it cannot be syllabified as part of a cluster in onset position; there are no branching onsets in Athapaskan.[32] The only way for /d/ to be realized is for it to fuse with the ROOT-initial consonant, a process commonly referred to as the *D-effect* (Howren (1971), Lamontagne and Rice (1994); see Krauss (1975) and Cook (2013) for the D-effect in Tsilhqút'ín and Sapir and Hoijer (1967), Young and Morgan (1972) and McDonough (2003) for the D-effect in Navajo).[33,34]

(20) a. ṣæ   ## nε-6   s-8 d-6.5   ʔæn̥
         mouth   ADV 1SG VOI/TR ROOT
         'I put it (round object) in my (own) mouth.'   [ṣɑnæst'æn̥]
         (Krauss 1975: 8)

     b. s-8   d-6.5   γʷεs
         1SG VOI/TR ROOT
         'I am ticklish.'   [həsɢʷəs]
         (Cook 1979: 19)

Although the Position 6.5 affixes differ in how they are realized (coda in (19) *vs.* being fused with the ROOT-initial consonant in (20)), we propose, as

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ence manifests in ways other than phonotactics as well; in Tsilhqút'ín, for example, only the continuants alternate at the right edge of roots (Cook 1977).

[32]There are word-initial clusters in some Athapaskan languages but these do not form branching onsets. In Ahtna, initial clusters can begin with /s/ (Rice 2003); in Witsuwit'en, they can begin with /s/, /ɬ/ or a homorganic nasal (Hargus 2007). As Rice points out for Ahtna, sC clusters have a coda+onset profile. We contend that the same holds for the three cluster types in Witsuwit'en. We thus analyze them all as coda+onset, as per GP (see Kaye 1992 and Goad 2012 on initial coda /s/ in Indo-European and Piggott 2003 on initial coda nasals in Selayarese (Malayo-Polynesian)).

[33]We use the term 'fusion' for cases where two input segments appear to coalesce into one segment in the output. We detail the actual formal mechanisms we employ, which are consistent with the cyclic syllabification we assume, in Section 4.3.2.

[34]The initial syllable in the surface form in (20b) is epenthetic; see further fn. 45.

mentioned above, that once these affixes enter the derivation, they are bound to the ROOT that follows such that the affix-ROOT boundary is not visible to any prefix that subsequently enters the derivation. The formal assumptions that underlie this proposal are as follows.

We propose that after each application of Iterative Root Prefixation in (7), syllabification applies, along with the syllable-related repairs it triggers. This follows standardly-held assumptions that syllabification, at least within the lower PWd, is ubiquitous: it applies at every stage of the derivation (Kiparsky 1985, Itô 1989).[35] Effectively, as soon as a Position 6.5 morpheme enters the derivation, it will be syllabified and syllabification will be sensitive to the presence of a consonant in ROOT-initial position.

In the case of /d/, we have seen that phonotactic constraints force this morpheme to lose its status as an independent segment and to, instead, fuse with the ROOT-initial consonant that follows. An important consequence of this is that any morpheme that later enters the derivation and prefixes onto the ROOT will not see the left edge of the /d/+ROOT complex as distinct from the left edge of the ROOT.

In the case of /l/ and /ɬ/, we have seen that the same phonotactic constraints ensure that these morphemes maintain their status as independent segments, but that they must be syllabified as codas. The significance of this is as follows. As mentioned earlier, we assume, following GP (Kaye, Lowenstamm and Vergnaud 1990), that a coda (rhymal dependent) enters into a governing relation with a following onset head, as shown in (21) for [ɣəilʔʷɛɬ] (from /ɣɛ-id-l-ʔʷɛɬ/) 'We are swimming' (19a)) at the point when Position 6.5 /l/ enters the derivation.

(21)   Interconstituent Government
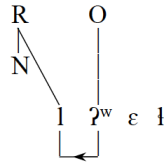
We propose that this governing relation serves to bind the coda to the following onset, such that the boundary between /l/∼/ɬ/ and the ROOT will no longer be visible. Consequently, any prefix that enters the derivation after this point will not be able to split these morphemes apart.

In sum, the behaviour of all of the Position 6.5 morphemes is explained through constraints on syllabification. If syllabification is cyclic, the morphemes in this position, by virtue of their segmental shape as single consonants, will be

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[35]One may question the claim that the prefixes under focus should be subject to cyclic syllabification, given that they are inflectional. There are, however, precedents for this in the literature. Kalin (2018), for example, argues that correct placement of the past tense infix *wa* in Turoyo (Central Neo-Aramaic) depends on the syllabification of inflectional material added on previous cycles.

bound to the ROOT when they enter the derivation. Consequently, subsequent affixes seeking out the left edge of the ROOT, as per Iterative Root Prefixation, will not see the left edge of the Position 6.5+ROOT complex as being distinct from the left edge of the ROOT. From a syntactic point of view, this is precisely the result we want: in spite of the fact that Positions 7 and 8 enter the derivation after Position 6.5, the former are appropriately located further away from the ROOT than is the latter. From a phonological point of view, our analysis would, of course, be strengthened if we provided empirical support for cyclic syllabification, that is, evidence that syllabification and syllable-related repairs follow each instance of Iterative Root Prefixation. We provide such evidence in section 4.3 when we examine the internal structure of the phonological word in Athapaskan, focusing again on Tsilhqút'ín. We must first address the variation that exists within Athapaskan in the realization of /d/ in D-effect constructions.

4.2.2 The D-effect across Athapaskan

Lamontagne and Rice (1994) provide an optimality-theoretic account of the cross-language variation observed in the D-effect. They divide Athapaskan languages into four groups, based on the degree to which /d/ is fused with the ROOT, which itself depends on the quality of the ROOT-initial segment. Later work by Hargus (2007) argues for the addition of a fifth group, to which Witsuwit'en belongs, that falls between Ahtna and Koyukan. The table in (22) is adapted from Hargus (2007: 729), which is itself built on Lamontagne and Rice (1994). Languages are ordered by the extent to which /d/ and the ROOT are fused. From the information provided in Cook (1989, 2013) and Krauss (1975), we can conclude that Tsilhqút'ín falls into the same group as Navajo, except that it lacks vowel-initial roots.

(22)   /d/ prefix typology (adapted from Hargus (2007: 729))

		/d/ most fused with ROOT ↔ /d/ least fused with ROOT				
		Navajo	Ahtna	Witsuwit'en	Koyukon	Hupa
d+ʔ		t'	t'	t'	t'	dV.ʔ
d+fricative		dz, dl, j, g	dz, dl, g/dɣ/t.ɣ, G/dɣ/t.ɣ	dz, dl, g/t.y, t.ɣ	dV.C	dV.C
d+n		n', n, d, dn	d.n	d.n	dV.n	dV.n
d+other C	non-coronal	C	d.C	d.C	dV.C	dV.C
	coronal	C	C	dV.C	dV.C	dV.C
d+V		dV	dV	–	dV	dV

The analysis we have outlined above can account for the cases where /d/ is fused with the ROOT-initial consonant (e.g., /d/+/ʔ/ → [t'] for all language groups except Hupa); where /d/ is realized as a coda (e.g., before /n/ in Ahtna and Witsuwit'en); where /d/ is (vacuously) fused with the ROOT-initial consonant (e.g., before a subset of coronals in Navajo and Ahtna); and where /d/ is realized in onset position before vowel-initial roots (when permitted in the language). The specific outcome before different types of ROOT-initial consonants varies from language group to language group, depending on the phonotactic constraints at play.

The challenge for our account concerns those cases where /d/ is realized with a following epenthetic vowel, most or all of the time in Koyukon and Hupa or under more restricted conditions in Witsuwit'en: it is not obvious how this morpheme could be bound to the ROOT in the way we envision if it is dV in shape. In the following paragraphs, we argue that, counter to appearances, the existence of dV outputs does not endanger the general approach we take. We focus on Witsuwit'en.[36]

The table in (22) indicates that in Witsuwit'en, /d/ is realized with a following epenthetic vowel when the ROOT-initial consonant is a coronal stop or affricate. A representative example is provided in (23), where the epenthetic vowel is underlined.

(23)   [neʔdəsd̠ətsəɬ]
        'he chopped himself'
        (Hargus 2007: 708)

We consider epenthesis in Witsuwit'en to be an OCP effect (McCarthy 1986), triggered by a prohibition against adjacent (near) identical consonants. In order to explain how the resulting form ([də]) could be bound to the ROOT, given that other morphemes shaped CV are not, we begin with the observation that roots in Witsuwit'en are stressed, like they are in many languages across the Athapaskan family, as mentioned earlier. Extensive data provided by Hargus (2007) reveals that this holds in Witsuwit'en, regardless of the rhymal profile of the ROOT, as shown in (24).

(24)   a.   CVC   [hə́nədèç]
                      'they're dancing'
                      (Hargus 2007: 639)

        b.   CəC   [hə́dətsə̀ɣ]
                      'we (du) are crying'
                      (Hargus 2007: 639)

        c.   CV   [ts'ə́səyè]
                      'she walked to the crest, came into view'
                      (Hargus 2007: 639)

It also holds when the syllable immediately preceding the ROOT is itself stressed (25), as well as when this syllable has a rhymal profile that could make it a better attractor for stress relative to the ROOT (26).

(25)   [dízq'ə̀n]
        'it's burning'
        (Hargus 2007: 638)

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[36]We follow Lamontagne and Rice in treating the vowel in the /d/ prefix as epenthetic rather than underlying; indeed, this will be a critical part of our analysis. We point out though that /d/ is reconstructed for Proto-Athapaskan as */də/ (Krauss 1965: 20).

(26) [bəts?áyin?à]
      'it sticks out from it'
      (Hargus 2007: 638)

Since rhyme shape has no impact on whether roots in Witsuwit'en are stressed, and since the data and generalizations provided by Hargus (2007) are consistent with regular stress being assigned from the left edge of PWd_{max} non-cyclically at the end of the derivation, we assume that the ROOT comes into the computation as footed (following a similar proposal for Turkish by Özçelik (2014)).[37] We assume further that the morphemes in Position 6.5, as single consonants, are defective, as proposed earlier for Tsilhqút'ín and Navajo, which prevents them from projecting their own syllable. Accordingly, these morphemes first strive to become codas preceding the ROOT-initial consonant. If the result is phonotactically well-formed (i.e., in the case of /l/ and /ɬ/), the coda enters into a governing relation with the following onset, shown earlier in (21), and is thus bound to this onset.

Empirical evidence that position 6.5 morphemes first strive to become codas, that is, that this analysis takes precedence over fusion, is that /l/ followed by a /d/-initial root does not surface as an affricate ([dl]) through the same fusion process that affects /d/, but is instead realized as coda+onset; compare (27a) and (27b). (The same holds of Tsilhqút'ín and Navajo.)

(27) a. /l/+/dVC/ – coda+onset:
          [mi? nəl.diɬ], *[mi? nə.dliɬ]
          'he's eating berries'
          (Hargus 2007: 342)

      b. /d/+/lVC/ – fusion:
          [denes.dlel]
          'he dreamed about himself'
          (Hargus 2007: 708)

Further, recall from the table in (22) that there are contexts in Witsuwit'en where /d/ is actually realized as a coda (as [t]), shown in (28).

(28) [?ədəstk^{w}ət]
      'she poked herself'
      (Hargus 2007: 708)

When phonotactic constraints prevent /d/ from surfacing in coda, this morpheme strives to merge with the ROOT-initial onset. Because roots enter the

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[37]Additional support for this proposal comes from Hargus's (2007: 642) observation that incorporated roots always receive primary stress in Witsuwit'en. In [hàwesádidìh] 'the sun isn't shining', primary stress does not fall on the initial syllable but, instead, on the incorporated root [sa] 'sun'. Compare [háwediɢìh] 'he didn't lose weight', which contains no incorporated root and so the initial syllable receives primary stress as per the regular stress parse. We thank Keren Rice for bringing this construction to our attention.

computation as footed, this means that /d/ must fall *inside* the foot present on the ROOT under these conditions.

There are two conditions under which phonotactic well-formedness can fail for /d/ in Witsuwit'en: poor sonority profile alone or poor sonority in combination with violation of the OCP. In the former case, the D-effect takes place: /d/ fuses with the ROOT-initial consonant, as shown in (29a). If, however, the ROOT-initial consonant is a coronal stop/affricate, the OCP triggers schwa epenthesis, as in (29b), repeated from (23) (stress added to examples as per information provided in Hargus 2007[38]). Fusion does not take place in such cases, presumably because of recoverability: many languages prohibit fusion when it is difficult or impossible to recover underlying material.

(29)   a.   Fusion (/d/+/ʔ/ → [t']):
          [néynist'ə̀y]
          'he cheated her'
          (Hargus 2007: 723)

    b.   Epenthesis:
          [neʔdə́sdə̱tsə̀ɬ]
          'he chopped himself'
          (Hargus 2007: 708)

As mentioned, since on our analysis the ROOT is underlyingly footed and the phonotactic violations can only be repaired by having /d/ look inside the ROOT, /d/ must fall inside the foot formed by the ROOT. This is shown in (30) for the examples in (29), at the point when /d/ enters the derivation.

(30)   a.   ...(ʔə́y)$_{Ft}$ → ...(d-ʔə́y)$_{Ft}$ → ...(t'ə́y)$_{Ft}$
       b.   ...(tsə́ɬ)$_{Ft}$ → ...(d-tsə́ɬ)$_{Ft}$ → ...(də̱tsə́ɬ)$_{Ft}$

In (30b), the existing foot structure binds /d/ to the ROOT, even though the epenthetic vowel inserted to repair the OCP violation separates the two morphemes.

Finally, we point out that Cə syllables are never stressed when immediately adjacent to the ROOT in Witsuwit'en. That this holds in the case of epenthetic schwa after /d/ is a necessary component of our analysis (and contrasts with the Position 6.5 affixes that fall into coda, where the syllable containing such an affix can be footed independently of the ROOT, e.g., [(tá́ɬ)(cə̀ɬ)] 'you'll take it' (Hargus 2007: 638)). We must ensure, though, that only də morphemes with epenthetic schwa, and not Cə morphemes more generally, end up bound to the ROOT. This follows straightforwardly from our proposal that Position 6.5 /d/ is defective, that is, underlyingly vowel-less. Cə morphemes whose vowel is not epenthetic are not subject to the same analysis because there is nothing to drive these morphemes inside the foot. As a result, morphemes that enter the computation later are able to 'push' these Cə morphemes leftward, away from

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[38]Hargus (p.c.) mentions that, for examples like that in (29b), there may also be stress on the initial syllable for some speakers.

the ROOT as appropriate.[39]

In sum, our analyses of Witsuwit'en, Tsilhqút'ín and Navajo are very similar. Although details differ across the languages, depending on the phonotactic constraints at play and the particular repairs employed, the analyses all rest on the proposal that Position 6.5 morphemes, as defective, are bound to the ROOT: as codas (in the case of /l/ and /ɬ/ and sometimes /d/), as onsets (in the case of /l/, /ɬ/ and /d/ before vowel-initial roots), through fusion with the ROOT-initial consonant (in the case of /d/), and as a foot-internal syllable (in the case of /d/ when followed by an epenthetic vowel).[40] Consequently, no morpheme that enters the derivation after this point can prefix directly onto the ROOT, as per Iterative Root Prefixation, as it will not see the left edge of the 6.5+ROOT complex as distinct from the left edge of the ROOT.

4.3 Phonology and bracketing

Although we have provided a phonological explanation for the unexpected location of Position 6.5 for the IRP account, recall that in the MM account, this position is correctly predicted to appear adjacent to the ROOT, as Position 9. At this point, then, the two accounts could seem to be equally explanatory, if the MM account could explain the appearance of Position 6 in the inflectional domain (perhaps by using the syntactic structure proposed in Travis (2010)). However, if phonological bracketing directly reflects syntactic bracketing, then the two accounts make different predictions about how the string of morphemes in the Athapaskan verb gets spelled out as a phonological word. In this section, we examine the issue of bracketing more directly, probing whether phonology can arbitrate between the alternative representations created by each account. Our focus will principally be on Position 8, in combination with other conjunct prefixes and the ROOT, and because of this, we will set aside the disjunct prefixes (Positions 1-3).

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[39]Although roots are stressed in most Athapaskan languages, our approach does not require that they always be underlyingly footed. In Tahltan, for example, roots are stressed but stress is assigned from right-to-left (Alderete and Bob 2005), which means that a foot can be built over the ROOT as part of the regular stress parse. Our analysis does, however, require that in languages where Position 6.5 morphemes are followed by an epenthetic vowel that the foot be present underlyingly, as in Witsuwit'en. As expected, this is not the case in Tahltan (Shaw 1991).

[40]We briefly mention one additional fact that may seem relevant for our analysis. Witsuwit'en allows 'branching codas' at the right edge of the conjunct domain, which motivated Hargus (2007) to analyze this domain as a PWd separate from that formed by the ROOT (see §4.1). From the examples provided, it is evident that C_2 is commonly VOI/TR (e.g., [yətacɬʔəs] 'I'm going to sneeze', [neʔəxʷɬyis] 'you (pl) are resting' (Hargus 2007: 604, 616); see also (28)) and, thus, we must ensure that the putative coda preceding the VOI/TR morpheme does not get trapped adjacent to the ROOT, before Position 6.5 has entered the derivation. Branching codas are illicit in GP. Further, as evident from the examples shown here, the clusters can have an unusual segmental profile, even for theories that permit branching codas. Thus, we suggest that only [ɬ] falls into coda, as in our earlier analysis, and that C_1 is an onset followed by an empty nucleus: $(cØ)_\sigma$ and $(x^wØ)_\sigma$. As a result, the morphemes containing these putative codas, [c] and [x^w], will not get bound to the ROOT-initial onset per Interconstituent Government in (21).

The bracketings in (31) show the internal structure of the phonological word under each of the MM and IRP accounts (we have excluded the foot for ease of exposition). In the former case, (31a), head movement within the inflectional domain of the verb creates a complex form, indicated by the bracketing of Positions 4-8, which is then merged together with the two *in situ* positions, Position 9 (a.k.a. 6.5) and the ROOT. In the latter case, (31b), a bracketing results where Iterative Root Prefixation consistently creates a right branching structure.

(31) Bracketing in MM *vs.* IRP

    a. [[[[[4] 5] 6] 7] 8] + [9 [ROOT]]   MM ACCOUNT
        → [[4 5 6 7 8]$_{PWd}$ [9 ROOT]$_{PWd}$]$_{PWd}$

    b. [4 [5 [6 [7 [8 [6.5 [ROOT]]]]]]]   IRP ACCOUNT
        → [4 5 6 7 8 6.5 ROOT]$_{PWd}$

4.3.1   Position 8

To probe the empirical effects of the bracketings in (31a) *vs.* (31b), we focus on Position 8, drawing on data from Tsilhqút'ín. The affixes that appear in this position are provided in (32):[41]

(32) Position 8: Subject agreement

s	1SG	id	1PL
εn	2SG	h	2PL
Ø	3SG	Ø	3PL

We begin with contexts where Position 6.5/9 is null. Notice that all overtly-realized affixes in (32) end with a consonant, and recall that all roots start with a consonant. If Position 8 leans rightward toward the ROOT over a soft (PWd-internal) edge, as per the IRP account, then the syllable contact that results must be assessed as soon as Position 8 enters the derivation, and ill-formed profiles repaired, as necessary – on voicing, place, and sonority dimensions.

We begin with voicing (see Krauss 1975). The data in (33a)-(33b) show that when there is a prefix that ends in a voiceless fricative in Position 8, either 1SG

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[41] The list in (32) differs from that in Cook (2013) in three ways. First, Cook provides two forms for 1SG, /s/ and /i/. In all of the examples we discuss, 1SG is underlyingly /s/ in shape, and so we set aside /i/. Second, Cook lists the underlying representation of 2PL as /εh/. We follow Krauss (1975) in analyzing it as /h/, as this accounts for why the vowel immediately preceding /h/ does not raise to [i] in the examples in (33b) and (36) (see fn. 27 on raising). Finally, we analyze 2SG as underlyingly /εn/. Following from earlier work (Cook 1986, 1989), Cook (2013) argues for /nε/ on grounds that in nouns and postpositions, the semantically parallel prefix is most commonly realized as [nε]; /nε/ then undergoes metathesis in the verbal domain. The problem with this analysis is that metathesis in this direction (CV to VC) cannot be phonologically motivated. For example, if a form like (37a) below were underlyingly /γε-nε-l-gɪš/ 'you are walking' (Cook 1986: 2), we would expect it to surface as *[γənεlgɪc], instead of as the attested [γə̄īlgɪc] because, in the former case, the prefix is completely recoverable and the output is optimally shaped. Further, Cook mentions that there is only one verb paradigm where 2SG surfaces as [nε]: [gænεt'in] 'you do so' (Cook 1989: 155).

or 2PL, and the ROOT begins with a voiced fricative, voicing assimilation must apply: ROOT-initial /z/ surfaces as [s] to agree with the voiceless fricative that precedes it; compare (33c) where ROOT-initial /z/ surfaces intact.

(33) Voicing assimilation

    a.   ʔɛ-$_4$ s-$_8$ Ø-$_{6.5}$ zɛz
          INDEF.OBJ 1SG VOI/TR ROOT
          'I sip.'   [ʔɛssɛz]
          (Krauss 1975: 12)

    b.   ʔɛ-$_4$ h-$_8$ Ø-$_{6.5}$ zɛz
          INDEF.OBJ 2PL VOI/TR ROOT
          'You (pl) sip.'   [ʔɛhsɛz]
          (Krauss 1975: 12)

    c.   ʔɛ-$_4$ Ø-$_8$ Ø-$_{6.5}$ zɛz
          INDEF.OBJ 3SG VOI/TR ROOT
          'He sips.'   [ʔɛzɛz]
          (Krauss 1975: 12)

Turning to place, another way in which we observe an interaction between the material in Position 8 and the ROOT is when the prefix in Position 8 ends in a nasal and the ROOT begins with a stop (see Krauss 1975, Cook 1986). In (34a)-(34b), the nasal in the 2SG prefix undergoes place assimilation to the following ROOT-initial stop; compare (34c) where the nasal surfaces with its underlying quality.

(34) Place assimilation

    a.   næ$_2$ # ɣɛ-$_7$ ɛn-$_8$ Ø-$_{6.5}$ biɬ
          ITER   MODE 2SG VOI/TR ROOT
          'You swim back.'   [naɣimbiɬ]
          (Krauss 1975: 19)

    b.   sɛ.ɣæ$_1$ # nɛ-$_7$ ɛn-$_8$ Ø-$_{6.5}$ qæχ
          1SG.FOR   MODE 2SG VOI/TR ROOT
          'Give it to me.'   [sæniŋqɑχ]
          (Cook 1986: 2)

    c.   ṣɛ-$_7$ ɛn-$_8$ Ø-$_{6.5}$ dæh
          MODE 2SG VOI/TR ROOT
          'Sit down.'   [ṣəindæh]
          (Krauss 1975: 7)

Turning finally to sonority, if Position 8 ends in /d/, as in the 1PL prefix, the D-effect must apply between this consonant and the ROOT-initial consonant (Cook 2013), as shown in (35). The example in (35a) closely parallels that

provided earlier in (20b).[42]

(35)   D-effect

    a.   tɛ-$_6$ γɛ-$_7$ id-$_8$ Ø-$_{6.5}$ γiɬ
        ADV MODE 1PL VOI/TR ROOT
        'We will backpack it.'   [təγɑGəiɬ]
        (Krauss 1975: 18)

    b.   yɛ-$_6$ id-$_8$ Ø-$_{6.5}$ yɛz
        ADV 1PL VOI/TR ROOT
        'We hiccough.'   [yidžɛz]
        (Cook 1979: 20)

In all of the cases examined here, the segmental profile of the material in Position 8 is sensitive to the profile of the ROOT-initial consonant, leading to repairs that mirror those that are commonly attested in PWd-internal coda+onset clusters across languages.

In this way, Position 8 parallels Position 6.5; certain repairs apply between Position 6.5 and the ROOT, but when this position is null, Position 8, in effect, takes its place. Specifically, the affix-final consonant, whether from Position 6.5 or from Position 8 when 6.5 is null, is bound to the ROOT, either as a coda or through fusion.

To summarize, we have seen that Position 8 and the ROOT are phonologically close. This is not what we would expect from the representation generated by the MM account, which suggests that Position 8 is spelled out as a phonological word with Positions 4-7 and that 9+ROOT is spelled out as a separate phonological word. Although these two PWds would be organized into a higher PWd (PWd$_{max}$), to appropriately circumscribe the domain for vowel pharyngealization and sibilant assimilation in Tsilhqút'ín for instance, because a hard edge separates Positions 8 and 9+ROOT, only post-cyclic processes, those that apply across-the-board, should be insensitive to this edge. As syllabification and syllable-related repairs are the processes we have used to arbitrate between the MM and IRP accounts, we must question whether the application of these processes could wait until after PWd$_{max}$ has been built. Before we address this (in section 4.3.3), we must first consider contexts where Positions 8 and 6.5 are both overt.

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[42]In Witsuwit'en, the 1DU prefix does not pattern identically to VOI/TR, unlike what we see here for Tsilhqút'ín. In Witsuwit'en, the corresponding morpheme is /də-D/ underlyingly (Hargus 2007: 356), where /də/ is fixed in shape and /D/ varies depending on the quality of the root-initial consonant. Unlike with VOI/TR /D/, no epenthesis is observed before coronal stops with 1DU and, instead, deletion (or vacuous fusion) of /D/ takes place: [hədətsəγ], *[hədədə̱tsəγ] 'we (du) are crying' (Hargus 2007: 715); cf. [neʔdəsdə̱tsəɬ] 'he chopped himself' in (23). Hargus suggests that this might reflect haplology, which Rice (2000) has observed commonly occurs with functional morphology in other Athapaskan languages. Although identical syllables (including adjacent [də]) are tolerated in other constructions in Witsuwit'en, it appears that they do not occur with adjacent functional elements (Hargus 2007: 715). In this case, it seems to us, it is auspicious that the two syllables belong to the same morpheme as well.

4.3.2 Positions 8 and 6.5

Under the IRP account, the affixes in Positions 8 and 6.5 both look rightward and thereby 'compete' for the same phonological position immediately before the ROOT. (For Position 6.5, we focus on /l/ and /ɬ/, that is, on cases where this affix can surface in coda.) Because Position 6.5 enters the derivation earlier, it should be realized, at the expense of Position 8. The consonant in Position 8, however, can seemingly fuse with the consonant in Position 6.5, when the two are phonologically compatible. This is shown for Tsilhqút'ín in (36) for 2PL /h/ and VOI/TR /l/.

(36) ṣɛ-₇   h-₈   l-₆.₅   tsin̦
       MODE 2PL VOI/TR ROOT
       'You (pl) made it.'   [sɛɬtsin̦]
       (Krauss 1975: 32)

The examples in (37), also from Tsilhqút'ín, illustrate what happens when the consonants are not phonologically compatible. In (37a), when 2SG /ɛn/ enters the derivation, /n/ competes with /l/ for the coda position adjacent to ROOT; /l/ wins over /n/, although nasality from /n/ is preserved on the preceding vowel. Similarly, in (37b), when 1PL /id/ enters the derivation, /d/ competes with /l/ and /l/ again wins. In this case, for phonotactic reasons, we would not expect /d/ to surface in coda, in contrast to the nasal in /ɛn/ in the illicit form in (37a). However, if /id/ were to enter the derivation first, /d/ in /id/ should undergo the D-effect with the following root-initial consonant (as in (35)); this would leave room for /l/ to occupy the coda position adjacent to the ROOT when it later entered the derivation, as shown in the illicit form in (37b).[43]

(37) a. ɣɛ-₇   ɛn-₈ l-₆.₅   gɪš
          MODE 2SG VOI/TR ROOT
          'You are walking.'   [ɣə̃ĩlgɪc]
          (Cook 1986: 2)   *[ɣəɪŋgɪc]

      b. nɛ-₄ ɣʷɛ-₇ id-₈ l-₆.₅   ʔin
          OBJ MODE 1PL VOI/TR ROOT
          'Let us look at it.'   [nəɣʷolʔin]
          (Cook 1979: 29)   *[nəɣʷolt'in]

If syllabification is cyclic, the results for Tsilhqút'ín in (36) and (37) are as expected under the IRP account: Positions 8 and 6.5 are structurally adjacent (they are inside the same lower PWd), they both look rightward, and the affix in Position 6.5 enters the derivation first and is therefore syllabified prior to the affix in Position 8, although Position 8 shows preservation effects when it can.

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[43]The vowel [o] in the surface form in (37b) arises as follows: /ɛ/ and /i/ fuse to /i/ (no hiatus); combined with [labial] and [phar] from the preceding /ɣʷ/, the output is [o] (see (10)).

Our analysis is seemingly challenged, however, when Position 8 is occupied by 1SG /s/: /s/ and /l/ are not phonologically compatible, but it is the former that is realized, as shown in (38).

(38) næ$_2$ # Ø-$_7$ s-$_8$ l-$_{6.5}$ džid
      ITER   MODE 1SG   VOI/TR ROOT
      'I crawl.'   [næsdžit]
      (Krauss 1975: 9)

This result is surprising, as all syntactic accounts of the Athapaskan verb predict that Position 6.5 enters the derivation before Position 8.

Clearly, an account of C_1 (Position 8) or C_2 (Position 6.5) preservation that is tied to person marking would not be principled. In view of this, we propose that the variable preservation of C_1 or C_2 is illusory only and is due entirely to the features present in each segment. Since C_2 enters the derivation first, we assume that C_2 is syllabified and thereby protected from deletion before C_1 enters the derivation; that is, there is no segmental fusion per se (cf. Causley (1994)). However, faithfulness constraints enable features from C_1 to be realized on C_2 to facilitate recoverability of the Position 8 morpheme.

We sketch our account as follows. We assume that all features are monovalent. In (36), where /...h$_1$-l$_2$-tsįn̥/ → [...ɬ$_2$-tsįn̥], the only feature that /h/ bears is [spread glottis] meaning that all place and manner features from C_2 will be faithfully realized in the surface form; combined with [SG] from C_1, this yields [ɬ]. In both forms in (37), no features from C_1 survive on C_2. In (37a), where /...n$_1$-l$_2$-gɪš/ → [...l$_2$-gɪc], the only feature that /n/ bears that /l/ does not is [nasal], but this feature can be preserved on the preceding vowel and, thus, the coda can be realized with all of the features of C_2 intact. In (37b), where /...d$_1$-l$_2$-ʔin/ → [...l$_2$-ʔin], the only feature that /d/ has that /l/ does not is [stop]; since word-internal coda stops are forbidden in Tsilhqút'ín, this feature cannot be parsed on C_2 and all features of C_2 surface intact. Finally, in (38), where /...s$_1$-l$_2$-džid/ → [...s$_2$-džit], /s/ bears [strident] and [SG] and has no other features that C_2 lacks. Preserving [strident] from C_1 on C_2, however, forces the loss of [lateral] from C_2, due to the universal absence of strident laterals. In combination with [SG], the output is [s].[44]

In sum, using data from Tsilhqút'ín, we have argued that Position 6.5 takes precedence over Position 8. Both affixes look rightward under the bracketing proposed by the IRP account, and due to their segmental shape (as consonant-

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[44]This analysis assumes that stops and continuants both bear [SG] as their laryngeal feature, compared with the proposal of Rice (1994) where stops contrast for [SG] and continuants for [voice] (both monovalent). Stops clearly contrast for [SG] in Athapaskan: /t/ is voiceless aspirated ([tʰ]) and /d/ is voiceless unaspirated ([t]). In (non-Athapaskan) languages that have /h/ and contrastive aspiration, /h/ also typically patterns as [SG]. We see this in Tsilhqút'ín in the behaviour of 2PL /h/ + /l/: /h/ imparts its laryngeal feature to /l/, yielding [ɬ]. If /h/ instead lacked a laryngeal feature and /l/ bore one (as in Rice (1994)), we would expect the output to be [l]. Further, since continuants pattern as one sonority class in Athapaskan (see note 31), we assume that /s/ is like /ɬ/ in bearing [SG]. This accounts for why 1SG /s/ + /l/ yields [s] and not [z]. Finally, the presence of a laryngeal feature on voiceless rather than voiced continuants is supported by the voicing assimilation data in (33).

final), compete for the coda position adjacent to the ROOT. Because Position 6.5 enters the derivation first, it survives at the expense of Position 8. However, some content from Position 8 can be realized, through feature preservation. Position 8 may sometimes appear to be retained at the expense of Position 6.5, as the quality of the surface segment depends entirely on the features available from the consonants in the two positions.

4.3.3 Cyclic syllabification

In this section, we return to the issue of phonological domains under the IRP *vs.* MM accounts. We argued in sections 4.3.1-4.3.2 that if syllabification is cyclic, then the phonological patterns discussed for Positions 8 and 6.5 are as expected under the IRP account because these positions are structurally adjacent (shown earlier in (31b)). Turning to the MM account, it is not obvious that we would expect the phonological interactions observed, as a hard (PWd) edge separates Positions 8 and 6.5 (a.k.a. 9) and, thus, the two positions are not structurally adjacent (shown earlier in (31a)). One could challenge this conclusion, however, on grounds that in both the MM and IRP accounts, Positions 8 and 6.5 are *linearly* adjacent. As syllabification (and the repairs it triggers) is the process we have used to arbitrate between these two accounts, it behooves us to show that it truly applies cyclically, that the same result could not be achieved with across-the-board application of this process.

To address this question, we return to the example in (37a): /ɣɛ-ɛn-l-gɪš/ 'You are walking'. As we saw, this word surfaces as [ɣə̃ĩlgɪc]; /l/ in Position 6.5 takes priority over /n/ in Position 8 (although nasality in the latter affix is preserved on the preceding vowel). Recall that only one of these positions can be realized intact because the affixes in both positions are consonant-final and, thus, they compete for the same coda position adjacent to the ROOT. One issue we have not addressed is why these affixes need to compete, why both cannot instead be realized with the Position 8 affix triggering epenthesis, thus enabling its consonant to be realized as an onset: *[ɣəinɛlgɪc]. The absence of this repair is particularly puzzling because Tsilhqút'ín, like other Athapaskan languages, permits outputs where there is a coda adjacent to the ROOT, and no codas upstream of this position (in the conjunct domain), meaning that many verbs are shaped CV.CVC.CVC, precisely the shape of the illicit form under consideration. As mentioned, for /ɣɛ-ɛn-l-gɪš/ to surface as CV.CVC.CVC, the affix in Position 8 would have to trigger epenthesis. Tsilhqút'ín, however, does not permit epenthesis to maximize the realization of affixes.[45]

With this information in mind, we now consider what the expected output of /ɣɛ-ɛn-l-gɪš/ would be if syllabification were to apply across-the-board instead of cyclically: would it be the correct [ɣə̃ĩlgɪc] or the incorrect *[ɣəiŋgɪc] (see (37a))? The representation in (39) is the output of the standard view that

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[45]Epenthesis is only observed when the following conditions are not satisfied: the verb complex does not begin with a consonant and it is not minimally bisyllabic. If these conditions are not met through affixation, [h] and/or [ɛ] will be epenthesized to augment the form (Krauss 1975, Cook 1989, 2013). See the example in (20b).

syllables are built from left-to-right.[46] Onsets and nuclei/rhymes are projected first, yielding cross-linguistically optimal CV syllables (possibly independent of directionality). Remaining material is then assessed for its potential to be in coda (syllabified as a rhymal dependent in (39)).[47] As can be seen, left-to-right syllabification favours /n/ over /l/ in coda, yielding the ill-formed *[ɣəɪŋgɪc].

(39)   Across-the-board syllabification
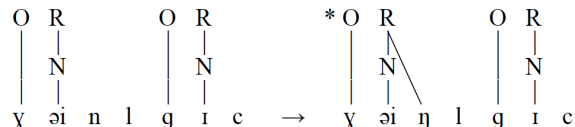
In sum, post-cyclic syllabification, which is sensitive to linear adjacency, applies left-to-right and thereby yields the incorrect result. Cyclic syllabification, which is sensitive to structure, effectively applies right-to-left under Iterative Root Prefixation, that is, from the ROOT outward as each prefix enters the derivation and seeks out the left edge of the ROOT.[48]

5   Conclusion and remaining issues

The Mirror Principle makes very strong predictions concerning word internal morpheme order, and yet, it has had remarkable success over nearly 35 years.

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[46]As our focus is on the ROOT-adjacent coda, we have ignored hiatus resolution in the first syllable. We have also shown the output of other processes, pharyngealization (yielding [əi]), place assimilation and ROOT-final allomorphy.

[47]We have deliberately not syllabified the word-final consonant in (39). While in standard GP, final consonants are onsets of empty-headed syllables (Kaye 1990), others (e.g., Piggott 1991) have argued that the formal status of final consonants, onset *vs.* coda, is parametric. According to Rice (2003), some Athapaskan languages motivate both options. Specifically, she has argued that phonological processes affecting ROOT-final consonants in Ahtna motivate a coda analysis when the preceding vowel is short and an onset analysis when the preceding vowel is long (see Goad (2002) for a similar analysis of English). In view of the complexity of options available, we cannot pursue this issue for Tsilhqút'ín in this paper.

[48]Cyclic syllabification can, of course, also apply left-to-right, namely, in languages where prefixation does not seek out the left edge of the ROOT. The question is whether across-the-board syllabification ever applies right-to-left. One example seemingly comes from Itô (1989), who argues that directionality in syllabification must be parametric, on grounds that this is needed to predict the location of epenthetic vowels in two dialects of Arabic. In Cairene, left-to-right syllabification ensures that a stranded consonant becomes an *onset* followed an epenthetic vowel: /ʔul-t-l-u/ → [ʔul.t̲i̲.lu] 'I said to him'; in Iraqi, right-to-left ensures that the stranded consonant becomes a *coda* preceded by an epenthetic vowel: /gil-t-l-a/ → [gi.l̲i̲t.la]. Notably, this analysis does not consider the phonotactic profile of the consonants being syllabified: in both varieties, the cluster that results is phonotactically free. This suggests that there may be no clusters at all in Arabic, that all syllables are instead CV in shape: [ʔu.lØ.t̲i̲.lu] *vs.* [gi.l̲i̲.t̲Ø.la] (Kaye 1990, Guerssel and Lowenstamm 1990). Directionality comes into effect in correctly predicting which empty positions are phonetically realized as [i] and which remain unpronounced (Ø), but importantly, the syllabification does not differ and, thus, this is not a true counterexample to our claim. We are not aware of other cases where directionality in across-the-board syllabification is truly parametric, yielding the equivalents of [ɣəɪŋgɪc] *vs.* [ɣə̃ɪlgɪc] for an input like /ɣɛ-ɛn-l-gɪš/ across languages/dialects.

Apparent counterexamples have led to the proposal that post-syntactic mechanisms are involved, such as lowering, local dislocation, and morphological merger (see, e.g., Marantz (1988), Embick and Noyer (2001)). The concern with introducing such mechanisms is that, when used in combination, they run the risk of removing any predictive power of the Mirror Principle. In this paper, we have proposed yet another method of affixation, Iterative Root Prefixation, but we have argued that it is less stipulative in that it is productive and predictable. What is novel is how the left edge is defined for attachment. Once the ROOT is chosen as the attachment site in the Athapaskan verbal system, the puzzling ordering of all but one of the prefixes is explained without the need to combine several post-syntactic morphological operations. Further, the behaviour of the outlying prefix can be explained when the segmental shape of this prefix is examined and the effect this has on the phonotactic profile of the verb word. Relatedly, the phonological interaction of the prefixes that appear adjacent to the ROOT favours the structure that is created through Iterative Root Prefixation rather than the combination of mechanisms employed in other accounts.

As the number of morphological mechanisms grows, so does the list of questions. We point to two here, one stemming from an assumption we made and the other from the mechanism we proposed. First, in our discussion of the bracketing differences between the MM and IRP accounts, we assumed that the different morphological structures employed would be expected to have different phonological signatures. Relatedly, in a system that allows both head movement and morphological merger, there is a question as to whether these should create different phonological boundaries. Second, Iterative Root Prefixation raises questions. The ordering puzzle posed by the Athapaskan verbal system is notable in its rarity. Ideally, we should be able to explain why this language family presents itself in this way, and ideally for the IRP account, this difference would follow from some particular characteristic of the left edge of the ROOT.

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