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Prosodic Word Recursion in a Polysynthetic Language (Blackfoot; Algonquian)

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Abstract: This paper focuses on prosodic adjunction at the Prosodic Word level in a polysynthetic language. I argue that recursion at a depth of more than two levels can only be generated by a theory which requires exact correspondence between certain syntactic phrases and Prosodic Words. Such a theory is similar to Phonological Phrase correspondence in Match Theory, suggesting there is an underlying shared property between correspondence at the Prosodic Word and Phonological Phrase levels. In addition, this theory must include a constraint which prohibits recursive prosodic constituents in order to generate the attested typology of clitics across languages. The empirical focus is the prosodic structure of the verbal complex in Blackfoot (Algonquian; ISO 639-3: bla). Using phonotactic evidence I argue that the *v*P phase corresponds to a Prosodic Word, and that each prefix to the stem is a Prosodic Word adjunct. I then compare several theories of the syntax-prosody interface, including versions of Alignment Theory, Wrap Theory, and Match Theory. A subset of schematic candidates with one or two prefixes to a stem are used to determine which theories generate the attested typology of clitics as well as a multiply recursive Prosodic Word structure.

Keywords: Blackfoot; Algonquian; recursion; adjunction; prosody; phonology–syntax interface

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1. Introduction

A large body of work on prosody adopts some version of the Prosodic Hierarchy Theory (Beckman and Pierrehumbert 1986; Nespor and Vogel 2007; Pierrehumbert and Beckman 1988; Selkirk 1978, 1981). These theories posit that the prosodic organization of words and sentences can be represented using a hierarchical structure which is related to syntactic structure, but which can ultimately diverge from syntactic structure in phonologically optimizing ways. However, these theories remain relatively untested in polysynthetic languages (Elfner 2018; Miller 2018), where 'words' contain a high degree of syntactic and prosodic structure. Additionally, although recursion is now an accepted part of prosodic structure (Elfner 2015; Itô and Mester 2007, 2009a, 2012; Selkirk 2011), recursion is still contested at the Prosodic Word level in particular. Some researchers argue that it does not occur at all (Vogel 2019), and others argue that it only occurs in a limited fashion (Bennett 2018; Kabak and Revithiadou 2009; Tyler 2019). It is unknown whether there is prosodic recursion in polysynthetic languages, nor whether existing theories can account for prosodic structure in these languages.

This paper presents an analysis of the prosodic structure of the verbal complex in Blackfoot (Algonquian; Frantz 2017), a polysynthetic language spoken in the United States and Canada. Syntactic evidence shows that the *v*P stem and CP verbal complex are built in the phrasal syntax. Independent phonological evidence shows that the *v*P stem prosodifies as a Prosodic Word and the CP verbal complex prosodifies as a Phonological Phrase. In other words, phonological 'words' in Blackfoot are in fact syntactically phrasal. Furthermore, each prefix to the verb stem is prosodified as a Prosodic Word adjunct, creating multiply recursive structures. The overall picture is that Prosodic Word recursion is robust and rampant, occurring whenever there is a prefix to the left of the verb stem, regardless of the internal or external syntax of that prefix.

I compare several theories of Prosodic Word correspondence in order to see whether these can account for the multiply recursive structure in Blackfoot: Alignment Theory (McCarthy and Prince 1994a; Selkirk 1996; Werle 2009), Wrap Theory (Kabak and Revithiadou 2009; Truckenbrodt 1999), and Match Theory (Selkirk 2011). All of these are couched in Optimality Theory (McCarthy and Prince 1994a; Prince and Smolensky 1993). This allows violable constraints which regulate structural correspondences to be evaluated in parallel with other phonological constraints, which in turn can account for the fact that prosodic structure is phonologically optimizing. None of the three theories can account for the multiply recursive structures in Blackfoot. Instead, I propose a theory which requires each phrasal syntactic constituent to prosodify to a unique Prosodic Word constituent. The result is very much like Match Phrase in Match Theory (Selkirk 2011), suggesting that there is an underlying shared property between correspondence at the Prosodic Word and Phonological Phrase levels.

The paper proceeds as follows. In Section 2, I contextualize the empirical and theoretical research questions which are addressed in this paper. Because the analyses rely on correspondences between syntactic and prosodic constituents, in Section 3, I discuss the syntax of the verbal complex as well as an overview of Blackfoot phonology and syllable structure. In Section 4, I then turn to the prosodic structure of the verbal complex in Blackfoot, and argue for two distinct prosodic domains, which I name the Prosodic Word and the Phonological Phrase, respectively. In Section 5, I show that prefixes adjoin to the Prosodic Word to create a recursive Prosodic Word structure, and I argue that prosodic adjunction is not limited to particular morphosyntactic properties. Finally, in Section 6, I compare several analyses which have been previously proposed in the literature to account for Prosodic Word correspondence. In Section 7, I discuss implications for theories of the syntax–phonology interface, and in Section 8, I conclude.

2. Recursion in Prosodic Phonology

In this section, I discuss some of the empirical and theoretical questions about Prosodic Word recursion that this paper addresses. I begin with an overview of my assumptions about prosodic phonology in Section 2.1. I then give an overview of previous research on recursion within a prosodic phonology framework, with a focus on recursion at the Prosodic Word (PWd) level in Section 2.2. I end by laying out the specific research questions addressed in this paper.

2.1. Prosodic Phonology

The domains of phonological generalizations correspond closely to syntactic constituents, but are not always isomorphic to those constituents (noted as early as Chomsky and Halle 1968; McCawley 1968; Selkirk 1974 and much subsequent work). Specifically, phonological domains can be influenced by language-specific phonological properties, including rate of speech, weight/size of constituents, or stress or tonal properties (cf. Nespor and Vogel 2007; Selkirk 1986, 2011). Because of this, I adopt a version of the Prosodic Hierarchy Theory, whereby phonological generalizations apply to a hierarchical prosodic structure which is independent of syntactic structure. Prosodic Hierarchy Theory was first developed in Selkirk (1978, 1980, 1981) and further developed by many researchers (a partial list includes: Beckman and Pierrehumbert 1986; Downing 1999; Hayes 1989, 1995; Hyman 1985; Inkelas 1990; Itô and Mester 2003, 2009a, 2009b, 2012; Ladd 2008; Nespor and Vogel 1982, 1983, 2007; Pierrehumbert and Beckman 1988; Selkirk 1984, 1996, 2009, 2011). Therefore, the Prosodic Hierarchy Theory itself has many different instantiations, but all of them assume there is a finite set of ordered prosodic categories, which are the domains for sets of phonological generalizations.

The prosodic categories which I adopt are shown in (1). I follow the majority of researchers, who assume that this set of prosodic categories is universal. This paper focuses on the Prosodic Word (PWd) level in particular. Not all researchers share this view; some argue that not all levels of the prosodic hierarchy are instantiated in every language (Green

1997; Jun 2005; Labrune 2012), or that prosodic constituents are emergent (Schiering et al. 2010).

(1) Prosodic categories

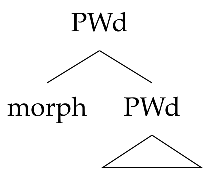
IPh intonational phrase
|
PPh phonological phrase
|
PWd prosodic word

The exact number of categories within the prosodic hierarchy differs among researchers. Many works also assume an Utterance (Utt) category above the Intonational Phrase (IPh) (Nespor and Vogel 2007; Selkirk 1978, 1980, 1986; and subsequent work), but recent work has argued that the Utt can be viewed as the maximal IPh (Itô and Mester 2012; Kawahara and Shinya 2008, later incorporated into Match Theory; Selkirk 2011). Still others have argued to expand the number of 'phrasal' categories (Nespor and Vogel 2007; Pierrehumbert and Beckman 1988; Poser 1984; Vogel 2009), or to add prosodic categories below the word level (Downing 1999; Inkelas 1990). However, these relatively minor differences do not affect the underlying core assumption that there is a finite set of distinct prosodic categories.

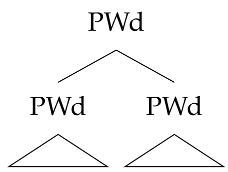
2.2. Prosodic Word Recursion

Early proposals of Prosodic Hierarchy Theory followed the Strict Layer Hypothesis (Beckman and Pierrehumbert 1986; Nespor and Vogel 2007; Pierrehumbert and Beckman 1988; Selkirk 1981, 1984, 1986), which assumed that prosodic structures were strictly organized and had different properties than syntactic structure. In particular, for this paper, the Strict Layer Hypothesis did not allow recursion. Converging evidence shows that there is in fact recursion in prosodic structure. Recursive prosodic structures were first described by Ladd (1986, 2008), and his findings were later corroborated by Kubozono (1987, 1989); Itô and Mester (2007, 2012); Wagner (2005, 2010); Dobashi (2003); Elfner (2012); Féry (2011); Féry and Truckenbrodt (2005); Frota (2000); Gussenhoven (2004); Kabak and Revithiadou (2009); van der Hulst (2010), among others. The focus of this paper is recursion at the Prosodic Word (PWd) level, which comes in two types, as seen below. The first kind is prosodic *adjunction*, involving unequal sisters (Booij 1996; Inkelas 1990; Peperkamp 1997; Selkirk 1996; Vigário 2003; Zec and Inkelas 1991). A prosodic adjunct (the 'morph' below) is both sister and daughter to a PWd. The second kind is prosodic *compounding*, involving equal sisters (Booij 1995; McCarthy and Prince 1994a; Vigário 2003). van der Hulst (2010) calls these unbalanced and balanced recursion, respectively. The scope of this paper is prosodic word adjunction.

(2) a. PWd adjunction



b. PWd compounding



The recursive structures above are not uncontested. Some researchers reject prosodic recursion outright, instead arguing that the number of levels in the prosodic hierarchy should be expanded. Specifically at the PWd level, there have been various proposals to add a prosodic category between the PWd and the PPh, such as the Clitic Group (or Composite Group; Nespor and Vogel 2007; Vogel 2009), the Prosodic Word Group (Vigário

2010), or Constituent X (Miller 2020). Others proposals allow recursion only at certain levels. For instance, Vogel (2019) restricts recursion to the phonological phrase and above, arguing instead that prosodic structure at the Composite Group and Prosodic Word levels are built in a different fashion. Finally, work such as Schiering et al. (2010) rejects a universal prosodic hierarchy, arguing instead that phonological domains are language-particular, intrinsic, and highly specific properties of individual phonological rules or constraints. In many languages, this results in a proliferation of the number of phonological domains rather than reducing these via recursion.

However, even researchers who allow prosodic word recursion disagree about what kinds of phonological correlates constitute evidence for recursion. Some people argue that the exact same phonological generalizations must exist at all levels of a recursive category (Vogel 2009). For example, Bennett (2018) argues for a recursive PWd in Kaqchikel Mayan by showing that the same phonotactic generalizations exist at the left edge of each level of the recursive PWd. Other recent work argues that different levels of a recursive category can exhibit distinct phonological generalizations Itô and Mester (2007, 2009b, 2012); Elfner (2015); Martínez-Paricio (2013). Specifically at the PWd level, there is extensive literature suggesting that a recursive prosodic word may optionally restructure or resyllabify, thereby only optionally exhibiting the phonological properties of the PWd (Booij 1996), or even develop new properties distinct from the (non-recursive) PWd or the PPh (Kabak and Revithiadou 2009).

A related question is whether prosodic recursion is a limited or general phenomenon. Kabak and Revithiadou (2009) argue that prosodic recursion is limited to a few types of syntactic constructions, such as clitic adjunction, phrasal verbs, and compounding. In other cases, PWd adjunction seems to be lexically specified and only occurs for a subset of morphemes which do not form a unified natural class (Bennett 2018; Tyler 2019). On the other hand, there is no difference in prosodification between prefixes and proclitics in Dutch Booij (1995, 1996) both form PWd adjuncts, suggesting that prosodic recursion in Dutch is not restricted. In this paper, I show that Prosodic Word adjunction in Blackfoot behaves more like Dutch, in that it is not limited to particular syntactic constructions. Instead, each prefix to the verb stem adjoins to the prosodic word corresponding to the stem, regardless of the internal or external syntax of the prefix.

Finally, some researchers argue that prosodic recursion is, by default, marked, and only occurs in order to create a structure which is isomorphic to a recursive syntactic structure. With the weakening of the Strict Layer Hypothesis, Selkirk (1996) suggested that the Strict Layer Hypothesis could be split into separate constraints, including a violable constraint against recursivity, *Recursivity. Admitting such a constraint to Con means that prosodic recursivity is marked, and that recursivity arises when some other constraint outranks *Recursivity Selkirk (1996); Truckenbrodt (1995, 1999). A different viewpoint has now arisen, whereby prosodic recursion results naturally by matching particular syntactic structures (Kabak and Revithiadou 2009; Selkirk 2011). Under such a theory, prosodic recursion is not marked at all, and there is no need to admit a constraint such as *Recursivity to the universal constraint set. Selkirk (2011) suggests that *Recursivity is not needed in a system that creates recursion via syntax–prosody correspondence constraints. However, Elfner (2018) points out that polysynthetic languages have not been the focus of prosodic studies, and that the correspondence between syntax and prosody may work differently in such languages.

To summarize, this paper addresses several research questions. First, does Prosodic Word recursion exist? Second, if so, then is it limited to particular syntactic constructions or lexical items? Third, what kind of analysis can account for Prosodic Word recursion, if it exists? Fourth, does an analysis require a constraint such as *Recursivity, implying that recursion is marked in prosodic structures?

In the next few sections, I first describe relevant aspects of Blackfoot syntax (Section 3.1) and phonology (Section 3.2) before turning, in Section 4, to a discussion of the the prosodic structure of simple verbal complexes. Then, in Section 5, I address the first of my research questions and establish that Prosodic Word recursion exists in Blackfoot.

3. Language Background

In this section, I establish some relevant facts about the syntax and prosody of Blackfoot which are necessary for understanding the prosodic structure of the verbal complex. In Section 3.1, I show that the stem is a *v*P/VP phrase while the verbal complex is a CP phrase. In Section 3.2 I show that the maximal syllable structure in Blackfoot is CVV or CVC, and that there are morphophonological alternations (epenthesis, vowel coalescence) which maintain this syllable structure.

3.1. Syntactic Structure of the Verbal Complex

Blackfoot is a polysynthetic, strongly head-marking language, and the verbal complex is correspondingly complex. As pointed out by Elfner (2018), Miller (2018), and Bennett and Elfner (2019, p. 158), there is a relative lack of understanding of the morphosyntactic organization in polysynthetic languages, and therefore a lack of understanding regarding the correspondences between syntax and prosody. This section contributes to this gap by examining independent syntactic evidence for the internal syntax of the Blackfoot verbal complex.

A basic morphological template is shown in (3). The stem can be preceded by a person prefix and any number of optional prefixes, and is followed by obligatory inflectional suffixes. The stem itself is also morphologically complex, containing a √ROOT followed by one or more verbalizing suffixes. The Blackfoot template is similar to that in other Algonquian languages, for which see Bloomfield (1946), among others. I give examples of this template in the following sections.

(3) MORPHOLOGICAL TEMPLATE OF THE VERBAL COMPLEX
person–(prefix*)–[STEM]–suffixes

In the following sections, I argue that the stem and the verbal complex are both phrasal syntactic constituents, rather than a complex head. Specifically, the stem is a *v*P/VP phrase (Section 3.1.1) and the verbal complex is a CP phrase (Section 3.1.2). As I discuss in Section 6.2, this poses a problem for theories of correspondence which assume that lexical heads (X^0 in X-bar theory; Jackendoff 1977) correspond by default to prosodic words.

3.1.1. The Stem Is a *v*P/VP Phrase

I focus on two arguments that the stem itself is phrasal. First, the stem contains suffixes instantiating the heads V^0 and v^0, indicating that the stem contains VP and *v*P phrasal projections. Second, the stem-internal √ROOT is a phrasal adjunct which freely modifies verbs or nouns. Both of these facts indicate that the stem is derived via phrasal syntactic operations.

The smallest intransitive verb stems consist of an a-categorical √ROOT and a verbal suffix. The suffix (bolded below) occurs only in intransitive stems and agrees with the grammatical (in)animacy of the single DP argument. In (4) the root √OMAHK 'big' combines with *-i* if the DP is animate, (4a), or *-o* if the DP is inanimate, (4b). The stem is given in square brackets.[1]

(4) Intransitive verbs

a. áakomahks**i**mma
áak–[√omahk–**i**]–mm–a
FUT–[√large–**AI**]–IND–3
'it (e.g., the pot) will be large'
[FR 190]

b. áakomahk**o**wa
áak–[√omahk–**o**]–Ø–wa
FUT–[√large–**II**]–IND–3
'it will be big' (BB)

The smallest transitive verbs consist of an a-categorical √ROOT and two verbal suffixes. The first suffix occurs only in transitive stems, while the second suffix (bolded below) agrees with the (in)definiteness and grammatical (in)animacy of the internal argument. In (5) the root √SSP 'high' combines with the transitive suffix *-inn* 'by hand'. The second suffix is *-ii*[2] if the internal argument is a DP and animate, (5a), *-i* if it is a DP and inanimate, (5b), and *-aki* if it is not a full DP, regardless of animacy. The subject of a transitive verb is always grammatically animate and sentient Kim (2015, 2017); Frantz (2017); Ritter and Rosen (2010); Wiltschko and Ritter (2015).

(5) Transitive verbs

a. isspínn**ii** ámo pookáá
[√ssp–inn–**ii**]–Ø–wa amo pookaa
[√high–by.hand.v–**3SUB**]–IND–3 DEM child.AN
'he lifted that child' (BB)

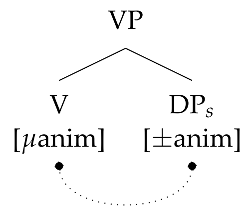
b. isspínn**i**ma ámo sináákia'tsis
[√ssp–inn–**i**]–m–a amo [√sin–a–aki]–a'tsis
[√high–by.hand.v–**TI**]–IND–3 DEM [√mark–v–AI]–INS.IN
'he lifted that book' (BB)

c. isspínn**aki** (pookáíks / sinááki a'tsiists)
[√ssp–inn–**aki**]–Ø–wa pookaa–iksi / [[√sin–a–aki]–a'tsis]–istsi
[√high–by.hand.v–**AI**]–IND–3 child–AN.PL / [[√mark–v–AI]–INS]–IN.PL
'he lifted (s.t./s.o.)' (BB)

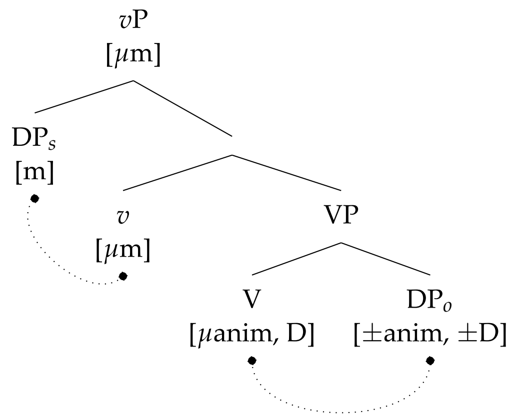
Based on derivational paradigms such as those above, Déchaine and Weber (2018) and Weber (2020) argue that the verbal suffixes instantiate verbal heads in the standard argument structures shown in (6), while the √ROOT remains a-categorical. In this way, there is a one-to-one mapping between the morphology and syntax of the verb stem. The restrictions on DP features discussed above are analyzed as the result of an Agree operation, where a head probes for a matching feature (Chomsky 2000).

Intransitive verbs contain a V^0 which is instantiated by the single suffix in intransitive verbs, and which selects one DP_s, (6b). This V^0 enters the derivation with an unvalued [μanim] feature enters a syntactic Agree relation with the local DP, which values the animacy feature as [+anim] or [-anim]. Transitive verbs contain two heads, big V^0 and little v^0 (Hale and Keyser 1993; Kratzer 1996; Marantz 1997), with V^0 selecting the internal argument, DP_o, and v^0 selecting the external argument, DP_s, (6b). Because the first suffix is restricted to transitive verbs I assume it instantiates v^0, and the second suffix instantiates V^0. The big V^0 in transitive verbs probes for animacy and definiteness (Weber and Matthewson 2017). Sentience is represented by the feature [m(ental state)] (Kim 2017).[3] Following Kim (2017), the higher v^0 enters the derivation with an unvalued [μm] feature and enters a syntactic relation with the external argument.[4]

(6) a. Intransitive verb



b. Transitive verb



For the purposes of this paper, the main takeaway is that the verbalizing suffixes in Blackfoot instantiate heads within the phrasal syntax. This shows that the verbal complex is phrasal and contains a VP and vP phrase. Further evidence for this claim is that the stem-internal √ROOT in Blackfoot is a phrasal adjunct to an intransitive VP or transitive vP, (7), as I argue below.[5]

(7) Root syntacticization as phrasal adjunct

a. Intransitive: $_{\mathrm{VP}}[\ \sqrt{\textsc{root}}$ $\quad _{\mathrm{VP}}[\ \mathrm{V}^0\ \mathrm{DP}_s\ ]_{\mathrm{VP}}\ ]_{\mathrm{VP}}$

b. Transitive: $_{v\mathrm{P}}[\ \sqrt{\textsc{root}}$ $\quad _{v\mathrm{P}}[\ \mathrm{DP}_s\ v^0$ $\quad _{\mathrm{VP}}[\ \mathrm{V}^0\ \mathrm{DP}_o\ ]_{\mathrm{VP}}\ ]_{v\mathrm{P}}\ ]_{v\mathrm{P}}$

Phrasal adjuncts have three correlates: (1) no categorical restrictions on their sister; (2) no limit on the number of adjuncts in a phrase; (3) phrasal adjuncts can themselves be phrasal. All three correlates are true for Blackfoot roots. First, the root √OMAHK 'big' can occur as a modifying prefix to a full verb stem, (8), or noun stem, (9). Second, roots can freely stack, as shown in (8), with the order of the prefixes determining scope relations (Bliss 2013).

(8) Adjunct to verb stem

ómahksiníkkssapiwa
√**omahk**–√inikk–[√ss–api]–Ø–wa
√**big**–√sulking–[√thus–look.AI]–IND–3
'she gave a sulking glance' [FR 73]

(9) Adjunct to noun stem

ómahkomitaa
√**omahk**–omitaa–wa
√**big**–dog–PRX
'big dog' [FR 188]

Third, the adjunct need not be a monomorphemic root; modifying prefixes can themselves be phrasal. In the example below, the modifier for the stem *opii* 'sit' is a multimorphemic phrase (a nominalized verb stem).

(10) Phrasal adjunct to verb stem

áakso'kaanópiiwa
aak–[[√yo'k–aa]–n]–opii]–Ø–wa
FUT–[[√sleep–AI]–NMLZ]–sit.AI]–IND–3
'he will doze (off)' [FR 320]

Adjuncts are usually optional, so it is surprising that the roots I analyze as vP/VP adjuncts are obligatory. As I showed above, the verbal heads contribute grammatical information (e.g., valency, and agreement with DP arguments) but they contribute very little, if anything, in terms of lexical/concrete meaning. Perhaps adjoined roots are obligatory because the verbal heads are so 'light' that event modifiers are required to restrict their denotation.[6] In this view, some languages restrict light verbs via nominal complements (e.g., English *take a seat*, *do the dishes*), while other languages restrict them via adverbial modifiers (e.g., Blackfoot).

3.1.2. The Verbal Complex Is a CP Phrase

In this section, I argue that the verbal complex itself is a CP. First, I argue that the verbal complex contains a C^0 merged with an IP complement, $_{CP}[\ C^0\ _{IP}[\ I^0 \ldots\ ]_{IP}\ ]_{CP}$. Then, I argue that the verbal complex has the distribution of a CP.

There are five morphological clause types in Blackfoot, which are each associated with a distinct set of clause-typing suffixes. Following Déchaine and Wiltschko (2010) and Ritter and Wiltschko (2014), I assume that these suffixes instantiate I^0. Two of the five morphological clause types are shown below (independent and imperative), with the clause-typing suffix bolded.

(11) INDEPENDENT
$_{CP}[$ Kitsówatoo**'p**oaa $]_{CP}$
kit–[io–wat–oo]–**'p**–oaa–<u>Ø</u>
2–[eat–*v*–TI]–**IND**–2PL–<u>3</u>
'You all ate it.' (BB)

(12) IMPERATIVE
$_{CP}[$ Oowátoo**k** $]_{CP}$
[oo–wat–oo]–**k**–<u>Ø</u>
[eat–*v*–TI]–**2PL.IMP**–<u>CMD</u>
'(you all) eat it!' (BB)

There is also a suffix in the verbal complex (underlined above) which Weber (2020) argues instantiates C^0. The evidence is that there are dependencies between the C^0 and its complement IP, such that C^0 selects the finiteness of the complement IP phrase. (For further arguments that this suffix is C^0, see Bliss 2013.) This is similar to the relationship between complementizers and (in)finite clauses in English, such as how *that* occurs with tensed clauses and *for* occurs with infinitive clauses. In Blackfoot, the relevant finiteness distinction is realis/irrealis rather than tense (Déchaine and Wiltschko 2010), which has semantic and morphological correlates; namely, person proclitics are only allowed in [+REALIS] clauses. Thus, the independent clause in (11) is [+REALIS], while the imperative clause in (12) is [-REALIS]. Weber (2020) considers the full range of C^0 heads, and argues that some types of C^0 require a [+REALIS] IP complement, some require a [-REALIS] IP complement, and some are neutral to the realis/irrealis distinction. The generalizations are given in Table 1.

Table 1. Dependencies between C^0 and IP features.

C^0	Features of the IP	Clause Types
-wa '3', *-yini* '3SG.OBV', *-yi* '3PL'	[+REALIS]	independent
-wa '3'	[+REALIS]	independent (non-assertive)
-Ø '3', *-yini* '3SG.OBV', *-yi* '3PL'	[+REALIS]	unreal
-i 'DEP'	*neutral*	conjunctive, subjunctive
-Ø 'IMP'	[-REALIS]	imperative

The entire verbal complex has the distribution of a CP: some clauses only occur in matrix clauses, some only occur in embedded contexts, and some are neutral with respect to embedding. For example, the C^0 head *-i* shown in (13) only occurs in embedded clauses, while the C^0 heads in (11) and (12) occur in matrix clauses.

(13) CONJUNCTIVE

$_{CP}$[Nítssksinii'pa	$_{CP}$[kitsówatoo**hs**oaa<u>yi</u>]$_{CP}$]$_{CP}$
Nit–[ssk–in–i]–'p–a	kit–[io–wat–oo]–**hs**–oaa–<u>yi</u>
1–[return–by.sight.*v*–TI]–IND–3	2–[eat–*v*–TI]–**CNJ**–2PL–<u>DEP</u>

'I know you ate it.' (Frantz 2017, 123, (f); re-glossed)

The generalizations for the full range of C^0 heads are given in Table 2.

Table 2. Dependencies between C^0 and embeddedness.

C^0	Matrix/Embedded?	Clause Types
-wa '3', *-yini* '3SG.OBV', *-yi* '3PL'	matrix	independent
-wa '3'	matrix	independent (non-assertive)
-Ø '3', *-yini* '3SG.OBV', *-yi* '3PL'	*neutral*	unreal
-i 'DEP'	embedded	conjunctive, subjunctive
-Ø 'IMP'	matrix	imperative

In sum, the verbal complex has the internal syntax and distribution of a CP. I conclude that the verbal complex is a CP.

3.1.3. Neither the Stem Nor the Verbal Complex Are a Complex Head

It is important to note that the *v*P/VP phrase cannot be reanalyzed as a complex syntactic head via head movement Baker (1988, 1996, 2003, 2009).[7] The V^0 would raise to v^0 in transitive verbs, and then raise into an adjunct position to adjoin with the √ROOT or multimorphemic phrase there. This would violate Baker's (1996, 2003) Proper Head Movement Generalization. (For similar arguments in the realm of Ojibwe denominal verbs, see Barrie and Mathieu 2016.) The verbal complex cannot be analyzed as a complex head for the same reason.

There are theoretical reasons to reject a head movement analysis as well. Syntactic theories such as Bare Phrase Structure (Chomsky 1995) erase any distinction between X^0 and XP. Because of this, recent constructionist theories such as Distributed Morphology Halle and Marantz (1993); Harley and Noyer (1999, 2014) Borer's Exoskeletal Model (Borer 2013), and Nanosyntax (Starke 2009) argue that complex words are constructed using the same syntactic principles which underlie phrases (Borer 2013; Halle and Marantz 1993; Marantz 1997; Starke 2009).

I conclude that the *v*P/VP stem and the CP verbal complex are both syntactic phrases which are derived via phrasal syntax. Since they are phrasal, phrasal theories of syntax–phonology correspondence should apply. I discuss what this means for theories of Prosodic Word correspondence in Section 6. In the next section, I briefly discuss some aspects of Blackfoot phonology which are relevant for diagnosing prosodic structure.

3.2. Blackfoot Phonology and Syllable Structure

In this section, I describe the Blackfoot phonological inventory (Section 3.2.1), syllable structure (Section 3.2.2), and alternations which optimize syllable structure (Section 3.2.3). I focus particularly on vowel epenthesis and coalescence. The reason is that these processes are domain delimited and provide evidence for prosodic structure. In a later section, I use these diagnostics to argue for two distinct prosodic constituents within the Blackfoot verbal complex.

3.2.1. Phonological Inventory

The inventories of Blackfoot consonants (Table 3) and vowels (Table 4) are given below. The pre-assibilants [ˢt] and [ˢt:] only occur after front vowels, but are included here because they are minimally contrastive with [t] and [t:] in the same position (Weber 2020). Coronal stops regular assibilate to [ts] or [tːs] before high front vowels (Frantz 2017; Weber 2020). The velar fricative /x/ has allophones [ç] after front vowels and [x^{w}] after round vowels (see Miyashita 2018; Weber 2020).

Table 3. Blackfoot phonemic consonant inventory (Weber 2020).

	Labial	Coronal	Dorsal	Glottal
Stops	p pː	t tː	k kː	ʔ
Assibilants		^{s}t ^{s}tː	ks	
Fricatives		s sː	x	
Nasals	m mː	n nː		
Glides	w	j	(w)	

Table 4. Blackfoot phonemic vowel inventory (Weber 2020).

	Front	Central	Back
High	i iː		o oː
Mid	ɛː		ɔː
Low		a aː	

The phonemes /x/ and /ʔ/ have extremely restricted distribution. The dorsal fricative /x/ only occurs before an obstruent (Elfner 2006; Reis Silva 2008; Weber 2020). The glottal stop /ʔ/ typically occurs before a consonant, although occasionally between vowels, as in the vocative /naʔá/ 'mother!' (Peterson 2004). The sibilants /s/ and /sː/ can occur before, after, or between other consonants. No other consonants have this distribution (Goad and Shimada 2014).

The sounds [k] and [ks] contrast before underlying vowels (Armoskaite 2006; Weber 2020), as shown by the minimal pair in (14), where both sounds occur before [ɪ]. This is relevant to this paper because /k/ and /ks/ neutralize to [ks] before epenthetic [i] Weber (2021, 2020). In Section 4, I argue that this neutralization is blocked across the right edge of a prosodic word.

(14) Contrast between [k] and [ks]

a. ⟦ʔɪs**k**ít⟧
iss**k**ít
[iss**k**–Ø–i]–t–Ø
[by.body–*v*–TI]–2SG.IMP–CMD
'break it!' [FR 266]

b. ⟦ʔɪs**ks**ít⟧
iss**ks**ít
[iss**k**–i]–t–Ø
[urinate–AI]–2SG.IMP–CMD
'urinate!' [FR 268]

I now turn to a brief discussion of syllable structure in Blackfoot.

3.2.2. Syllable Structure

The syllable template in Blackfoot is CV(V) or CV(C). An extra final consonant is allowed at the right edge of the phrase. I briefly defend each aspect of this syllable template.

Onsets are required in Blackfoot. A glottal stop is epenthesized before vowel-initial phrases, (15). Otherwise, vowel hiatus across morpheme boundaries is resolved via coalescence and other strategies (Bliss 2013; Elfner 2006; Weber 2020).

(15)	*UR*	*IPA*	*Gloss*	
	/apíːt/	[ʔa.píːt]	'sit!'	(BB)
	/imitâː/	[ʔi.mi.tâː]	'dog'	(BB)
	/otán/	[ʔo.tʌ́n]	'his/her daughter'	(BB)

Evidence for the two rime shapes (VV and VC) comes from vowel-length neutralization in closed syllables. The examples in (16a) show that vowel length is distinctive in open syllables (CV vs. CVV). However, vowel length is neutralized to short in closed syllables, (16b) (only CVC allowed; *CVVC prohibited). All five vowel qualities neutralize to a centralized vowel [ɪ], [ɛ], [ʌ], [ɔ], or [ʊ] specifically before geminate consonants or /sC/ clusters. This neutralization is supported by morpheme alternations, as discussed in (Elfner 2006; Weber 2020).

(16)		*Shape*	*IPA*	*Gloss*	
	a.	CV	[ʔâː.**ko**.kaː]	'he will rope'	(BB)
		CVV	[ʔâː.**koː**.kaː]	'she will hold a Sundance'	(BB)
	b.	CVC	[só.**kaʔ**.sim]	'shirt, dress'	(BB)
			[**ʔɪm**.mo.jáːn]	'fur coat'	(BB)
			[**pʌs**.káːn]	'dance'	(BB)
		CVVC	—	—	

Finally, two additional syllable shapes, CVVC and CVCC, are allowed at the right edge. These are exactly the same as the syllable template above, plus an additional consonant. This additional consonant has unusual properties compared to phrase-internal codas, three of which I discuss here.[8] First, vowel length remains contrastive before the final consonants. The near-minimal pairs in (17) show that short or long vowels may occur before a final [t] or [n].

(17)		*IPA*	*Orthography*	*Gloss*	
	a.	[ʔɪs.sa.p**í**t]	*issapít!*	'look!'	(NC)
		[ʔa.p**í**ːt]	*apíít!*	'sit!"	(NC)
	b.	[pɪs.k**ʌ́**.ni̥]	*pisskáni*	'buffalo jump'	(NC)
		[pʌs.k**á**ː.ni̥]	*passkááni*	'dance"	(NC)

Second, clusters and geminates are also allowed at the right edge of bare nouns, even though medial codas are never complex. For example, coda /x/ and coda /ʔ/ can both precede /s/ at the right edge of a bare noun, (18). The clusters that are allowed at the right edge of a phrase are a subset of those allowed as as medial heterosyllabic clusters. If the medial clusters are composed of a coda and an onset, then this suggests that the right edge clusters are also composed of a coda plus an additional consonant.

(18)		*IPA*	*Orthography*	*Gloss*	
	a.	[ʔo.nɪ.^{s}tá**xs**]	*onistááhsa*	'calf'	(BB)
	b.	[sí.kx^{w}.ko**ʔs**]	*síkohko'sa*	'cast iron pan'	(BB)
	c.	[míʔ.ksː.kɪ**mm**]	*mí'ksskimma*	'metal'	(BB)

Third, final consonants apparently count towards minimal size restrictions. The smallest noun or verb is CVVC or CVCC. No noun or verb is as small as a *CV, *CVV, or *CVC. Although it is surprising that the minimal size is larger than bimoraic, there are at least two explanations for this restriction: (1) perhaps this prosodic unit must include a branching structure, such as a syllable and extrametrical consonant, or two syllables within a foot; or (2) in Section 4.3, I argue that this prosodic unit is the Phonological Phrase (PPh) and that the minimal Prosodic Word (PWd) is minimally bimoraic; perhaps the PPh must be larger than a minimal PWd, and that is the reason for the extra consonant.

(19) MINIMAL VERBAL AND NOMINAL COMPLEXES

	IPA	*Orthography*	*Gloss*	
CVVC	[píːt]	píít	'enter!'	(BB)
	[sóːt] ∼ [so.wóːt]	sóót ∼ sowóót	'go to war!"	(BB)
	[kóːn]	kóón	'ice"	(BB)
CVCC	[pónn]	pónn	'bracelet'	(BB)
	[kóʔs]	kó's	'dish, bowl'	(BB)

This syllable structure is maintained by phonological alternations, which I discuss in the next section. In the following section, I use interruptions to these alternations to argue for the prosodic structure of the verbal complex.

3.2.3. Alternations

Processes of epenthesis and vowel coalescence occur in derived contexts to maintain well-formed syllable structure. The evidence for epenthesis comes from two patterns of alternation for stem-internal suffixes. One group of suffixes exhibits an [i] ∼ Ø alternation at the left edge after consonants and vowels, respectively. For example, the suffix /-pi^{s}t/ 'tie' is [-ipi^{s}t] after a consonant, (20a), but [-pi^{s}t] after a vowel, (20b). I have bolded the suffix-initial [-ip] and [-p] sequences below.

(20) a. AFTER C

⟦nitâːksox^{w}ks**ip**i^{s}taː⟧
nitáaksoohks**ip**istaa
nit–aak–[√yoohk–**p**ist–aa]–(hp)
1–FUT–[√lid–**tie.***v*–AI]–(IND)

'I will close the tipi flap' [FR 319]

b. AFTER V

⟦ʔamo**pí**^{s}taːni⟧
amo**pí**staani
[[√amo–**p**ist–aa]–n]–i
[[√gather–**tie.***v*–AI]–NMLZ]–IN.SG

'ceremonial bundle' [FR 13]

This is crucially different from suffixes which begin in a vowel after consonants and vowels. For example, the suffix /-ipi/ 'bring' is [-ipi] after a consonant, (21a), but surfaces with an initial diphthong as [-oipi] when it follows an [o]-final root, (21b), where the diphthong [oi] is the output of the underlying /o+i/ sequence.

(21) a. AFTER C

⟦ʔomats**íp**iːs⟧
omats**íp**iisa
[√omat–**ip**i–ːs]–Ø
[√start–**bring**.*v*–2SG:3.IMP]–CMD

'transport him!' [FR 193]

b. AFTER V

⟦ʔamó**íp**iːsaːwḁ⟧
amó**íp**iisaawa
[√amo–**ip**i–ːs]–Ø=aawa
[√gather–bring.*v*–2SG:3.IMP]–CMD=PRX.PL

'gather them!' [FR 195]

There are multiple vowel hiatus resolution strategies in Blackfoot, which means that the suffix [-ipi] 'bring' has other realizations after other vowels. For example, this suffix is realized as [-ɛːp] after an [a], like the root-final [a] in √SA 'out', (22), where [ɛː] is a coalesced vowel that reflects an underlying /a+i/sequence.

(22) AFTER V

⟦s**ɛ**ː**p**íːs⟧
sa**ip**íís
[√sa–**ip**i–ːs]–Ø
[√out–**bring**.*v*–2SG:3.IMP]–CMD

'bring her out!' [FR 236]

Those alternations are summarized in (23). Suffixes such as 'tie' begin in a vowel after consonants and a consonant after vowels. Abstracting away from vowel coalescence, suffixes such as 'bring' begin in a vowel in both environments. There are other suffixes which begin in vowel qualities other than [i] after consonants and vowels as well (Weber 2020, forthcoming). I take this as evidence that 'tie' begins in an underlying consonant, while 'bring' begins in a vowel. The [i] ∼ Ø alternation at the left edge of 'tie' and the vowel hiatus resolution strategies can be analyzed as epenthesis between consonants, which is driven by principles of syllabification (Itô 1986); namely, these strategies avoid illicit codas and syllables without onsets.

(23)		*After C*		*After V*	*UR*	*Gloss*
	a.	[-ipiˢt]	∼	[-piˢt]	/-piˢt/	'tie.*v*'
	b.	[-ipi]	∼	[-ipi]	/-ipi/	'bring.*v*'

Finally, a morpheme-final /k/ always assibilates to [ks] before the epenthetic vowel [i]. In (20a) the root √yoohk 'lid' surfaces with a final [ks] before the epenthetic vowel [i]. This root ends in [k] before other vowels, such as [a] in (24a) and [o] in (24b), which I take as evidence that the morpheme ends in an underlying /k/, but that *only* [ks] is allowed before epenthetic [i].

(24) a. ⟦ʔáka:jóxʷ**k**anɪn:imḁ⟧
ákaayóóh**k**aninnima
akaa–[√yooh**k**–an–inn–i]–m–a
PRF–[√lid–SHEET–by.hand.*v*–TI]–IND–3
'he has shut it (as a window)' [FR 318]

b. ⟦ʔâksoxʷ**k**ójiji:wájḭ⟧
áaksooh**k**óyiyiiwáyi
aak–[√yooh**k**–oyi–i–yii]–Ø–w=ayi
FUT–[√lid–mouth–*v*–3SUB]–IND–3=OBV.SG
'she will cover it with a lid' [FR 319]

In the next section, I argue that there are two distinct prosodic constituents within the verbal complex, which I call the Phonological Phrase and the Prosodic Word. After this section, I turn to a discussion of how prefixes are prosodified into this structure.

4. Prosodic Structure of the Verbal Complex

In this section, I argue that there are distinct edge constraints which hold at the left and right edges of the *v*P/VP stem and the CP verbal complex. These constraints are active in the phonology because they drive root alternations or block regular phonological processes. The root alternations conspire to avoid different natural classes of segments at the left edge of the *v*P/VP and CP, which I take as evidence for two distinct prosodic left edges. The process of epenthesis is interrupted at the right edge of the *v*P/VP, which I take as further evidence for a prosodic constituent. I conclude that there are two distinct prosodic constituents within the verbal complex, which I call the Prosodic Word (PWd) and the Phonological Phrase (PPh).

4.1. Distinct Left Edge Constraints

In this section, I consider root alternations in two positions: at the left edge of the CP verbal complex versus after a prefix. The root alternations conspire to avoid glides at the left edge of the CP verbal complex and to avoid stops at the left edge of the *v*P/VP stem. To account for this, I argue that there are two distinct prosodic boundaries, each associated with a different edge constraint.

Consider roots which begin with a long vowel at the left edge of the CP verbal complex. Some of these roots also begin in a long vowel after a prefix; if the prefix ends in a vowel, then vowel hiatus is resolved in one of several ways. For example, √IITSSK 'scuffle' begins with a long [i:] at the left edge, (25) and this long [i:] coalesces with a preceding [a] to form [ɛ:i], (26).[9]

(25) Left edge
⟦ʔ**i**ːtsːkáːt⟧
iitsskáát
[√**ii**tssk–aa]–t–Ø
[√scuffle–ai]–2sg.imp–cmd
'fight!' [FR 38]

(26) After V
⟦ʔɛ́ːsoːk**ɛ́ːi**tsːkaːwḁ⟧
áísook**áíi**tsskaawa
a–isook**a**–[√**ii**tssk–aa]–Ø–wa
ipfv–used.to–[√scuffle–ai]–ind–3
'he used to fight' [FR 319]

This behavior contrasts with roots which begin with a long vowel at the left edge but a glide after a prefix. For example, √jiip 'decrease' begins with a long [iː] at the left edge, (27) but with [j] after a preceding [a] in (28), blocking vowel coalescence.

(27) Left edge
⟦ʔiːpiˢtótsit⟧
iipístotsit
[√**y**iip–istot–i]–t–Ø
[√decrease–caus.*v*–ti]–2sg.imp–cmd
'decrease the volume of it!' [FR 35]

(28) After V
⟦nitá**j**iːpiˢtot͡siʔpḁ⟧
nitá**y**iipistotsii'pa
nit–a–[√**y**iip–istot–i]–hp–a
1–ipfv–[√decrease–caus.*v*–ti]–ind–3
'I am decreasing the amount' [FR 313]

Those alternations are summarized below. Abstracting away from vowel coalescence, roots like √iitssk 'scuffle' begin in a long vowel at the left edge of the CP verbal complex as well as after a vowel; these roots begin in an underlying long vowel. Roots such as √jiip 'decrease' begin in a long vowel at the left edge of the CP verbal complex, but a palatal glide [j] after a vowel. Since no roots begin in a glide in both positions, I take this as evidence that roots such as √jiip begin in an underlying glide which deletes at the left edge of the CP verbal complex.

(29)

	Left edge		After V	UR	Gloss
a.	[iːtsːk]	∼	[iːtsːk]	/iːtsːk/	'scuffle'
b.	[iːp]	∼	[jiːp]	/jiːp/	'decrease'
c.	*[jiːp]	∼	*[jiːp]		

Now consider roots which begin with a plosive at the left edge of the CP verbal complex. There are two main patterns of alternation. In the first pattern, a root which begins in a plosive at the left edge of the verbal complex surfaces with an [i] at the left edge of the root after either a consonant or a vowel.[10] For example, √pomm 'transfer' begins with a [p] at the left edge, (30), but [ip] after any prefix. After a consonant, the evidence is that there is an extra vowel [i] between the two consonants which causes assibilation of a preceding /k/, (31a). After a vowel, the evidence is that the vowel length and quality of the prefix /a-/ 'ipfv' changes to [ɛː], (31b), exactly as it would from an underlying /a+i/ sequence.

(30) Left edge
⟦**p**ʊmːóːs⟧
pommóós
[√**p**omm–o–ːs]–Ø
[√transfer–*v*–2sg:3.imp]–cmd
'transfer (e.g., the medicine bundle) to him!' [FR 91]

(31) a. After C
⟦ʔâːks**ip**ʊ́mːojiːwájḭ⟧
áaks**ip**ómmoyiiwáyi
aak–[√**p**omm–o–yii]–Ø–w=ayi
fut–[√transfer–*v*–3sub]–ind–3=obv.sg
'he will transfer it to her' [FR 91]

b. After V
⟦ʔɛ́ː**p**ʊmːakiwḁ⟧
á**í**pommakiwa
a–[√**p**omm–Ø–aki]–Ø–wa
ipfv–[√transfer–*v*–ai]–ind–prx
'the one transferring' [FR 249]

In the second pattern, a root which begins in a plosive at the left edge of the CP verbal complex surfaces with [oxʷ] at the left edge of the root after either a consonant or a vowel. For example, the root for 'buy' begins with a [p] at the left edge, (32), but [oxʷp] after any prefix. After a consonant, the evidence is that there is an interconsonantal [xʷ], (33a), just as there would be if the prefix were followed by a root which began in an underlying /ox/ sequence. After a vowel, the evidence is that the vowel quality changes exactly as it would if the root began in an underlying /ox/ sequence. In (31b) the prefix /a-/ 'ipfv' surfaces as [ɔ], as if from an /a+o/ sequence before a coda consonant.

(32) Left edge
⟦pʊmːáːt⟧
pommáát
[√pomm–aa]–t–Ø
[√buy–ai]–2sg.imp–cmd
'buy!' [FR 175]

(33) a. After C
⟦ʔâːkxʷpʊmːaːwḁ⟧
áak**ohp**ommaawa
aak–[√**ohp**omm–aa]–Ø–wa
fut–[√buy–ai]–ind–3
'she will buy' [FR 175]

b. After V
[ʔɔ́xʷpʊmːa]
á**óh**pommaawa
a–[√**oh**pomm–aa]–Ø–wa
ipfv–[√buy–ai]–ind–3
's/he is shopping' (BB)

There are also roots which begin in invariant [i] or invariant [oxʷ] in both positions. For example, the root √ipotsim 'poison' is realized with an initial [ip] at the left edge of the verbal complex as well as after a consonant-final prefix, (34). Similarly, the root √ohpo 'grease' is realized with an initial [oxʷp] at the left edge of the verbal complex as well as after a consonant-final prefix, (35).

(34) Roots with invariant [i]

a. Left edge

⟦ʔ**ip**ótsimatsís⟧
ipótsimatsísa
[√**ip**otsim–at–:s]–Ø
[√poison–*v*–2sg:3.imp]–cmd

'poison him!' [FR 92]

b. After C

⟦ʔâ:ks**ip**ótsimatsi:wḁ⟧
áaks**ip**ótsimatsiiwa
aak–[√**ip**otsim–at–ii]–Ø–wa
fut–[√poison–*v*–3sub]–ind–3

'she will poison him' [FR 92]

(35) Roots with invariant [oxʷ]

a. Left edge

⟦ʔ**oxʷp**óískinis⟧
ohpóísskinisa
[√**ohp**o–isski–n–:s]–Ø
[√grease–face–by.hand.*v*–2sg:3.imp]–cmd

'paint his face!' [FR 174]

b. After C

⟦ʔâ:k**xʷp**oiskini:wáji̥⟧
áak**ohp**oisskiniiwáyi
aak–[√**ohp**o–isski–n–ii]–Ø–w=ayi
fut–[√grease–face–by.hand.*v*–3sub]–ind–3=obv.sg

'she will paint his face' [FR 174]

These alternations are summarized below. Abstracting away from vowel coalescence, the roots meaning 'transfer' and 'buy' begin in a plosive at the left edge of the CP verbal complex, but a vowel after a prefix of any kind. Roots such as √ipotsim 'poison' and √ohpo 'grease' begin in a short vowel at the left edge of the verbal complex, as well as after a vowel. Under the simplest analysis, roots like √ipotsim 'poison' and √ohpo 'grease' begin in an underlying short vowel, which raises the question of what the underlying forms of the roots 'transfer' and 'buy' could be. Since no roots begin in a plosive in both positions, it seems likely that either 'transfer', 'buy', or both roots begin in an underlying plosive.

(36)

	Left edge		*After prefix*	*UR*	*Gloss*
a.	[pʊm:]	∼	[ipʊm:]	/pom:/	'transfer'
b.	[pʊm:]	∼	[oxʷpʊm:]	{ /pom:/, /oxʷpʊm:/ }	'buy'
c.	[ipotsim]	∼	[ipotsim]	/ipotsim/	'poison'
d.	[oxʷpo]	∼	[oxʷpo]	/oxpo/	'grease'
e.	*[pʊm:]	∼	[pʊm:]		

I posit that √pomm 'transfer' begins in an underlying plosive, and that the root undergoes epenthesis of [i] after a prefix. Just like elsewhere in the verbal complex, an underlying /k/ assibilates to [ks] before this epenthetic [i], as shown in (31a). Finally, since the root for 'transfer' does not pattern like √ohpo 'grease' or √pomm 'transfer', the underlying form which is distinct from both in some way. I posit that there are two underlying forms for

√pomm 'buy', {/pomm/, /oxpomm/}. The reason is that there is no regular phonological process to derive one form from the other, so the two forms must be unpredictable allomorphs.

Note that the epenthesis at the left edge of √pomm is not driven by syllable structure, because it occurs after vowels as well as consonants. In (37a), repeated from (31b) with syllabification, epenthesis occurs after the [a-] 'ipfv' prefix, even though a form which simply concatenates the prefix and the root together, (37b), is well-formed in terms of syllable structure, and in addition does not contain the long vowel of the attested form, which is typologically marked. If this process of epenthesis is not motivated by syllable structure, then what is the underlying cause?

(37) a. ⟦ʔɛ́ː**.p**ʊm.ma.ki.wḁ⟧
áí**p**ommakiwa
a–[√**p**omm–Ø–aki]–Ø–wa
ipfv–[√transfer–*v*–ai]–ind–prx
'the one transferring' (=31b)

b. * ⟦ʔá.**p**ʊm.ma.ki.wḁ⟧
á**p**ommakiwa
a–[√**p**omm–Ø–aki]–Ø–wa
ipfv–[√transfer–*v*–ai]–ind–prx
'the one transferring'

Crucially, all roots which exhibit alternations have one form at the left edge of the CP verbal complex, and a second form after a prefix of any kind, regardless of whether the prefix ends in a consonant or a vowel. Weber (2020) considers a range of diverse alternations, summarized in (38). For example, after a prefix, roots may exhibit *epenthesis*, (a)–(b), an [ox] *accretion*, (c), *deletion* (d), or *glide substitution*, (e). However, the distribution of forms is uniform across all the patterns; namely, one form occurs at the left edge and the other form occurs elsewhere. (As before, all forms are abstracted away from vowel coalescence.)

(38)

	Left edge	After C	=	After V	Gloss
a.	[pomː]	[**i**pomː]	=	[**i**pomː]	'transfer'
	[kipita]	[**ip**ːita]	=	[**ip**ːita]	'aged'
b.	[pomː]	[**ox**pomː]	=	[**ox**pomː]	'buy'
c.	[iːp]	[**j**iːp]	=	[**j**iːp]	'decrease'
d.	[**m**aːn]	[an]	=	[an]	'recent'
	[**n**iːpo]	[ipo]	=	[ipo]	'upright'
e.	[**m**aːk]	[**j**aːk]	=	[**j**aːk]	'arrange'
	[**n**aːm]	[**j**aːm]	=	[**j**aːm]	'alone'

Generalizing over all root alternations shows that certain segments are prohibited at the left edge of roots in each of these two positions. Table 5 summarizes these restrictions. Roots never begin with a glide (e.g., a [-cons] segment; solid line) when they stand at the left edge of a verbal complex, and roots never begin with a stop (e.g., a [-cont] segment; dashed line) after a prefix.[11]

Table 5. Segments allowed at left edge of roots in two positions

	p	**k**	**m**	**n**	**j**	**w**	**iː**	**oː**	**ɛː**	**ɔː**	**aː**	**i**	**o**	**a**
Left edge	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓	✓	✓	✓	✓
After prefix	✗	✗	✗	✗	✓	✓	✓	✓	✗	✗	✗	✓	✓	✓

These edge restrictions are active phonological constraints because they drive the root alternations discussed above, including deletion of /j/ at the left edge, (27)–(28), epenthesis of [i] after a prefix, (30)–(31), and allomorph selection, (32)–(33) as well as in (38). I take this as evidence that they define prosodic boundaries rather than morphosyntactic boundaries. Following Hall (1999, p. 3*ff*), I assume that phonotactic generalizations may define prosodic constituents, and I take these two phonotactic constraints as evidence for two distinct prosodic constituents within the CP verbal complex, (39), each associated with a different left-edge restriction. The left edge of the CP verbal complex corresponds with a Phonological Phrase (PPh) constituent which prohibits [-cons] segments at the left edge, marked by a curly brace, {, below. The left edge of the *v*P/VP stem corresponds with a Prosodic Word (PWd) constituent which prohibits [-cont] segments at the left edge, marked by a parenthesis, (, below.

(39) Distinct left edges

No prefixes:	PPh{	PWd(STEM–suffixes
With prefixes:	PPh{ person–prefix*–	PWd(STEM–suffixes

These prosodic boundaries account for the root alternations in the following ways. A root-initial glide /j/ deletes at the left edge of the CP verbal complex in order to satisfy the restriction against [-cons] segments at the left edge of the PPh. The same glide surfaces intact after a prefix because it does not stand at the left edge of a PPh. The examples from above with √JIIP 'decrease' are shown again in (40) and (41) with prosodic boundaries marked.

(40) Left edge
⟦{(ʔiːpiˢtótsit⟧
iipístotsit
[√**y**iip–istot–i]–t–Ø
[√decrease–CAUS.*v*–TI]–2SG.IMP–CMD
'decrease the volume of it!' (=27)

(41) After V
⟦{nitá(**j**iːpiˢtot͡siʔpḁ⟧
nitá**y**iipistotsii'pa
nit–a–[√**y**iip–istot–i]–hp–a
1–IPFV–[√decrease–CAUS.*v*–TI]–IND–3
'I am decreasing the amount' (=28)

Epenthesis occurs at the left edge of obstruent-initial roots in order to displace stops away from the prosodic boundary, thereby satisfying the edge restriction against [-cont] segments; this is the reason that epenthesis occurs after consonants and vowels. To return to the example of √POMM 'transfer' after a vowel, epenthesis removes the plosive [p] from the left edge of the PWd, (42a), whereas the form without epenthesis has a [p] at the left edge of a PWd, violating the constraint against [-cont] segments, (42b).

(42) a. ⟦{ʔɛ́(**ɛ́p**ʊmːakiwḁ⟧
á**íp**ommakiwa
a–[√**p**omm–Ø–aki]–Ø–wa
IPFV–[√transfer–*v*–AI]–IND–PRX
'the one transferring' (=37a)

b. * ⟦{ʔá(**p**ʊmːakiwḁ⟧
á**p**ommakiwa
a–[√**p**omm–Ø–aki]–Ø–wa
IPFV–[√transfer–*v*–AI]–IND–PRX
'the one transferring' (=37b)

The other types of root alternations serve the same function. Some of the root alternations above involve lexically listed allomorphs. I adopt the framework in Bonet et al. (2007); Mascaró (2007), where allomorphs are lexically organized as a partially ordered set. If no ordering is established, allomorphic choice is determined by the phonology and, in particular, by The Emergence of The Unmarked (McCarthy and Prince 1994b). The distribution of allomorphs is phonologically optimizing, because glide-initial allomorphs never occur at the left edge of the PPh (where they would violate the restriction against [-cons] segments), and stop-initial allomorphs never occur after a prefix (where they would violate the restriction against [-cont] segments). For cases such as √POMM 'buy', the /oxpomm/ allomorph is preferred over the /pomm/ allomorph, because /ohpomm/ avoids the restriction against [-cont] segments at the left edge of the PWd. The stop-initial allomorph occurs at the left edge of the PWd precisely when it aligns with the left edge of the PPh, e.g., when there are no prefixes. However, this too is phonologically optimizing because this allomorph creates an onsetful syllable at the left edge of the PPh.

To summarize this section, root alternations in Blackfoot show that glides are avoided at the left edge of the PPh and stops are avoided at the left edge of the PWd. In the next section, I show that the PPh and PWd constituents also have distinct right edges.

4.2. Distinct Right Edge Constraints

In this section, I show that the right edges of the PPh and PWd are distinct. The evidence for the right edge of the PPh is that an extra final consonant is allowed in this position, as I discussed in Section 3.2.2. Example (43) (repeated from (15)) shows that a PPh-final [t] can occur after a long [i], even though vowel length is neutralized before PPh-internal codas.

(43) [ʔa.p**íː**t]
apí**ít**
[ap–**ii**]–t–Ø
[sit–AI]–2SG.IMP–CMD
'sit!' (NC) (=15)

However, an extra final consonant is not allowed at the right edge of the PWd. The reason is that the entire PPh forms one domain for syllabification. Example (44) includes the same stem as in (43) followed by a consonant cluster /xp/. The /x/ (as allophone [ç] after [i]) is parsed to a coda position, and the stem-final vowel shortens, as discussed in Frantz (2017). (The vowel is written as long in the orthography to maintain transparency across the inflectional paradigm.)

(44) ⟦ni.tsíː.p**iç**.pɪn.naːn⟧
nitsíípi**ii**hpinnaan
nit–[ii\op–**ii**]–hp–nnaan
1–[IC\sit–**AI**]–IND–1PL
'we sat/stayed' (Frantz 2017, p. 6)

The evidence for the right edge of the PWd is that /k/-assibilation before an epenthetic vowel is blocked across the right edge of the *v*P/VP stem. The inverse suffix /-ok/ is the only /k/-final suffix which can occur at the right edge of the *v*P/VP stem. The examples below contain /-ok/ 'INV' followed by the plural agreement suffix [-ɪnːaːn] ∼ [-nːaːn] '1PL'. As discussed by Frantz (2017, p. 57), this suffix begins with a vowel after a consonant, (45), and a consonant after a vowel, (46).

(45) AFTER C
⟦nitsikákomɪmːok**ɪn**ːaːni̥⟧
nitsikákomimmok**inn**aani
nit–ik–[√akom–imm–ok]–Ø–**nn**aan–i
1–DEG–[√favor–by.mind.*v*–INV]–IND–**1PL**–3PL
'They love us (excl.).' (Frantz 2017, p. 61, (i))

(46) AFTER V
⟦nitsikákomɪmːʌ**n**ːaːni̥⟧
nitsikákomimma**nn**aani
nit–ik–[√akom–imm–aa]–Ø–**nn**aan–i
1–DEG–[√favor–by.mind.*v*–3OBJ]–IND–**1PL**–3PL
'We (excl.) love them.' (Frantz 2017, p. 57, (g))

The inverse suffix clearly ends in a consonant when it occurs before other suffixes, as shown in (47). In other words, the vowel [ɪ] is not part of the inverse suffix.

(47) ⟦nitsikákomɪmːok**ḁ**⟧
nitsikákomimmok**a**
nit–ik–[√akom–imm–ok]–Ø–**a**
1–DEG–[√favor–by.mind.TA–INV]–IND–**3**
'My daughter loves me.' (Frantz 2017, p. 61, (c))

The pattern of alternation for the '1PL' suffix is summarized below in (48a). Vowels are predictably short and lax before geminates (Derrick 2007; Elfner 2006; Weber 2020), so I have transcribed the vowel at the left edge of the '1PL' suffix as [i] below. Crucially, there are no suffixes which begin in a consonant in both positions, as in (48b). In other words, the alternation is compatible with a consonant-initial underlying form, /-nːaːn/ '1PL', where the [i] at the left edge is epenthetic and only occurs between consonants. However, epenthesis does not cause the stem-final /k/ to assibilate to [ks], unlike epenthesis within the stem. I take this as evidence for a prosodic boundary at the right edge of the stem, which prohibits [ks], even before epenthetic [i].

(48)

	After C		*After V*	*UR*	*Gloss*
a.	[-inːaːn]	∼	[-nːaːn]	/-nːaːn/	'1PL'
b.	*[-C]	∼	*[-C]		'PL'

The generalizations above can be accounted for under an analysis where there are two distinct prosodic constituents within the verbal complex, (49). The right edge of the PPh allows an extra consonant slot, and the right edge of the PWd prohibits [ks], even before an epenthetic vowel.

(49) DISTINCT RIGHT EDGES

No prefixes: $\quad$ STEM$)_{\text{PWd}}$ –suffixes $\}_{\text{PPh}}$
With prefixes: person–prefix*– STEM$)_{\text{PWd}}$ –suffixes $\}_{\text{PPh}}$

To summarize this section, an extra consonant slot is licensed at the right edge of the PPh, but not the right edge of the PWd. The right edge of the PWd can be diagnosed because /k/-assibilation to [ks] before epenthetic vowels is blocked across this boundary. In the next section, I discuss evidence beyond edge restrictions that confirms the PPh and PWd are distinct constituents.

4.3. Minimal Size Constraints and Obligatory Stress

In this section, I discuss two further phonological diagnostics from Weber (2020) which are not edge restrictions.[12] First, the PPh and the PWd have different minimal size constraints. Second, the PPh is the domain of obligatory stress, while the PWd is not.

As I discussed in Section 3.2.2, the smallest minimal PPh is CVVC or CVCC. A minimal noun is a bare (uninflected) noun stem, so the most minimal noun stem happens to be the same size as a PPh, which is either CVVC or CVCC, (50). Minimal verbal complexes consist of a verb stem plus at least one inflectional suffix, where the smallest inflectional suffixes are *-t* '2SG.IMP' and *-k* '2PL.IMP'. That means that the smallest VP verb stems, (51), happen to be CVV—the size of the most minimal verbal complex with the final suffix removed.

(50) MINIMAL NOUN STEMS

Size	*IPA*	*Orthography*	*Gloss*	
CVVC	[kóːn]	kóón	'ice'	(BB)
CVCC	[pónn]	pónn	'bracelet'	(BB)
	[kóʔs]	kó's	'dish, bowl'	(BB)

(51) MINIMAL VERB STEMS

Size	*IPA*	*Orthography*	*Gloss*	
CVV	[píː-]	píí-	'enter!'	(BB)
	[sóː-] ∼ [sowóː-]	sóó- ∼ sowóó-	'go to war!'	(BB)

These data suggest that minimal nouns are at once PWds and PPhs, which is why they are the size of a PPh. Minimal verb stems exhibit a CVV minimal size restriction, because they are parsed as a PWd and are distinct from the minimal PPh. As further evidence that the minimal PWd is CVV, consider the functional morphemes, /ki/ 'CONJ' and /tsa/ 'WH'. Normally, these procliticize to the following word or phrase, e.g., [kjámo] 'and that' (< /ki/ 'CONJ' + /amo/ 'DEM'), or [tsá:nɪˢtaʔpi:] 'how are things?' (< /tsa/ 'WH' + /aniˢtaʔpi:wa/ 'it is that way'). However, when they occur before a pause, the vowel is long, e.g., [ki:] 'CONJ' and [tsa:] 'WH'. Assuming these are parsed as PWds, the vowel lengthening can be seen as fulfilling the CVV minimal size restriction on the PWd.

The domain for obligatory stress is the PPh; primary stress does not necessarily fall within the PWd Weber (2016, 2020, forthcoming). Example (52a) contains a stem without any prefixes; the stress falls on the stem (underlined), e.g., within the PWd. Example (52b) contains a stem with one prefix; the stress falls on the prefix (underlined), e.g., outside the PWd. These examples show that stress falls within the PPh, but not necessarily within the PWd.

(52) a. STRESS WITHIN PWD
⟦ʔɪst**á**:wa̰⟧
isst**áá**wa
[√<u>isst–aa</u>]–Ø–wa
[√<u>wish–AI</u>]–IND–3
'she wants' [FR 272]

b. STRESS OUTSIDE PWD
⟦ʔiks**í**ms:ta:wa̰⟧
iks**í**msstaawa
√<u>iks**i**m</u>–[√sst–aa]–Ø–wa
√<u>secret</u>–[√wish–AI]–IND–3
'he thought' [FR 61]

To summarize this section, I have argued that the prosodic structure of the verbal complex is as in (53). The generalizations in the preceding sections can be accounted for if there is a Phonological Phrase (PPh) constituent which corresponds to the entire verbal complex, designated with { }, and a distinct Prosodic Word (PWd) constituent which corresponds to the stem, designated with ( ). Both constituents are motivated by distinct phonotactic restrictions on either edge. The PPh prohibits glides at its left edge and allows an extra consonant at its right edge. The PWd prohibits [-cont] segments at its left edge, and prohibits [ks] at its right edge, even before an epenthetic vowel. The PPh and PWd also have different minimal sizes, and the PPh is also the constituent with obligatory stress, while the PWd is not. Note that the PWd and the PPh cannot be analyzed as a single category with multiple projection Itô and Mester (2007, 2012), because they have distinct phonological generalizations (cf. arguments in Vogel 2009).

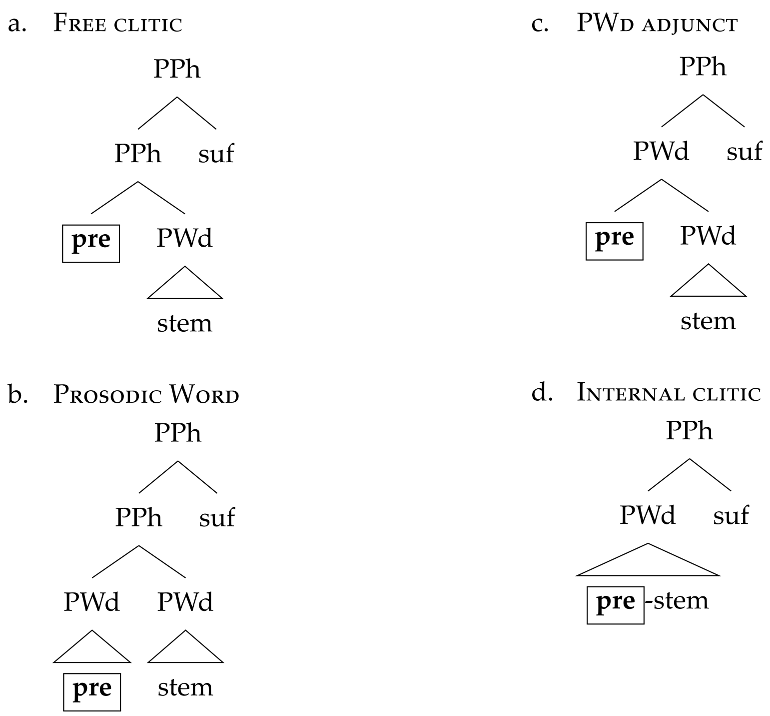
(53) PROSODY OF THE VERBAL COMPLEX
{person–prefix*– $(\text{STEM})_{\text{PWd}}$ –suffixes$\}_{\text{PPh}}$

The question still remains of how prefixes are prosodified into this structure. In the next section, I argue that prefixes are prosodic adjuncts to the PWd, creating a recursive PWd structure.

5. Evidence for Recursive Prosodic Words

There are four ways that a prefix could prosodify into the structure discussed in the previous section (Peperkamp 1997; Selkirk 1996; Werle 2009). First, the prefix may prosodify as a free clitic (a daughter to a PPh and a sister to a PWd), (54a). Second, as a separate PWd, (54b). Third, as a PWd adjunct (a daughter to a PWd and a sister to a PWd; this is called an 'affixal clitic' in Selkirk 1996), (54c). Fourth, as an internal clitic (inside the same PWd as the stem), (54d). The prefix in question is boxed in the trees below.

(54)



The four structures above make different predictions about the phonological generalizations that should hold for the prefix and the stem, as shown in Table 6. If the prefix is a free clitic, (54a), it should have the same left-edge restrictions as a PPh. In any of the other structures, the prefix should have the same left-edge restrictions as a PWd. If the prefix is a Prosodic Word, (54b), it should have the same right-edge restrictions and minimal size constraints as a PWd. In any of the other structures, the prefix should have neither the right-edge restrictions nor the same minimal size constraints of a PPh or a PWd. Finally, if the prefix is a free clitic, a Prosodic Word, or a PWd adjunct, (54a)–(54c), then the left edge of the stem should have the left-edge restrictions and minimal size constraints of a PWd. In contrast, if the prefix is an internal clitic, (54d), then the left edge of the stem should not have the same left-edge restrictions as a PWd, and the prefix and stem together should have the same minimal size constraints as a PWd.

Table 6. Comparison of prefixes and PWd diagnostics

	a. Free Clitic	b. Prosodic Word	c. PWd Adjunct	d. Internal Clitic
Prefix left edge = PPh?	✓	✗	✗	✗
Prefix right edge = PWd?	✗	✓	✗	✗
Prefix minimal size = PWd?	✗	✓	✗	✗
Stem left edge = PWd?	✓	✓	✓	✗
Stem minimal size = PWd?	✓	✓	✓	✗

In this section, I argue that the structure in (54c) is correct. Each prefix prosodifies as a PWd adjunct, creating a recursive PWd structure. I compare the properties of prefixes to PPh diagnostics in Section 5.1 and to PWd diagnostics in Section 5.2. In Section 5.3, I consider various prosodic structures and argue that the only compatible structure is one where the prefix is a PWd adjunct.

5.1. *Prefixes and the PPh: No Shared Phonological Properties*

In this section, I compare the prosodic correlates of prefixes to the prosodic correlates of a phonological phrase (PPh). I show that prefixes do not share any of the edge restrictions of a PPh, nor do they have the same minimal size constraints.

Prefixes do not share the same left-edge restrictions as the PPh. Glides are prohibited at the left edge of the PPh, but are tolerated at the left edge of a prefix. Consider the prefix √YIIST 'on back', which begins in an underlying glide /j/, (55). When the prefix stands at the left edge of a PPh, (55a), the glide does not surface. However, when another prefix precedes the prefix within the PPh the initial glide of the prefix surfaces, (55b). If glides were prohibited at the left edge of a prefix in all positions, then the long /iː/ in *yiist* 'on back' would coalesce with the preceding /a/ to form a type of long, mid front vowel (Weber 2020), as in (55c). This shows that as long as the left edge of the prefix does not coincide with the left edge of a PPh, there is no particular prohibition against glides at the left edge of a prefix.

(55) a. PREFIX AT LEFT EDGE
⟦ʔiːˢt͡sipʊ́mːatoːt⟧
iistsipómmatoot
√**y**iist–[√pomm–at–oo]–t–Ø
√on.back–[√transfer–*v*–TI]–2SG.IMP–CMD
'unload it from your back!' [FR 315]

b. PREFIX AFTER V
⟦niːtáʔpa**j**iːˢt͡sipʊmːatoːmḁ⟧
niitá'pa**y**iistsipommatooma
niita'p–a–√**y**iist–[√pomm–at–oo]–m–a
really–IPFV–√on.back–[√transfer–*v*–TI]–IND–3
'he started to take it off his back/body' [FR 315]

c. * ⟦niːtáʔpɛː**i**ˢt͡sipʊmːatoːmḁ⟧
niitá'p**aii**stsipommatooma
niita'p–a–√**y**iist–[√pomm–at–oo]–m–a
really–IPFV–√on.back–[√transfer–*v*–TI]–IND–3
'he started to take it off his back/body'

Prefixes do not share the same right edge restrictions as the PPh. An extra final consonant is allowed at the right edge of the PPh but not at the right edge of a prefix. The reason is that the entire PPh forms one domain for syllabification. There are two additional restrictions which hold at the right edge of the PPh, but not at the right edge of a prefix: (1) glottal stops are prohibited at the right edge of the PPh, and (2) non-alternating glides are allowed at the right edge of the PPh. Regarding glottal stops at the right edge, no PPh ends in a glottal stop. In contrast, prefixes such as √SSKA' 'shock', (56), can end in an underlying glottal stop, which always occurs in a pre-consonantal position on the surface (Frantz and Russell 2017; Peterson 2004). The verb stem without this prefix begins with the vowel [i], (57), and the glottal stop metathesizes with this vowel, feeding vowel coalescence, in order to occur just before the following consonant [p], as shown in (56).

(56) ⟦ʔsːkéj**ʔ**papʊmːḁ⟧
sskáí**'**papomma
√sska**'**–[√ipap–o]–mm–a
√shock–[√emit.burst–II]–IND–3
'the lightning really flashed' [FR 64]

(57) cf. ⟦ʔipapʊmːḁ⟧
ipapómma
[√ipap–o]–mm–a
[√emit.burst–II]–IND–3
'there was lightning' [FR 83]

Regarding glides at the right edge, a PPh may end in a non-alternating glide. Totsinámm is a speaker of the Káínai dialect, and in her speech a PPh can end in a non-alternating [j] but no PPh ends in a [w]. In the example below, (58), a [j] occurs before a PPh that begins in an underlying mid, back, round vowel [ɔ]. As I discuss below, a prefix-final [j] never occurs before back vowels.

(58) (ʔitɔ́xʷtoji amí)$_{PPh}$ (ʔiːmaxkḭna**j**)$_{PPh}$
iitáóhtoyii amí iimahkihkina**y**
ii\it–a–[√yooht–o–ii]–Ø–wa am–i [ii\√omahk–ihkin–aa]–**yi**
ic\then–ipfv–[√hear–ta–3sub]–ind–3 dem–obv [ic\√big–hair–ai]–**obv**
(ʔɔ́xʷkomiːnɛː)$_{PPh}$
áóhkomiinai.
a–[√ohkom–i]–Ø–yini=ai
ipfv–[√bellow–ai]–ind–3obv=obv.sg
'[He was still picking and] he heard this goat.'
(Pear Story, told by Totsinámm (BB))

Some prefixes end in a glide whose form depends on the following vowel. A prefix-final glide is always [j] before [i], [ç], or [s], and the glide is [w] before any other sound. In the examples below, the glide at the right edge of √ksiw 'at ground level' is [j] before a following [ç], (59), and [w] before a following [ɛː] (60a), [a] (60b), or [o] (60c).

(59) ⟦ʔiːksí**j**çpijiwḁ⟧
iiksí**y**ihpiyiwa
ii\√ksi**w**–[ihpi–yi]–Ø–a
ic\√ground.level–[dance–ai]–ind–3
'he danced low' [FR 66]

(60) a. ⟦ʔiˢtsiksi**w**ɛ́ːnakaʔsit⟧
istsiksi**w**áínaka'sit
ist–√ksi**w**–a–[inak–a'si]–t–Ø
there–√ground.level–ipfv–[roll–ai]–2sg.imp–cmd
'roll there!' [FR 66]

b. ⟦ksi**w**awakaːsiwḁ⟧
ksi**w**awakaasiwa
√ksi**w**–[awa–ka–a'si]–wa
√ground.level–[meander–leg–ai]–prx
'spider' (lit. 'ground-level deer') [FR 142]

c. ⟦kso**w**óxʷtsi⟧
kso**w**óóhtsi
√ksi**w**–ooht–i
√ground.level–ward–in.sg
'down low' [FR 142]

In other words, the glides [j] and [w] never contrast at the right edge of a prefix, and instead the choice is conditioned by the following segment. This differs from the distribution of [j] and [w] at the right edge of a PPh, where they are not conditioned by the following segment.

Prefixes do not have the same minimal size constraints as a PPh. Prefixes can be as small as V, CV, or VC,[13] even though the smallest minimal PPh is CVVC or CVCC.

(61) Minimal prefixes

V	a-	'ipfv'
CV	sa-	'out'
VC	on-	'hurry'

Prefixes do not have obligatory stress like a PPh. In example (52) I showed that stress may fall on a stem, or on a prefix if one exists. The example (62) below contains the same stem with several prefixes; the stress falls on only one of the prefixes (underlined). This example shows that stress is not obligatory on the stem (PWd), nor on each prefix. Instead, stress is only obligatory within the verbal complex (PPh), with the location determined by the morphological composition of the verb.

(62) STRESS ON ONE OF MULTIPLE PREFIXES
[ʔitanɪ́ˢtsɪksɪmʔsːtaja]
itan**í**stsiksimsstaya
it–$\underline{\sqrt{\text{anist}}}$–$\sqrt{}$iksim–[$\sqrt{}$sst–aa]–Ø–yi=aawa
then–$\underline{\sqrt{\text{manner}}}$–$\sqrt{}$secret–[$\sqrt{}$wish–AI]–IND–3PL=PRX.PL
'they decided thus' (BB, 2013-02-13, 'Old Woman in the Cold')

In summary, prefixes do not share any of the properties of a PPh, as shown in Table 7.

Table 7. Comparison of prefixes and PPh diagnostics.

Diagnostic	Prefix	PPh
Glides prohibited at left edge?	✘	✓
Glottal stop prohibited at right edge?	✘	✓
Glides contrast at right edge?	✘	✓
Minimal size?	V, CV, VC	CVVC, CVCC
Obligatory stress?	✘	✓

I now turn to a comparison of prefixes against the properties of the PWd.

5.2. Prefixes and the PWd: Only Left-Edge Restrictions Are Shared

In this section, I compare the prosodic correlates of prefixes to the prosodic correlates of a prosodic word (PWd). I show that prefixes share the same prohibition against stops at the left edge as a PWd, but they do not share the same right-edge restrictions, nor the same minimal size constraints.

Prefixes have the same left-edge restrictions as the PWd. Stops are prohibited at the left edge of the PWd (as long as that edge is distinct from the left edge of a PPh). This restriction is reinforced by many different kinds of root alternations, which avoid stops at the left edge of a PWd. For example, the quantifier $\sqrt{}$KAN ∼ $\sqrt{}$OHKAN 'all' begins with the obstruent [k] at the left edge of the PPh, as in (63a), but with [oxʷk] when the root is preceded by a prefix within the same PPh, as in (63b). As discussed above, the distribution of allomorphs is phonologically optimizing. In particular, the [oxʷkan] allomorph avoids stops at the left edge of the PWd.

(63) a. ROOT AT LEFT EDGE
⟦**k**anáʔpsːik⟧
kaná'pssik
[$\sqrt{}$**k**an–a'pssi]–k–Ø
[$\sqrt{}$**all**–be.AI]–2PL.IMP–CMD
'you (pl.) gather for an event!' [FR 164]

b. Root after a prefix
⟦ʔâːk**xʷk**anáʔpsːijaːwḁ⟧
áak**ohk**aná'pssiyaawa
aak–[√**ohk**an–a'pssi]–k–Ø
fut–[√**all**–be.ai]–2pl.imp–cmd
'they will gather for a sporting event' [FR 164]

The quantifier √kan ∼ √ohkan 'all' can also occur to the left of a stem as a prefix, where it exhibits the same type of allomorphy. This shows that the same restriction against stops holds at the left edge of a prefix, and it is maintained by the same types of alternations. The quantifier begins with [oxʷk] after a consonant, (64a), and not with [k], (64b). There must be a restriction against stops at the left edge of the prefix in order to explain why the [oxʷkan] allomorph occurs in this position. The stem in (64) is shown alone in (65) to show that √kan 'all' is external to the stem in (64).

(64) Prefix after C
a. ⟦ʔâːk**xʷk**ánsːʌmːawḁ⟧
áak**ohk**ánssammawa
aak–√**ohk**an–[√ss–amm–a]–Ø–wa
fut–√**all**–[√thus–watch.ta–3obj]–ind–3
'she will be watched by all' [FR 163]

b. * ⟦ʔâːksi**k**ánsːʌmːawḁ⟧
áaksi**k**ánssammawa
aak–√**k**an–[√ss–amm–a]–Ø–wa
fut–√**all**–[√thus–watch.ta–3obj]–ind–3
'she will be watched by all'

(65) cf. ⟦ʔɪsːʌ́mːiːwáji̥⟧
issámmiiwáyi
[√iss–amm–ii]–Ø–w=ayi
[√thus–watch.ta–3sub]–ind–3=obv.sg
'he looked at him' [FR 263]

The same prefix √kan ∼ √ohkan 'all' also begins with [oxʷk] after a vowel, (66a). There must be a restriction against stops at the left edge of the prefix in order to explain why the [kan] allomorph does not occur in this position, (66b). The same stem in (66) is shown again in (67) without any prefixes; this shows it is a full stem and that √kan ∼ √ohkan 'all' truly occurs in a prefix position.

(66) Prefix after V
a. ⟦ʔ**ɔ́xʷk**anokɪmːawḁ⟧
á**óhk**anokimmawa
a–√**ohk**an–[√ok–imm–a]–Ø–wa
ipfv–√**all**–[√bad–by.mind.ta–3obj]–ind–3
'he is scolded by all' [FR 163]

b. * ⟦ʔá**k**anokɪmːawḁ⟧
á**k**anokimmawa
a–√**k**an–[√ok–imm–a]–Ø–wa
ipfv–√**all**–[√bad–by.mind.ta–3obj]–ind–3
'he is scolded by all'

(67) cf. ⟦ʔâːkokɪmːiːwaji̥⟧
áakokimmiiwáyi
aak–[√ok–imm–ii]–Ø–w=ayi
FUT–[√bad–by.mind.TA–3SUB]–IND–3=OBV.SG
'she will scold him' [FR 184]

Prefixes do not share the same right edge restrictions as the PWd. A regular process of /k/ assibilation to [ks] before epenthetic [i] is blocked across the right edge of the PWd, as discussed above. Turning now to prefixes, a /k/ at the right edge of a prefix assibilates before an epenthetic vowel [i]. For example, the prefix √ISTTOHK 'thin' can precede an obstruent-initial stem such as [soka'sim] 'shirt', (68).[14] When it does, an epenthetic vowel [i] occurs between the final /k/ of *isttohk* 'thin' and the initial /s/ of 'shirt'. The final /k/ of *isttohk* 'thin' assibilates to [ks] before the epenthetic vowel. Example (69) confirms that 'shirt' is truly obstruent initial and that the [i] at the left edge must be epenthetic.[15]

(68) ⟦ʔɪˢtːx̥ʷ<u>ks</u>**í****s**okaʔsimi⟧
isttoh<u>ks</u>**is**oka'simi
√isttoh**k**–[**s**oka'sim]–i
√thin–[shirt.*n*]–IN.SG
'shirt' [FR 109]

(69) cf. ⟦**s**okáʔsimi⟧
soká'simi
[**s**oka'sim]–i
[shirt.*n*]–IN.SG
'shirt, dress, outer garment' (BB)

This process of prefix-final /k/ assibilation before an epenthetic vowel is similar to the behavior of a /k/ at the right edge of a morpheme inside the PWd, but unlike the behavior of a PWd-final /k/.

Prefixes do not have the same minimal size constraints as a PWd. Prefixes can be as small as V, CV, or VC, repeated below, even though the smallest minimal PWd is CVV.

(70) MINIMAL PREFIXES
V a- 'IPFV'
CV sa- 'out'
VC on- 'hurry'

In summary, prefixes share the same left-edge restrictions as a PWd, but not the right-edge restrictions, nor the same minimal size constraints, as summarized in Table 8.

Table 8. Comparison of prefixes and PWd diagnostics

Diagnostic	Prefix	PWd
Stops prohibited at left edge?	✓	✓
Right edge [k] occurs before epenthetic [i]?	✘	✓
Minimal size?	V, CV, VC	CVV

Having compared prefixes to the properties of a PPh and a PWd, I next consider the four different ways that a prefix could prosodify into a PPh, as discussed at the beginning of this section.

5.3. Prefixes and Prosody: Prefixes Are Prosodified as a PWd Adjunct

The four trees in (54) are repeated in (71) using bracket notation. Not all of these structures are compatible with the Blackfoot data, given the phonological properties of prefixes discussed in the preceding two sections. The structure in (a) is not possible because the left edge of a prefix does not have the same left-edge restrictions as a PPh. The structure in (b) is not possible because a prefix does not have the same right-edge restrictions nor the same minimal size constraints as a PWd. However, the structures in (c) and (d) are both possible—they both predict that the left edge of a prefix should display the left-edge restrictions of a PWd, but not any other properties of a PWd.

(71) $_{\mathrm{CP}}$[prefix $_{v\mathrm{P}}$[√ROOT–v–V]$_{v\mathrm{P}}$ –I^0–C^0]$_{\mathrm{CP}}$

a. *$_{\mathbf{PPh}}$(prefix– $_{\mathrm{PWd}}$(√ROOT–v–V)$_{\mathrm{PWd}}$ –I^0–C^0)$_{\mathbf{PPh}}$ (free clitic)
b. *$_{\mathrm{PPh}}$($_{\mathbf{PWd}}$(prefix–)$_{\mathbf{PWd}}$ $_{\mathrm{PWd}}$(√ROOT–v–V)$_{\mathrm{PWd}}$ –I^0–C^0)$_{\mathrm{PPh}}$ (prosodic word)
c. $_{\mathrm{PPh}}$($_{\mathbf{PWd}}$(prefix– $_{\mathbf{PWd}}$(√ROOT–v–V)$_{\mathbf{PWd}}$)$_{\mathbf{PWd}}$–I^0–C^0)$_{\mathrm{PPh}}$ (PWd adjunct)
d. $_{\mathrm{PPh}}$($_{\mathbf{PWd}}$(prefix– √ROOT–v–V)$_{\mathbf{PWd}}$ –I^0–C^0)$_{\mathrm{PPh}}$ (internal clitic)

The only difference between (c) and (d) concerns the prosodification of the stem. The structure in (c) predicts that the left edge of a stem-internal root should have the same restrictions as the left edge of a PWd, while (d) does not. Of course, the unusual restrictions at the left edge of roots are what motivated a prosodic edge in this position in the first place. Indeed, there are examples which show two sites of epenthesis within a single word: one at the left edge of the stem, and one at the left edge of a prefix. For example, the prefix √EXTREME begins with [ik] after a prefix in (72), even though the same root begins with a stop [k] at the left edge of the PPh in (73). Similarly, the root √SSTO 'cold' begins with [ist] after a vowel in (72), even though the same root begins with [st] at the left edge of a PPh in (74).[16]

(72) ⟦ʔâːks**ik**otski**ɛ́s**tojiwḁ⟧
áaks**ik**otskiá**íss**toyiwa
aak–√**k**otski–a–[√**ss**to–yi]–Ø–wa
FUT–√extreme–IPFV–[√cold–II]–IND–3
'it will be extremely cold' [FR 139]

(73) cf. ⟦**k**oːtskiɛ́ːsajâːkiːwḁ⟧
kootskiáísayáakiiwa
√**k**ootski–a–[[√say–i]–[aakii]]–Ø–wa
√extreme–IPFV–[[√lie–AI]–[woman]]–IND–3
'she is a terrible liar' [FR 139]

(74) cf. ⟦ʔ(ɪ)**s**tojíːwḁ⟧
(i)**ss**toyííwa
[√**ss**to–yii]–Ø–wa
[√cold–II]–IND–3
'it is/was cold' [FR 274]

In the example below, the prefix √OHKAN begins with [oxʷk] after a prefix in (75), even though the same root begins with a stop [k] at the left edge of the PPh in (76). Similarly, the root √SAPA'KOT 'stack' begins with [is] after a vowel in (75), even though the same root begins with [s] at the left edge of a PPh in (77).

(75) ⟦stám**xʷk**ánɛː**s**apaʔkotsːtoːtaːwḁ⟧
stám**ohk**ána**is**apa'kotsstootaawa
stam–√**ohk**an–a–[√**s**apa'kot–sstoo]–t–Ø=aawa
just–√all–IPFV–[√stack–put.TI]–2SG.IMP–CMD=PRX.PL
'stack all of them (e.g., chairs)! [FR 241]

(76) cf. ⟦**k**anáʔps:ik⟧
kaná'pssik
[√**k**an–a'pssi]–k–Ø
[√**all**–be.AI]–2PL.IMP–CMD
'you (pl.) gather for an event!' (=63a)

(77) cf. ⟦**s**apáʔkotxʷto:t⟧
sapá'kotohtoot
[√**s**apa'kot–ohtoo]–t–Ø
[√stack–put.TI]–2SG.IMP–CMD
'layer it (e.g., the material that you are sewing)!' [FR 241]

I conclude that the structure in (54c) and (71c) is the only compatible structure: prefixes are prosodified as PWd adjuncts. For clarity, the prosodic structures for (72) and (75) are shown below in (78) and (79), respectively.

(78) ((ʔâ:ks (**ik**otski (**ɛ́** (**s**toji)$_{PWd}$)$_{PWd}$)$_{PWd}$)$_{PWd}$.wḁ)$_{PPh}$
áaks**ik**otskiá**íss**toyiwa
aak–√**k**otski–a–[√**ss**to–yi]–Ø–wa
FUT–√extreme–IPFV–[√cold–II]–IND–3
'it will be extremely cold' (=72)

(79) ((stám (**x**ʷ**k**án (**ɛ** (**ɛs**apaʔkots:to:ta:)$_{PWd}$)$_{PWd}$)$_{PWd}$)$_{PWd}$ wḁ)$_{PPh}$
stám**ohk**ána**is**apa'kotsstootaawa
stam–√**ohk**an–a–[√**s**apa'kot–sstoo]–t–Ø=aawa
just–√all–IPFV–[√stack–put.TI]–2SG.IMP–CMD=PRX.PL
'stack all of them (e.g., chairs)! (=75)

The question remains of *why* prefixes prosodify as PWd adjuncts. As I discussed in Section 2.2, many researchers argue that PWd recursion is limited to specific morphosyntactic constructions (Kabak and Revithiadou 2009) or is lexically specified (Bennett 2018; Tyler 2019). In the next section, I show that there are no consistent syntactic or lexical correlates with the recursive PWd structure. Instead, I argue that PWd recursion is a much more general process and affects all prefixes, similar to recursion in Dutch Booij (1995, 1996); Peperkamp (1997).

5.4. Syntactic and Lexical Properties Do Not Motivate Prosodic Word Recursion

Kabak and Revithiadou (2009) argue that that recursion is not an inherent property of phonology, but arises when prosody mirrors recursive structures at the morphosyntactic level, such as clitic adjunction, phrasal verbs, and compounding. If this is true, then PWd recursion will only arise for prefixes which create such structures, and other types of prefixes will have a different prosody. There is a potential difference in prosody between morphosyntactic adjuncts and heads. The reason is that only morphosyntactic adjuncts create a recursive syntactic category, while heads project their own category. Under this hypothesis, if the prefix is an adjunct, it creates a recursive *v*P/VP, and it prosodifies as a prosodic adjunct to create a recursive prosodic structure. If the prefix is a head F^0, then it projects an FP instead of a recursive *v*P/VP and there is no such requirement on prosody. A stronger version of the hypothesis might be that only syntactic adjuncts are even *allowed* as prefixes, and that every prefix is prosodified as a PWd adjunct. However, there is no evidence that this is the case.

Below, I have collected a sample of prefixes which shows the wide range of their meanings and categories. In all cases, the form on the left occurs at the left edge of a PPh and the form in the middle occurs after a prefix. The meanings include (80) aspectual and modal operators, (81) negatives and focus operators, (82) numerals and quantifiers, (83) control verbs (verb-like morphemes which take a VP stem as their complement), (84) relative roots (adpositional elements which add an oblique argument), plus a wide array of modifiers, including various (85) aspectual, degree, and other event modifiers, and (86) locative (including more nominal-like temporal and spatial locatives, such as 'at night' and 'forest'), directional, and positional modifiers.

(80) Aspect and modal operators

a-	-ya-	'ipfv'
ohkott-	-ohkott-	'able'

(81) Negative and focus operators

saw-	-isaw-, -ssaw-	'neg'
kaak-	-ikak-	'foc'

(82) Numerals and quantifiers

naat-, niist-	-ist-	'two'
kan-	-ohkan-	'all'

(83) Control verbs

omat-	-omat-	'start to'
mato-	-oto-	'go to'
ssaak-	-issaak-, -sssaak-	'try to'

(84) Relative roots

ist-, st-	-it-	'then, there'
oht-, t-	-oht-	'from, source, purpose'
ohp-, p-	-ohp-	'with'

(85) Aspectual, degree, event modifiers

ksist-	-iksist-	'finish'
sam-	-isam-	'long' (in time)
kam-	-ikkam-	'fast'
maohk-	-omaohk-	'red'
simi-	-isimi-	'secretly, on the sly'
mak-	-ok-	'bad'

(86) Locative, directional, and positional modifiers

sipi-	-isipi-	'at night'
isttss-	-isttss-	'forest'
pisst-	-ipsst-	'inside'
poohsap-	-ipoohsap-	'towards speaker'
niipo-	-ipo-	'upright'

The categorization of prefixes into the types above is based primarily on translation rather than rigorous semantic and syntactic tests. However, it seems unlikely that these are all syntactic adjuncts, since many of these correspond to heads and semantic operators in other languages. As shown above, the forms which occur after a prefix involve the same types of processes (e.g., [i]-epenthesis, /ox/ accretion, etc.) regardless of whether the prefix is a modifying adjunct or not. I conclude that syntactic adjunction does not motivate prosodic word adjunction.

Bennett (2018) and Tyler (2019) find that individual morphemes may subcategorize for different prosodic constituents. If this is true, then there should be an arbitrary set of prefixes which derive PWd recursion, and other prefixes will have a different prosody. There is no evidence that prosodic adjunction is lexically specified for individual morphemes in Blackfoot, contrary to the findings in Bennett (2018) for Kaqchikel Mayan and Tyler (2019) for English. To my knowledge, the prosodic correlates I discussed in the previous section hold for *all* prefixes and for all combinations of prefixes and stem. The only property held in common is linearization: every prefix to the left of a PWd prosodifies as a PWd adjunct. I conclude that syntactic and lexical properties are not responsible for this prosodic structure, so prosodic constraints must be responsible.

In the next section, I examine three theories of correspondence within the Prosodic Phonology framework to determine whether they account for Blackfoot prosodic structure. I raise several properties that must hold for any theory or correspondence in order to account for multiple recursion.

6. Analysis of Correspondence

In the preceding sections, I used phonological evidence to argue that Prosodic Word recursion exists in Blackfoot: the stem prosodifies as a PWd and each prefix prosodifies as a PWd adjunct. I also used independent syntactic evidence to argue that these prosodic constituents correspond to phrasal syntactic structures and cannot be reduced to a simplex or complex head. In this section, I examine three theories of Prosodic Word correspondence which have been proposed in the literature to see which can account for multiple recursion in Blackfoot.

After giving an overview of the theories in Section 6.1, the following three sections discuss properties which are necessary for any theory to account for multiple recursion. First, I reiterate in Section 6.2 that the correspondence relations must hold of a syntactic phrase rather than a complex head. Second, I argue in Section 6.3 that it is insufficient for only the *v*P/VP phase to correspond to a PWd; instead, each phrasal constituent above the *v*P/VP must also correspond to a PWd. Third, I show in Section 6.4 that a *Recursivity constraint is necessary in order to derive multiple recursion.

6.1. Overview of Theories and Constraints

The following are the three theories:

1. Alignment Theory (McCarthy and Prince 1994a; Selkirk 1996; Werle 2009)
2. Wrap Theory (Kabak and Revithiadou 2009; Truckenbrodt 1999)
3. Match Theory (Selkirk 2011)

All of the theories are couched in Optimality Theory (McCarthy and Prince 1994a; Prince and Smolensky 1993), such that these correspondence relationships are violable. In this way, the three algorithms can account for mismatches from syntactic structure which are based on phonological properties, such as binarity, or stress or tone features (see Nespor and Vogel 2007).

6.1.1. Alignment Theory

Selkirk (1996) and Werle (2009) used Alignment Theory (McCarthy and Prince 1994a), along with the markedness constraints Exh and *Rec, to derive the full typology of prosodic clitics.[17] The Alignment constraints in Selkirk (1996) specifically require the edges of a *lexical category word* and a Prosodic Word to align, as below. (These constraints will be redefined for evaluation in a later section.)

(87) Align(Lex^0, L/R, PWd, L/R)
For every Lex^0, there is a prosodic word, PWd, such that the left/right edge of Lex^0 and the left/right edge of the PWd align.

The theory in Selkirk (1996) also includes markedness constraints which regulate prosodic structure. Selkirk (1996) argues that the earlier Strict Layer Hypothesis Beckman and Pierrehumbert (1986); Nespor and Vogel (2007); Pierrehumbert and Beckman

(1988); Selkirk (1981, 1984) should be split into a set of separate and violable constraints (e.g., Inkelas 1990; Itô and Mester 2003; Nespor and Vogel 2007; Selkirk 1996). She posits that Layeredness and Headedness are inviolable and presumably part of Gen, while Exhaustivity and *Recursivity are violable and part of Con. Exhaustivity prohibits 'level-skipping' within prosodic structure, while *Recursivity prevents recursive prosodic constituents. The constraint definitions below are modeled on Werle (2009), who notes that Exhaustivity and *Recursivity both define families of constraints. The Exhaustivity constraints subcategorize for the superordinate and subordinate prosodic constituents.[18]

(88) Exhaustivity(p,q)
Assign a violation for every prosodic constituent q, $q < p - 1$, which is dominated by a prosodic constituent p. (After Werle 2009, p. 23)

(89) *Recursivity(p)
Assign a violation for every prosodic constituent p which dominates a prosodic constituent p. (After Werle 2009, p. 23)

6.1.2. Wrap Theory

In order to derive recursion at the Phonological Phrase level, Truckenbrodt (1995, 1999) argues that a constraint such as Wrap-XP, (90), must be added to Con. This constraint is satisfied as long as each XP is contained within *some* phonological phrase.

(90) Wrap-XP
Each XP is contained in a phonological phrase. (Truckenbrodt 1999, p. 228)

Recursive phonological phrases are derived when Wrap-XP and phrasal Alignment constraints (Selkirk 1995) dominate *Recursivity (*Rec) (Selkirk 1996). For example, the following partial ranking is used in Truckenbrodt (1999) to derive a recursive phonological phrase in Kimatuumbi. Candidate (a) violates an alignment constraint, because the right edge of XP_2 does not align with the right edge of a phonological phrase. Candidate (b) violates Wrap-XP, because XP_1 is not contained within a phonological phrase. The optimal candidate (c) satisfies both constraints by creating a recursive phonological phrase structure, which incurs a violation of the lower-ranked constraint, *Rec. I have also included a candidate (d) which is suboptimal because it incurs additional violations of *Rec without satisfying any higher-ranked constraints.

(91) Recursion derived with Wrap-XP (Truckenbrodt 1999)

$[X_1\ XP_2\ XP_3\ ]_{XP_1}$	Align-XP,R	Wrap-XP	*Rec	Align-XP,L
a. $(X_1\ XP_2\ XP_3\ )_{PPh}$	XP_2!			XP_2!XP_3
b. $(X_1\ XP_2\ )_{PPh}\ (XP_3\ )_{PPh}$		XP_1!		XP_2
☞ c. $(\ (X_1\ XP_2\ )_{PPh}\ XP_3\ )_{PPh}$			*	XP_2XP_3
d. $(\ (X_1\ XP_2\ )_{PPh}\ (XP_3\ )_{PPh}\ )_{PPh}$			**!	XP_2

Wrap Theory was extended to the Prosodic Word level by Kabak and Revithiadou (2009), who define Wrap as in (92). (This constraint will be redefined for evaluation in a later section.)

(92) Wrap
Each X^0/XP is contained in its own PW/PPh, respectively.
(Kabak and Revithiadou 2009, p. 116)

This is quite different than the original definition in Truckenbrodt (1995, 1999). Instead of simply requiring syntactic constituents to be contained in *some* prosodic constituent, this definition requires each syntactic constituent to be contained in a *separate* ('its own') prosodic constituent. This has the effect of mirroring morphological or syntactic constituency in the prosodic structure, much like Match Theory does at the Phonological Phrase level (Selkirk 2011; described below).

At the phrasal level, this definition leads to different predictions than the original definition. The tableau below has the same candidates as above, but evaluates WRAP-XP using the definition from Kabak and Revithiadou (2009). Here, candidate (a) incurs two violations of WRAP-XP because although XP_1, XP_2, and XP_3 are contained within *some* phonological phrase, they are not contained in distinct phonological phrases. Similarly, candidate (c) incurs a violation of WRAP-XP because XP_1 and XP_3 are not contained in distinct phonological phrases. The optimal candidate with this definition is (d), which is not the correct phrasing for Kimatuumbi.

(93) RECURSION DERIVED WITH WRAP-XP (Kabak and Revithiadou 2009)

$[X_1\ XP_2\ XP_3\ ]_{XP_1}$	ALIGN-XP,R	WRAP-XP	*REC	ALIGN-XP,L
a. $(X_1\ XP_2\ XP_3\ )_{PPh}$	$XP_2!$	$XP_2!XP_3$		$XP_2!XP_3$
b. $(X_1\ XP_2\ )_{PPh}\ (XP_3\ )_{PPh}$		$XP_1!$		XP_2
☹ c. $(\ (X_1\ XP_2\ )_{PPh}\ XP_3\ )_{PPh}$		$XP_3!$	*	XP_2XP_3
☞ d. $(\ (X_1\ XP_2\ )_{PPh}\ (XP_3\ )_{PPh}\ )_{PPh}$			**	XP_2

However, Kabak and Revithiadou (2009) propose this alternative definition of WRAP-XP based on empirical generalizations at the Prosodic Word level—not at the Phonological Phrase level. It is possible that this kind of definition is necessary at the PWd level, even though it is incorrect at the PPh level. For this reason, I evaluate a version of their constraint below.

6.1.3. Match Theory

Match Theory (Selkirk 2011) represents a sharp break from earlier theories of syntax–prosody correspondence, such as Align-XP Selkirk (1986, 1995) and Wrap Theory Truckenbrodt (1995, 1999). Rather than assuming that prosodic structure has different properties than syntactic structure, with algorithms designed to 'flatten' syntactic structure into a well-formed prosodic representation, Selkirk (2011) assumes that prosodic structure exactly matches syntactic structure by default. As a consequence, recursive and weakly layered structures are typical, and there is no *REC markedness constraint in the theory. Other types of prosodic well-formedness constraints exist though, such as those requiring binarity.

Match Theory defines a family of correspondence constraints (MATCH) which require exact correspondence between syntactic constituents and prosodic constituents of particular types, represented informally in (94). Because phonological constraints in OT are evaluated in parallel, this predicts that the default correspondence between syntactic and prosodic structure can be violated in order to satisfy any higher-ranked well-formedness constraints.

(94) SYNTAX-PROSODY CORRESPONDENCES IN MATCH THEORY

'syntactic clause'	([Comp, C] or [Comp, Force])	$\longleftrightarrow$	ι	(intonational phrase)
'syntactic phrase'	(XP)	$\longleftrightarrow$	φ	(phonological phrase)
'syntactic word'	(Lex^0)	$\longleftrightarrow$	ω	(prosodic word)

Selkirk (2011) originally defined MATCH constraints by requiring both edges of syntactic and prosodic constituents to align. Elfner (2012, p. 28) later defined MATCHPHRASE more precisely to evaluate correspondence between sets of terminal nodes dominated by syntactic constituents, as in (95). This has the effect of ignoring any phonologically null terminal nodes, such as traces.

(95) MatchPhase
Suppose there is a syntactic phrase (XP) in the syntactic representation that exhaustively dominates a set of one or more terminal nodes α. Assign one violation mark if there is no phonological phrase (φ) in the phonological representation that exhaustively dominates all and only the phonological exponents of the terminal nodes in α. (Elfner 2012, p. 28)

This type of constraint definition was extended to the Prosodic Word level by Guekguezian (2017). He also argues that Match constraints must distinguish between overparsing (including material in the PWd which was not part of the phonological representation of the X_0) and underparsing (excluding material from the PWd which was part of the phonological representation of the X_0). This results in two related constraints below. (These constraints will be redefined for evaluation in a later section.)

(96) MatchWord
a. MatchWord(All)

Suppose there is an X_0 in the input syntactic representation that exhaustively dominates a set of morphemes α. Assign a violation mark for every segment that (1) is an exponent of a morpheme in α and (2) is *not* dominated by a PWd in the output phonological representation corresponding to the X_0.

b. MatchWord(Only)

Suppose there is an X_0 in the input syntactic representation that exhaustively dominates a set of morphemes α. Assign a violation mark for every segment that (1) is an exponent of a morpheme *that is not* in α and (2) is dominated by a PWd in the output phonological representation corresponding to the X_0. (Guekguezian 2017, p. 22, (14))

Match Theory also includes a set of well-formedness constraints on prosodic structure. This set does not include *Rec, but does include constraints such as BinMin, which requires at least two prosodic words in every phonological phrase. (This constraint will be redefined for evaluation in a later section.)

(97) BinMin (Bin)
A PPh must consist of at least two prosodic words. (Inkelas and Zec 1995)

Now that I have briefly described all three theories of Prosodic Word correspondence, I turn in the next three subsections to three necessary properties of any theory of PWd correspondence for Blackfoot.

6.2. *The Phrasal vP (Not a Lex^0 Head) Corresponds to a PWd*

All three theories described in the previous section assume that a PWd corresponds by default to a syntactic X^0 head, or sometimes specifically a lexical category word (Lex^0). However, I argued in Section 4, on the basis of edge restrictions and patterns of morpheme alternation, that the PWd in Blackfoot corresponds to a *v*P stem. This suggests that the correspondence constraints should be redefined to refer to the *v*P rather than a syntactic head in order to account for Blackfoot.

The same conclusion can be reached by considering what kind of constituent in Blackfoot instantiates a 'lexical category word'. A lexical category word is often interpreted as a terminal element X^0 in X-bar theory (Jackendoff 1977) which is lexically categorized, e.g., N^0, V^0, or A^0. However, in the syntactic analysis given in Section 3.1, where categorization occurs by merging a functional categorizing head, it is clear that a 'lexical category word' must be more rigorously defined for Blackfoot. There are three plausible interpretations: (a) the √ROOT, which contributes the main 'lexical' or 'concrete' meaning to the verb; (b) the V^0 head, which is a syntactic terminal element and which introduces the internal argument; or (c) the entire *v*P/VP. For Blackfoot, only (c) can be correct.[19] Neither the √ROOT nor the V^0 head have the same prosodic correlates as a verb or noun.[20] For example, as discussed above, the smallest verbs and nouns are either CVCC or CVVC (Weber 2020), but roots can be much smaller, such as CV *sa*- 'out' or VC *on*- 'hurry', and V^0 can be as small as a single vowel. The same is true of a √ROOT which occurs as a prefix; as discussed above, these prosodify as PWd adjuncts rather than as full PWds. I conclude the Prosodic Word in Blackfoot must correspond to a multimorphemic syntactic *v*P or VP phrase, rather than to any of its constituent parts.

These findings raise the possibility that the Phonological Phrase *and* the Prosodic Word could be defined by correspondence to distinct phrasal syntactic constituents: the *v*P/VP and the CP, respectively. Yet even this requires some interpretation for Blackfoot because the √ROOT is a phrasal adjunct which merges *outside* of the *v*P/VP and yet is included in the PWd. I posited above that the √ROOT is required to restrict the denotation of a light verbal *v*P/VP, essentially by providing a semantic predicate. Perhaps the syntactic *v*P/VP phase (or the prosodic PWd) is semantically driven and does not 'close' until the √ROOT has merged and a semantic predicate is formed. The syntactic units of correspondence can then be restated in terms of phases (Chomsky 2001): the Prosodic Word corresponds with the *v*P/VP phase, and the Phonological Phrase corresponds with the CP phrase.

Because of these arguments, I redefine the PWd correspondence constraints in the following section to refer to a *v*P phase instead of X^0 or Lex^0.

6.3. Each Constituent (Not Just the vP) Corresponds to a PWd

In this section, I show that none of the three theories above can account for multiple recursion in Blackfoot. The problem is that all three theories require the *v*P phase to correspond to a PWd, but none require larger constituents which contain the *v*P phase to correspond to a PWd. Crucially, a theory which can account for Blackfoot must require all syntactic constituents to correspond to a PWd. Since Blackfoot words contain phrasal syntactic constituents, I argue that a version of Match Phrase is an appropriate alternative, and I show that it accounts for Blackfoot PWd recursion.

Each of the theories comprises an optimality-theoretic system (Alber et al. 2016), defined by the constraints and the structures they evaluate. Each OT system predicts a factorial typology, which is the set of all grammars defined by a constraint ranking. A possible language within the typology is defined by the set of optimal candidates within a grammar. Of interest to us is how closely these factorial typologies match the the attested empirical typology.

I evaluate the theories in the following way. First, I ask whether the OT system can generate the clitic typology in Selkirk (1996). Second, I ask whether the OT system generates a doubly recursive PWd structure when two prefixes occur on a stem. If such a candidate is harmonically bound, it is suboptimal in every grammar and therefore impossible within that OT system. I use a subset of schematic candidates with one or two prefixes on a stem, as in (98). This type of comparison is based on prosodic typology but abstracts away from phonological details of the language. I use the same set of candidates for all three OT systems in order to facilitate comparison across the theories. Although this represents a small subset of possible candidates, this set does allow us to evaluate the two questions above, as well as see that the theories make different predictions about typology.

(98) INPUT TO TEST WHETHER THE OT SYSTEM ALLOWS...
[pre–[stem]$_{vP}$]$_{CP}$ full clitic typology
[pre–pre–[stem]$_{vP}$]$_{CP}$ multiple recursion

The syntax–prosody correspondence constraints are defined more precisely for each theory in the following subsections. In addition to the correspondence constraints, I also include the following three well-formedness constraints on prosodic structure. EXHAUSTIVITY and *RECURSIVITY are used in all three theories, while BIN is used only for Match Theory. Because the recursive candidates technically have multiple prosodic words in them, I have modified BINMIN from Inkelas and Zec (1995) to only be satisfied by prosodic words which are sisters.

(99) EXHAUSTIVITY(PPh,σ) (Abbrev: EXH)
Assign a violation for every prosodic constituent σ which is dominated by a prosodic constituent PPh. (After Werle 2009, p. 23)

(100) *RECURSIVITY(PWd) (Abbrev: *REC)
Assign a violation for every prosodic constituent PWd which dominates a prosodic constituent PWd. (After Werle 2009, p. 23)

(101) BINMIN (Abbrev: BIN)
A PPh must consist of at least two sister PWds.
(Modified from Inkelas and Zec 1995)

6.3.1. Alignment Theory

The Alignment constraints from Selkirk (1996) are redefined below to require the edges of a *v*P phase and a Prosodic Word to align.

(102) ALIGN(*v*P,L,PWd,L) (Abbrev: ALL(*v*P))
For every *v*P phase, there is a prosodic word, PWd, such that the left edge of the *v*P and the left edge of the PWd align.

(103) ALIGN(*v*P,R,PWd,R) (Abbrev: ALR(*v*P))
For every *v*P phase, there is a prosodic word, PWd, such that the right edge of the *v*P and the right edge of the PWd align.

(104) ALIGN(PWd,L,*v*P,L) (Abbrev: ALL(PWD))
For every prosodic word, PWd, there is a *v*P phase, such that the left edge of the PWd and the left edge of the *v*P align.

(105) ALIGN(PWd,R,*v*P,R) (Abbrev: ALR(PWD))
For every prosodic word, PWd, there is a *v*P phase, such that the right edge of the PWd and the right edge of the *v*P align.

The tableaux below include these four constraints plus EXH and *REC, along with schematic inputs and outputs. The *v*P phase and the CP are marked in the input. In the output, the Phonological Phrase edges are marked by { } and the Prosodic Word edges are marked by ( ). I only consider a subset of candidates which are evaluated differently by different theories. I do not consider any candidates with recursive Phonological Phrases, nor candidates with no PWds. The only reason for this is to minimize the number of candidates shown.

As shown in (106), these constraints derive the full prosodic typology of clitics. The candidates (a)–(d) are all possible structures generated by this constraint set, because none are harmonically bound. Note that the candidate with balanced recursion, (e), is harmonically bound (indicated by HB) by candidates (a) and (d), because it violates all of the same constraints as candidate (a) or candidate (d) plus more. It is suboptimal under any constraint ranking.

(106)

[pre–[stem]$_{vP}$]$_{CP}$	AlL(PWd)	AlR(PWd)	AlL(vP)	AlR(vP)	Exh	*Rec
a. {(pre–(stem))}	*					*
b. {pre–(stem)}					*	
c. {(pre–stem)}	*		*			
d. {(pre)–(stem)}	*	*				
HB e. {((pre)–(stem))}	*	*!				*!

The problem is that this set of constraints cannot generate the amount of recursion that occurs in Blackfoot forms with two prefixes. The tableau in (107) includes a subset of the possible candidates for an input form with two prefixes. Candidate (a) below is the structure that is compatible with the Blackfoot data. However, it is harmonically bound by (b), because it incurs extra violations of AlL(PWd) and *Rec without satisfying some other constraint.

(107)

[pre–pre–[stem]$_{vP}$]$_{CP}$	AlL(PWd)	AlR(PWd)	AlL(vP)	AlR(vP)	Exh	*Rec
HB a. {(pre–(pre–(stem)))}	**!					**!
b. {(pre–pre–(stem))}	*					*
c. {pre–pre–(stem)}					*	
d. {(pre–pre–stem)}	*		*			
e. {(pre–pre)–(stem)}	*	*				
HB f. {(pre)–(pre–stem)}	**!	*!	*			

Even with the schematic examples above, it is clear that an analysis with Alignment constraints, Exhaustivity, and *Recursivity cannot generate the multiply nested structure that occurs in Blackfoot.

6.3.2. Wrap Theory

The definition of Wrap in Kabak and Revithiadou (2009) requires each syntactic constituent to be contained in a *separate* ('its own') prosodic constituent. This is repeated below.

(108) Wrap

Each X^0/XP is contained in its own PW/PPh, respectively.

(Kabak and Revithiadou 2009, p. 116)

The definition in Truckenbrodt (1999) can be satisfied by a single Phonological Phrase in the output as long as it contains all syntactic XPs. In contrast, the constraint in Kabak and Revithiadou (2009) is ideally satisfied by multiple Prosodic Words in the output, each one corresponding to a different syntactic X^0. This type of correspondence is easily captured with syntax–prosody correspondence constraints (Itô and Mester 2019), an extension of Correspondence Theory (McCarthy and Prince 1995). Since Blackfoot PWds correspond to a syntactic vP, Wrap can be understood as as the following constraints.[21] The containment effect arises from an interaction with alignment constraints.

(109) SP-Correspondence Constraints (Blackfoot)

Let S be an input syntactic representation and P its corresponding output phonological representation.

a. SP:Max (SP:M): A constituent of type vP phase with phonological content in S corresponds to some constituent of type PWd in P.

b. PS:Dep (PS:D): A constituent of type PWd in P corresponds to some constituent of type vP phase in S.

When there is a candidate with multiple PWds in the following tableaux, I only consider candidates where the PWd which mostly closely aligns to the edges of the stem is the PWd which corresponds to the the stem. For clarity, I have co-indexed corresponding constituents with superscript numbers. Since none of the candidates considered here violate AlR(vP) or SP:Max, I have left these constraints out of the tableaux. As shown in (110), this version of Wrap-XP correctly generates the prosodic clitic typology. Just as for Alignment Theory, the candidate with balanced recursion, (e), is harmonically bound by candidates (a) and (d).

(110)

[pre–[stem]$^1_{vP}$]$_{CP}$	AlL(PWd)	AlR(PWd)	AlL(vP)	PS:D	Exh	*Rec
a. {(pre–(stem)^1)^2}	*			*		*
b. {pre–(stem)^1}					*	
c. {(pre–stem)^1}	*		*			
d. {(pre)^2–(stem)^1}	*	*		*		
HB e. {((pre)^2–(stem)^1)^3}	*	*!		**!		*!

This theory cannot generate a multiply recursive candidate such as (a) in (111); this candidate is harmonically bound by candidate (b) because it violates all of the same constraints as (b) and more.

(111)

[pre–pre–[stem]$^1_{vP}$]$_{CP}$	AlL(PWd)	AlR(PWd)	AlL(XP)	PS:D	Exh	*Rec
HB a. {(pre–(pre–(stem)^1)^2)^3}	**!			**!		**!
b. {(pre–pre–(stem)^1)^2}	*			*		*
c. {pre–pre–(stem)^1}					*	
d. {(pre–pre–stem)^1}	*		*			
e. {(pre–pre)^2–(stem)^1}	*	*		*		
HB f. {(pre)^2–(pre–stem)^1}	**	*	*!	*		

Even with the schematic examples above, it is clear that an analysis with Alignment constraints, SP-correspondence constraints, Exhaustivity, and *Recursivity cannot generate the multiply nested structure that occurs in Blackfoot.

6.3.3. Match Word Theory

The definitions below require each vP phase to correspond to a PWd, and each PWd to correspond to a vP phase, respectively. This definition evaluates correspondence between sets of terminal nodes dominated by syntactic constituents, similarly to the definition of MatchPhrase in Elfner (2012, p. 28). Since the schematic candidates cannot distinguish overparsing from underparsing, I do not split these constraints into MatchWord(all) and MatchWord(only), as in Guekguezian (2017).

(112) Match(vP,PWd) (Abbrev: M(vP))

Suppose there is a syntactic vP phase in the syntactic representation that exhaustively dominates a set of one or more terminal nodes α. Assign one violation mark if there is no prosodic word (PWd) in the phonological representation that exhaustively dominates all and only the phonological exponents of the terminal nodes in α.

(113) MATCH(PWD,vP) (Abbrev: M(PWd))
Suppose there is a prosodic word (PWd) in the phonological representation that exhaustively dominates a set of phonological exponents. Assign one violation mark if there is no syntactic vP phase in the syntactic representation that exhaustively dominates one or more terminal nodes α which correspond to all and only the phonological exponents of the PWd.

Although Match Theory does not require *REC by hypothesis, I have included it here for comparison with the previous analyses. I also include BIN. The tableaux below includes the same small set of candidates as before.

The MATCHWORD constraints in (114) cannot generate a recursive PWd structure (a), because this candidate is harmonically bound by the binary branching, non-recursive candidate (d). This candidate satisfies all three well-formedness constraints, and only violates Match(PWd,vP) once because there is a PWd in the output which parses the prefix but does not correspond to a vP phase in the input. This candidate also harmonically bounds many of the other candidates, which are attested structures in other languages.

(114)

[pre–[stem]$_{vP}$]$_{CP}$	M(vP)	M(PWD)	EXH	BIN	*REC
HB a. {(pre–(stem))}		∗		∗!	∗!
b. {pre–(stem)}			∗	∗	
HB c. {(pre–stem)}	∗!	∗		∗!	
HB d. {(pre)–(stem)}		∗			
HB e. {((pre)–(stem))}		∗∗!			∗!

In (115) the multiply recursive PWd candidate (a) is also harmonically bound. Note that BIN favors candidates (e) and (f), where one or both of the prefixes are parsed into a separate PWd.

(115)

[pre–pre–[stem]$_{vP}$]$_{CP}$	M(vP)	M(PWD)	EXH	BIN	*REC
HB a. {(pre–(pre–(stem)))}		∗∗!		∗!	∗!∗
HB b. {(pre–pre–(stem))}		∗		∗!	∗!
c. {pre–pre–(stem)}			∗	∗	
HB d. {(pre–pre–stem)}	∗!	∗		∗!	
e. {(pre–pre)–(stem)}		∗			
HB f. {(pre)–(pre–stem)}	∗!	∗∗!			

Even with the schematic examples above, it is clear that an analysis with Match constraints, EXHAUSTIVITY, BIN, and *RECURSIVITY cannot generate the multiply nested structure that occurs in Blackfoot.

6.3.4. Match Phrase Theory

The problem with all three theories above is that none of the prosodic well-formedness constraints encourage recursive structures—in fact, *REC prohibits these structures, as pointed out by Kabak and Revithiadou (2009). The motivation for creating recursive prosodic structures must then come from the syntax–prosody correspondence constraints. However, since the three analyses above only require the vP phase to correspond to a PWd, there is no incentive to match other constituents to additional PWds. For Match Theory, the BIN constraint favors candidates where the prefixes are parsed as separate PWds, but there is no incentive to have this PWd contain the PWd of the vP stem.

What is needed is an analysis that requires every unique prosodic constituent to correspond to a PWd. Instead of simply requiring the vP phase and a PWd to match, the definitions of the correspondence constraints in this theory would require each syntactic constituent to match to a PWd. In this way, MATCH(XP,PWd) is nearly identical to MATCH-PHRASE from Elfner (2012, p. 28) in (95), except that it requires XPs to match to a PWd instead of a PPh.

(116) MATCH(XP,PWD) (Abbrev: M(XP))
Suppose there is a syntactic phrase (XP) in the syntactic representation, *where XP = vP or XP dominates vP*, which exhaustively dominates a set of one or more terminal nodes α. Assign one violation mark if there is no *prosodic word (PWd)* in the phonological representation that exhaustively dominates all and only the phonological exponents of the terminal nodes in α.

(117) MATCH(PWD,XP) (Abbrev: M(PWd))
Suppose there is a prosodic word (PWd) in the phonological representation that exhaustively dominates a set of phonological exponents. Assign one violation mark if there is no syntactic constituent (XP), *where XP = vP or XP dominates vP*, in the syntactic representation that exhaustively dominates one or more terminal nodes α which correspond to all and only the phonological exponents of the PWd.

There are two problems with these constraints. First, phonological structure in Blackfoot does not extend to syntactic phrases below *v*P. The constraints above rather arbitrarily ignore any syntactic constituents which are smaller than the *v*P phase. Second, XPs are now required to match to a PWd (by MATCHWORD) and also a PPh (by MATCHPHRASE). I set both issues aside for now, but return to this in Section 7.

As shown in (118), this version of Match Theory generates most of the prosodic clitic typology, except that candidate (b), which allows non-exhaustive parsing, is harmonically bound. In addition, the balanced recursive PWd in (e) is allowed in this system, even though it is harmonically bound in the other four systems above.[22]

(118)

$[\text{pre}–[\text{stem}]_{XP}]_{XP}$	M(XP)	M(PWD)	EXH	BIN	*REC
a. {(pre–(stem))}				*	*
HB b. {pre–(stem)}	*		*!	*	
c. {(pre–stem)}	*			*	
d. {(pre)–(stem)}	*	*			
e. {((pre)–(stem))}		*			*

This version of Match Theory also allows the multiply recursive candidate (a) below. The candidates which are harmonically bound differ from some of the other OT systems shown above.

(119)

$[\text{pre}–[\text{pre}–[\text{stem}]_{XP}]_{XP}]_{XP}$	M(XP)	M(PWD)	EXH	BIN	*REC
a. {(pre–(pre–(stem)))}				*	**
b. {(pre–pre–(stem))}	*			*	*
HB c. {pre–pre–(stem)}	**		*!	*	
d. {(pre–pre–stem)}	**			*	
e. {(pre–pre)–(stem)}	**	*			
f. {(pre)–(pre–stem)}	**	*			

I conclude that a version of Match Theory which requires each syntactic constituent to correspond to a PWd can account for Blackfoot prosodic structure. However, some details of the formalism remain to be worked out. I return to these problems below.

6.4. A *Recursivity Constraint Is Necessary

Finally, I turn to the question of whether a *Recursivity constraint is necessary. Selkirk (2011) originally posited that this constraint is superfluous in Match Theory, because prosodic recursion arises only by matching syntactic structure. However, *Rec *does* appear to be necessary at the PWd level in order to generate the full clitic typology.

The Match Phrase Theory system with one prefix from (118) is shown again below, but without *Rec. The recursive candidate (a) is still available. If *Rec is removed, then the recursive PWd candidate in (a) harmonically bounds candidates (b) and (c). Additionally, candidate (e) harmonically bounds candidate (d). The only possible candidates are the unbalanced and balanced recursive candidates.

(120)

[pre–[stem]$_{XP}$]$_{XP}$	M(XP)	M(PWd)	Exh	Bin
a. {(pre–(stem))}				∗
HB b. {pre–(stem)}	∗!		∗!	∗
HB c. {(pre–stem)}	∗!			∗
HB d. {(pre)–(stem)}	∗!	∗		
e. {((pre)–(stem))}		∗		

The Match Phrase Theory system with two prefixes from (119) is shown again below, but without *Rec. The recursive candidate (a) harmonically bounds candidates (b)–(d). Again, the only possible candidates are the unbalanced and balanced recursive candidates.

(121)

[pre–[pre–[stem]$_{XP}$]$_{XP}$]$_{XP}$	M(XP)	M(PWd)	Exh	Bin
a. {(pre–(pre–(stem)))}				∗
HB b. {(pre–pre–(stem))}	∗!			∗
HB c. {pre–pre–(stem)}	∗!∗		∗!	∗
HB d. {(pre–pre–stem)}	∗!∗			∗
e. {(pre–pre)–(stem)}	∗∗	∗		
f. {(pre)–(pre–stem)}	∗∗	∗		

The *Rec constraint is necessary to add balance so that the full attested clitic typology can be generated. Adding *Rec to the constraint set penalizes all of the candidates that are otherwise optimal. As far as I know, this type of effect on the factorial typologies of each OT system has not previously been noted. I also do not know if other constraints would create the same effect.

6.5. Summary of Models

In summary, I compared three OT systems, based on Alignment Theory, Wrap Theory, and Match Theory at the Prosodic Word level. I modified these systems so that the correspondence constraints referred to the *v*P phase rather than a Lex^0 or X^0. For all three systems, a recursive prosodic structure is harmonically bound and is not possible under any constraint ranking. In other words, the prosodic structure in Blackfoot is predicted to be unattested.

The only OT system which can account for Blackfoot requires each unique syntactic constituent to correspond to a PWd, much like MatchPhrase in Match Theory (Elfner 2006; Selkirk 2011). It seems that a simple interpretation of the Lexical Category Condition is not strong enough—it is not enough for a categorized *v*P phase to correspond to a PWd, and instead there must be some pressure to match syntactic constituency exactly in the Prosodic Word structure. In addition, this system must include a constraint such as *Rec to generate the typology of clitics from Selkirk (1996). Without this constraint, many actually attested structures are harmonically bound. This settles another question in the literature, which is whether this constraint should be admitted to Con or not. Doing so essentially means that prosodic recursion is typologically (and analytically) marked.

Finally, even with the small number of schematic candidates examined here, there were empirically testable differences among the OT systems. The reason is that different systems predict that different types of candidates will be unattested. Computational tools now exist to help researchers compare entire typologies (see, for example, Kalivoda 2018). These tools could be used in future work to flesh out entire typologies.

7. Discussion

In the previous section, the only analysis which could generate multiple recursion in Blackfoot is one with constraints that require each unique morphosyntactic constituent to correspond to a Prosodic Word (PWd). This kind of constraint is quite similar to MatchPhrase (Elfner 2012; Selkirk 2011). A natural question is whether this is a coincidence or not.

One answer may be that the correspondence constraints look 'phrasal' because the syntactic and prosodic structure inside of the Blackfoot verbal complex is phrasal. In terms of phonology, I showed that there are two distinct phonological constituents within the verbal complex. If the smaller one is a PWd, then the larger one must be a phonological phrase. In terms of syntax, I then used independent syntactic evidence in Blackfoot to show that the stem and the verbal complex are constructed in phrasal syntax. Some syntactic theories, such as Bare Phrase Structure (Chomsky 1995), erase the distinction between heads and phrases, so there are also theoretical reasons to expect a parallel between 'words' and 'phrases'. From an empirical and theoretical perspective, then, it is not surprising that Blackfoot uses a 'phrasal' method of prosody–syntax correspondence. This might be a parameter we expect to differ between polysynthetic and other languages.

An alternative answer might be that this is the definition of word-level correspondence in all languages. Perhaps MatchWord and MatchPhrase could somehow be conjoined into a single correspondence algorithm. That would mean that the algorithm sometimes puts a syntactic phonological phrase in correspondence with a phonological phrase, and other times with a prosodic word. The differences between the two could arise from elsewhere in the grammar. For example, maybe the choice between prosodic words and phonological phrases is related to phases: the algorithm makes all syntactic phrasal constituents correspond to a PWd, unless the syntactic XP is as large or larger than some other phase boundary, such as CP. The result would be a unified theory of the prosodic phonology of stems and verbal complexes which is built on universal syntactic definitions such as phases, rather than language-specific morphosyntactic units. I leave this idea for future research.

The correspondence constraints which can account for Blackfoot rather arbitrarily ignore the syntactic phrases which are smaller than an *v*P phase. This is because all of the theories I examined take the input to phonology to be a complete syntactic derivation. However, if the theories were altered to allow multiple spell-out (Chomsky 2000; Uriagereka 1999), the *v*P phase could be captured directly—it would simply be the first chunk of derivation sent to phonology, and the internal constituency would not be accessible to phonology. Presumably some other type of phase spells out as a Phonological Phrase, and this is responsible for some syntactic phrases corresponding to PWds while others correspond to PPhs. I leave the question of how to modify the theories of syntax–prosody correspondence to include multiple spell-out for future research.

An empirical gap in this paper is that I do not consider how suffixes prosodify typologically, and suffixes are not included in the schematic constraints above. One issue is the lack of strong empirical evidence for or against prosodic boundaries in Blackfoot suffixes in Section 4.2. The evidence that /k/-assibilation is blocked across the right edge of a Prosodic Word comes from exactly one suffix. An equally compatible analysis is that suffixes in this position begin in a vowel, which is deleted after another vowel. If so, this raises the question of whether this deletion occurs only at the right edge of the stem, or whether there are other suffixes inside and outside of the stem which exhibit the same kind of alternation. If all suffixes inside and outside of the stem exhibit the same types of alternation, then there is no strong evidence for a prosodic boundary at the right edge of the stem; the right edge of the PWd would align with the right edge of the PPh. In that case, Blackfoot prosody would match that of many other languages, where suffixes incorporated into a PWd while prefixes are prosodically less integrated (e.g., Booij 1995; Nespor and Vogel 2007). It is possible that further research will have something more definite to say about the prosody of suffixes. Furthermore, there is a typological asymmetry between how prefixes and suffixes are prosodified (Bye and de Lacy 2000), and suffixes tend to be more tightly bound prosodically to the stem. However, I do not consider any of the constraints which might create this asymmetry, such as StrongStart (Selkirk 2011). In some cases, StrongStart cannot generate asymmetrical systems and both Match and Align constraints must be used in a single system (Bellik et al. 2022). I did not consider such a system in this paper.

One gap in this paper is that I do not give a specific analysis for Blackfoot. One problem concerns small mismatches at the edges of prosodic constituents, which are not captured by the schematic candidates in this paper. The left edge of the PWd in Blackfoot often misaligns from a syntactic constituent via epenthesis at the left edge but never via overparsing material from neighboring morphemes. Recall that a plosive-initial root such as √pomm 'transfer' begins with an epenthetic [i] after a consonant or a vowel, and that this epenthetic [i] coalesces with a preceding vowel, as in (122). Since this epenthesis cannot be motivated by syllable structure constraints, I took this as evidence for a prosodic edge.

(122) ⟦ʔ**ɛ́ː.p**ʊm.ma.ki.wḁ⟧
á**íp**ommakiwa
a–[√**p**omm–Ø–aki]–Ø–wa
ipfv–[√transfer–*v*–ai]–ind–prx
'the one transferring' (=37a)

However, because Alignment and Match constraints are violated by epenthesis but also by including or excluding phonological material, it is unclear how this candidate is optimal. In the tableau below, the constraint *#[-cont] prohibits non-continuants at the left edge of the PWd. Syntactic boundaries are shown with a square bracket, and PWd boundaries with a parenthesis. In order for the attested candidate (c) to win, *#[-cont] must outrank the Match constraints as well as Dep. However, a candidate such as (b), which overparses the PWd containing stem, harmonically bounds (c), indicated by ☹.

(123)

[a-[pom:-aki-wa	*#[-cont]	M(PWd)	M(XP)	Dep	*Rec
a. (ʔ[á.([pʊm.ma.ki.wḁ	*!	*	*	*	*
☞ b. (ʔ([á.[pʊm.ma.ki.wḁ		*	*	*	*
☹ c. (ʔ[ɛ́(ɛ́.[pʊm.ma.ki.wḁ		*,*!	*,*!	**!	*

Solving this would require changes to how the alignment or Match constraints are evaluated, possibly in addition to relaxing Proper Headedness (Itô and Mester 2003). Another solution might rely instead on cyclic or derivational phonology, where epenthesis occurs at the left edge of the PWd before syllabification occurs. The interaction between epenthesis and syllabification would then be opaque. This would explain why epenthesis does not occur in order to optimize syllable structure, as well as why syllable boundaries appear to 'straddle' the left edge of the PWd. (For a different take on a cyclic solution to Blackfoot recursion, see Miller and Sande 2021, this volume.) These solutions are beyond the scope of this paper.

Finally, I argued that Prosodic Word recursion in Blackfoot is not restricted to specific morphosyntactic structures. The main reason for this is that prefixes have a wide range of semantic function and morphosyntactic size. They do not seem to form a natural class. One interesting counter analysis would be if all prefixes could be shown to be syntactic adjuncts. This would mean there is a division between syntactic heads such as I^0 and C^0 as suffixes, and non-projecting adjuncts as prefixes. (Person agreement clitics occur before and after the verb.) If this were true, then perhaps Prosodic Word recursion arises in exactly the cases where there is syntactic adjunction. However, this hypothesis would need further testing in Blackfoot, especially since some of the prefixes have semantic functions that are typically taken to be head-like (e.g., negation, quantification, tense/aspect prefixes, and control verbs).

8. Conclusions

This paper used evidence from phonotactic edge restrictions (Bennett 2018; Hall 1999) and patterns of morpheme alternation in Blackfoot to establish that multiply recursive Prosodic Words (PWd) exist within the verbal complex, much like Dutch Booij (1996, 1995). This contrasts with previous research which argues that Prosodic Word recursion does not exist Nespor and Vogel (2007); Vigário (2010); Vogel (2009, 2019). PWd adjunction in Blackfoot is not restricted to certain morphosyntactic structures such as compounding or clitics, as argued by Bennett (2018); Kabak and Revithiadou (2009); Tyler (2019). Instead, it is a more general process that affects all prefixes to the left of the stem. This suggests that PWd recursion arises from general constraints on prosodic structure and correspondence with syntax, just as has been argued at the phonological phrase level Selkirk (1995, 2011); Truckenbrodt (1999).

I then used the empirical facts in Blackfoot to address several theoretical questions about Prosodic Word recursivity. I compared several theories of syntax–prosody correspondence at the PWd level in an Optimality Theory framework. I did this by evaluating a subset of possible prosodic structures against the constraints needed for each theory. Even with this small number of candidates, this comparison shows that the theories do make different predictions with respect to their factorial typologies, which could be falsified or confirmed empirically by considering the typology of attested languages.

First, the unit which corresponds to a PWd must be a *phrasal* *v*P, rather than simply a lexical syntactic head. The reason is that the verb stem in Blackfoot is internally complex, consisting minimally of an a-categorical root and one or more verbalizing suffixes. Because some stem-internal morphemes are phrasal adjuncts, there is no alternative analysis which treats the stem or the verbal complex as a complex syntactic head. It is the entire *v*P constituent which corresponds to a PWd, rather than any of the subcomponents. Second, I show that it is not enough to simply require correspondence between the *v*P stem and a PWd. In order to derive a multiply nested prosodic structure, the *v*P and each larger phrasal syntactic constituent must map to a PWd, where the larger phrasal syntactic constituents are formed by Merging a prefix. This is in contrast with most existing theories, which require only the stem or a lexical category word to map to a PWd and which derive recursivity via other constraints such as *Recursivity or Wrap-X^0. Third, I find that the markedness constraint *Recursivity is required to generate the multiply recursive structure in Blackfoot. This answers the question in the literature of whether *Rec should be included in the universal constraint set Con in Optimality Theory (Prince and Smolensky 1993). Although Selkirk (2011) takes the strong position that constraints such as *Recursivity and Exhaustivity are not necessary, this paper shows otherwise. This means that prosodic recursivity is indeed marked in some sense. Instead, any instance of prosodic recursion or level skipping is the direct result of *satisfying* a higher-ranked syntax–prosody correspondence constraint.

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Abbreviations

The following abbreviations are used in this manuscript:

1	First person;
2	Second person;
3	Third person;
AI	Animate intransitive;
AN	Animate;
CAUS	Causative;
CMD	Command clause;
CNJ	Conjunctive order;
CONJ	Conjunction;
DEG	Degree marker;
DEM	Demonstrative;
DEP	Dependent clause;
FOC	Focus;
FUT	Future;
IC	Initial change;
II	Inanimate intransitive;
IMP	Imperative;
IN	Inanimate;
IND	Independent order;
INS	Instrumental;
INV	Inverse;
IPFV	Imperfective;
NEG	Negative;
NMLZ	Nominalizer;
OBJ	Object;
OBV	Obviative;
PL	Plural;
PRF	Perfect;
PRX	Proximate;
SG	Singular;
SHEET	Two-dimensional flexible material;
SUB	Subject;
TA	Transitive animate;
TI	Transitive inanimate;
WARD	Direction/locative nominal;
WH	Content question marker.

Notes

1 Any examples marked with '(BB)' or '(NC)' are from the author's fieldwork with Totsinámm (Beatrice Bullshields) and Ááhsaikamo'sáákii (Natalie Creighton), and the IPA transcriptions are based on the speakers' pronunciations and surrounded by single brackets, [ ]. Data from Frantz and Russell (2017) is cited with '[FR #]', where # is the page number. For examples taken from reference materials, the IPA transcriptions are converted from the orthography and are surrounded by double brackets, ⟦ ⟧. (See Weber 2020 for a description of how IPA transcriptions are derived from the orthography.) For the morphemic analysis of examples, I use the orthography in Frantz (2017) and Frantz and Russell (2017), which maps closely to phonemic or broad phonetic transcription (except that /ʔ/ = <'>, /j/ = <y>, /x/ = <h>, /ɛː/ = <ai>, /ɔː/ = <ao>, and other long sounds are doubled.) The stem is given in square brackets, [ ].

2 This suffix takes different forms depending on the person features of both arguments. For certain configurations of subject and object, the suffix agrees with one of the two arguments, while for others, the suffix is simply *-ok* 'INV'. This type of direct/inverse agreement system occurs across the Algonquian family (Oxford 2014).

3 This feature is similar to [H(igh animacy)] in Wiltschko and Ritter (2015).

4 This syntactic analysis follows Déchaine and Weber (2018) and Weber (2020). Other syntactic analyses of Algonquian verb stems agree that the first suffix after the √ROOT is a light verbal head, but differ in how the √ROOT and the second suffix in transitive verbs are syntacticized (Bliss 2013; Branigan et al. 2005; Brittain 2003; Hirose 2000; Quinn 2006).

5 Déchaine and Weber (2018) argues that a √ROOT in Blackfoot and Plains Cree may syntacticize in one of three ways: XP-adjuncts, X^0-adjuncts computed online, or precompiled X^0-adjuncts. Here I focus only on XP-adjoined roots.

6 A semantic argument for why verbal heads are bound is also pursued in Déchaine and Weber (2015) for Blackfoot and Plains Cree and in Slavin (2012) for Oji-Cree. In contrast, Déchaine and Weber (2018) takes the view that this is a morphosyntactic requirement.

7 See Bliss (2013) for a different syntactic analysis of the Blackfoot verbal complex which does use head movement.

8 Weber (2020) argues that final consonants pattern more like a syllable onset and analyzes final consonants as degenerate syllables with no nucleus.

9 This pattern of vowel coalescence holds for roots which begin in long [iː] or long [oː] at the left edge. A [w] is epenthesized between a vowel and a root which begins in long [ɛː], [aː], or [ɔː], which Weber (2020) analyzes as mora preservation on [-high] vowels. For the sake of space, I abstract away from the various vowel hiatus resolution strategies here.

10 A small subset of this type also involve an irregular pattern of root-internal gemination which arose from a historical process of short vowel deletion with subsequent full assimilation of the resulting consonant cluster (Berman 2006; Elfner 2006; Thomson 1978). For example, the root √KIPITA 'aged' surfaces as [kipita] at the left edge of the CP verbal complex, but [ippita] after a prefix.

11 The prohibition against long [ɛː], [aː], and [ɔː] is unrelated. Weber (2020) argues that these roots epenthesize [w] after a prefix in order to avoid deletion of a mora attached to a [-high] vowel.

12 The PPh constituent is also well established as the domain of several phonological processes, such as vowel coalescence and /t/-assibilation (Bliss 2013; Weber 2020). I do not discuss these processes further in this paper.

13 There are some roots which can apparently be smaller, such as √P 'release' and √SS 'break'. These always occur immediately adjacent to a bound verbalizing head, and cannot occur left of another root. In Algonquianist terminology, they are initials, but never prefixes.

14 Although this example involves a noun and not a verb, the root √ISTTOHK 'thin' can also occur before verb stems, where I expect the same process to occur. I could find no examples of a /k/-final prefix before a consonant-initial verb stem in Frantz and Russell (2017).

15 For some speakers, this noun is [asoka'simi] 'shirt' with an initial vowel [a]. It is possible that for these speakers, the initial vowel alternates between [a] at the left edge of the PPh and [i] elsewhere.

16 The parentheses around the initial vowel in this form probably indicate intraspeaker or interspeaker variation.

17 A similar typology occurs in Peperkamp (1997) without Alignment constraints. In her model, lexical structure is built cyclically, so includes a FAITHFULNESS constraint which requires previously built prosodic structure to be respected Peperkamp (1997, p. 189). This constraint dominates a *REC constraint to derive recursive PWd structures.

18 If the rhythmic categories of feet, syllables, and moras are separated from the prosodic hierarchy, as in Inkelas (1990), then EXHAUSTIVITY could be redefined as a family of PARSE-INTO-X constraints (Itô and Mester 2009a).

19 For this kind of interpretation of 'lexical category word' for other morphologically complex languages, see Guekguezian (2017) and Newell (2008).

20 Windsor (2017) treats each √ROOT as a PWd, under the assumption that these elements are categorized adverbs/adjectives. The fuller consideration here of the phonological and syntactic properties of √ROOTS shows this is incorrect.

21 These constraints on their own do not ensure that each vP phase corresponds to 'its own' PWd. Presumably this comes from the interaction of other constraints, such as high-ranked constraints which prohibit a vP phase in the input from corresponding to multiple PWds in the output, and which prohibit a PWd in the output from corresponding to multiple vP phases in the input.

22 Note that in the second tableau, candidates (e) and (f) have the same violation profile. These two must differ in some other constraint not shown here.

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