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RESEARCH

Recursive prosodic words in Kaqchikel (Mayan)

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Following the development of Prosodic Hierarchy Theory (Selkirk 1984; Nespor & Vogel 1986), evidence has accumulated that prosodic categories may be recursively self-embedded (e.g. Selkirk 1995; Truckenbrodt 1999; Wagner 2010; Itô & Mester 2013, etc.). However, this conclusion is not universally accepted (e.g. Vogel 2009a), and even the need for prosodic categories has been recently disputed (e.g. Scheer 2012b).

In this article I argue that the prefixal phonology of Kaqchikel provides clear and convincing evidence for unbounded (iterable) recursion of the prosodic word ω. Patterns of [ʔ]-insertion and degemination receive a simple, elegant treatment if recursion of the prosodic word is permitted. Theories of prosodic phonology which do without recursion are forced to resort to *ad hoc* stipulations to account for the same facts. Both derivational (e.g. Kiparsky 1982) and transderivational (e.g. Benua 2000) analyses of these patterns fail on morphological grounds. The overall conclusion is that both abstract prosodic structure and recursion of the prosodic word are indispensable parts of any theory of word-level phonology.

Keywords: prosody; prosodic word; recursion; morpho-phonology; Kaqchikel; Mayan

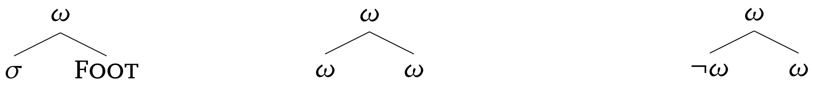
1 Introduction

The central claim of Prosodic Hierarchy Theory is that phonotactic patterns may be conditioned by abstract phonological constituents—also known as *prosodic categories*—which are distinct from the constituents provided by morphology and syntax (Selkirk 1978; 1980a; b; 1984; 1986, etc.; Nespor & Vogel 1986; and many others). Early work within this theory adopted a strong version of the Strict Layer Hypothesis (SLH), essentially a set of formal restrictions governing the hierarchical nesting of prosodic categories (Selkirk 1984; Nespor & Vogel 1986, etc.). As originally conceived, the SLH took the form in (1) (assuming a fairly standard inventory of prosodic categories, e.g. Itô & Mester 2009; 2010; 2012; 2013).

(1) Strict Layer Hypothesis
  a. Prosodic categories are arranged into a hierarchy reflecting their relative sizes: $\upsilon > \iota\mathrm{P} > \phi\mathrm{P} > \omega > \textsc{Foot} > \sigma > \mu$
  b. Prosodic constituents of level κ only dominate constituents of level κ–1.

Empirical challenges to the strongest form of the SLH (1) have come from apparent instances of *level-skipping* (κ dominating κ–n, $n > 1$) and *recursion* (κ dominating κ) (e.g. Kager 1989; Selkirk 1995; Booij 1996; Peperkamp 1997; Itô & Mester 1992/2003; 2009; Kabak & Revithiadou 2009 and references there; see also Kaisse 1985; Hyman et al. 1987; Odden 1987; Seidl 2001; Pak 2008 for separate critiques). Focusing on the prosodic word (ω), instances of level-skipping take the form of (2a), while instances of recursion take the form of (2b, c) (van der Hulst 2010).

(2) a. Level skipping b. Balanced recursion c. Unbalanced recursion



While level-skipping (2a) has proven to be an important component of prosodic phonology, prosodic recursion remains more contentious. Some authors have argued that prosodic recursion is indeed possible, and perhaps widespread in phonological systems (e.g. Selkirk 2011; Itô & Mester 2012; for the prosodic word *ω* specifically, see Selkirk 1995; Booij 1996; Peperkamp 1997; Vigário 1999; 2003; Itô & Mester 1992/2003; 2007; 2009; 2010; Kabak & Revithiadou 2009; Padgett 2012 and references there). Others deny the possibility of prosodic recursion in any form, hewing to a stronger version of the SLH (1) (e.g. Jackendoff & Pinker 2005; Vogel 2009a; b; Schiering et al. 2010).[1] Still others have taken an intermediate position, accepting the need for unbalanced recursion (2c) (involving sister nodes of different category types), while rejecting balanced recursion (2b) (involving sister nodes of the same category type; Vigário 2010; Frota & Vigário 2013; cf. Myrberg 2013: 78). Lastly, some authors reject Prosodic Hierarchy Theory as a whole, and thus necessarily reject prosodic recursion as well (e.g. Kaisse 1985; Seidl 2001; Pak 2008; Samuels 2009; Scheer 2010; 2012a; b; see Elordieta 2008 for a useful summary).

In this article I argue that recursion of the prosodic word *ω* is indispensable for an adequate theory of prefixal phonology in Kaqchikel (Mayan). The key phenomenon—initial glottal stop insertion—receives a simple treatment if unbounded, iterative recursion of the prosodic word is permitted (3).

(3) [$_{\omega}$ **ʔ**W$_1$ [$_{\omega}$ **ʔ**W$_2$ [$_{\omega}$ **ʔ**W$_3$ [$_{\omega}$ **ʔ**W$_4$]]]]

As we will see, treatments of this pattern which do without recursion are forced to accept an *ad hoc* proliferation of prosodic categories which are otherwise unmotivated in Kaqchikel, or in other languages (§3). Purely derivational treatments of these facts, which model the prefixal phonology of Kaqchikel using the serial interleaving of phonology and morphology rather than prosodic structure, make incorrect predictions regarding other aspects of the grammar of this language (§5.1). Similarly, an analysis based on transderivational faithfulness rather than prosodic structure (e.g. Benua 2000) runs up against the "missing base" problem previously identified for such frameworks (e.g. Kiparsky 2000; Wagner 2002; Bermúdez-Otero 2011; Mascaró 2016) (§5.2). The overall conclusion is that both abstract prosodic categories and prosodic recursion are needed to correctly characterize word-level phonotactic domains in Kaqchikel and elsewhere.

Before proceeding, it should be noted that the analysis developed here only bears on the need for unbalanced recursion (2c) (also known as "recursive adjunction") in prosodic phonology. Whether balanced recursion (2b) is also possible will need to be settled by means of additional data; see Itô & Mester (2007); Ladd (2008: Ch.8); Vigário (2010); Frota & Vigário (2013), and Myrberg (2013) for discussion.[2]

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[1] Vogel (2009a; b), drawing on results discussed in Ladd (2008: Ch.8), allows for *ι*P recursion but not for recursion of other prosodic categories.

[2] Vogel (2009a; b); Vigário (2010); and Frota & Vigário (2013) note that much of the existing evidence for balanced recursion (2b) involves gradient phonetic patterning at higher intonational phrases such as the *ι*P (e.g. Ladd 2008: Ch.8; see also Fougeron & Keating 1997; Cho & Keating 2009; Myrberg 2013). The lack of clear *categorical* diagnostics for balanced recursion has been a cause for skepticism over whether this type of prosodic recursion is in fact possible. In this paper I am concerned exclusively with categorical diagnostics for unbalanced recursion of a lower domain (*ω*) in Kaqchikel.

2 Kaqchikel

Kaqchikel is a K'ichean-branch Mayan language spoken by at least 500,000 people in the central highlands of Guatemala (Richards 2003; Fischer & Brown 1996: fn.3). The data in this article primarily comes from descriptive grammars and dictionaries of Kaqchikel written by native-speaker linguists (Cojtí Macario et al. 1998; García Matzar et al. 1999; Patal Majzul et al. 2000; Patal Majzul 2007). In this article I focus on two diagnostics for word-level prosodic structure in the language, glottal stop insertion and degemination. For in-depth discussion of these phenomena and other aspects of the morpho-phonology of Kaqchikel, see Bennett et al. (2018). When possible, the phonological patterns outlined below have been confirmed through original fieldwork with Kaqchikel speakers in Guatemala (including native-speaker linguists). For more on the phonology of Kaqchikel, see Cojtí Macario & Lopez (1990); Chacach Cutzal (1990); Bennett (2016); Bennett et al. (In revision); Bennett (To appear) and references there.

The phenomena presented here (glottal stop insertion and degemination) are widespread within the Mayan family, and occur in similar morphological and prosodic contexts even in Mayan languages which are not very closely related to Kaqchikel (e.g. Barrett 2007; Kaufman 2015; Bennett 2016; England & Baird 2017; Coon 2017). I suspect that the evidence for ω-recursion in Kaqchikel could be easily replicated in other Mayan languages, but this suspicion remains to be confirmed in a rigorous way.

2.1 *High vs. low-attaching prefixes*

Kaqchikel has two classes of prefixes which are distinguished by their prosodic behavior (4). *Low-attaching* prefixes are parsed into the same prosodic word as their stem, while *high-attaching* prefixes are parsed outside the prosodic word containing their stem. (The terms high-/low-attaching refer only to the prosodic patterning of these prefixes, and *not* to their morpho-syntax; see sections 4 and 5.1.)

(4) a. [$_\omega$ LowPref-Stem]
b. [HighPref = [$_\omega$ Stem]]

These prosodic differences can be diagnosed by convergent evidence from glottal stop insertion (§2.1.1) and degemination (§2.1.2). In section 3 I argue that high-attaching prefixes induce recursion of the prosodic word, [$_\omega$ HighPref = [$_\omega$ Stem]].

2.1.1 Glottal stop insertion

In Kaqchikel, underlyingly vowel-initial words bear an epenthetic glottal stop on the surface, /V…/ → [ʔV…] (García Matzar et al. 1999: 12; Barrett 2007; Bennett 2016).[3] The forms in (5) show that [ʔ]-insertion is conditioned only by the initial segment of the word, and not by syllable count or stress (which is almost always word-final in Kaqchikel).

(5) Initial [ʔ]-insertion (Patal Majzul 2007: 166, 175, 179, 300)
a. *ik* [ˈʔikʰ] 'chile'
b. *ixim* [ʔi.ˈʃim] 'corn'
c. *eleq'om* [ʔe.le.ˈʠ̥om] 'thief'
d. *oyonib'äl* [ʔo.jo.ni.ˈɓ̥əl̥] 'telephone'

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[3] Data is given in the standard Kaqchikel orthography and the IPA. Phonetic transcriptions are set off with "//" for underlying forms and "[ ]" for surface forms.

Initial [ʔ]-insertion reflects a more general strategy for avoiding onsetless syllables in Kaqchikel, particularly in hiatus, e.g. *xeb'iyin* [ʃ-e-ɓ̥ijin] 'they walked' vs. *xe'atin* [ʃ-e**ʔ**-atin] 'they bathed' (García Matzar et al. 1999: 80).[4] In the terms of Optimality Theory (OT) (Prince & Smolensky 1993/2004), [ʔ]-insertion is driven by the ranking Onset ≫ Dep-C (McCarthy & Prince 1995; 1999), along with a ranking of markedness constraints that guarantees [ʔ] will be the least-marked, default epenthetic consonant (see de Lacy 2006: Ch.3).

Initial [ʔ]-insertion is bled by the addition of certain prefixes to vowel-initial stems (6)–(8). The lack of [ʔ]-insertion with these prefixes suggests that they are syllabified together with their stems, and preempt [ʔ]-insertion by providing an onset consonant for the stem-initial vowel.

(6) Verbal aspect prefixes (Patal Majzul 2007: 296)
a. *-ok* /-ok/ 'to enter'
b. *okib'äl* [**ʔ**ok-i-ɓ̥əl̥] 'entryway'
c. *xok* [ʃ-okʰ] '(s)he entered'
d. **x'ok* [ʃ-**ʔ**okʰ]

(7) Ergative possessive prefixes (Patal Majzul 2007: 507)
a. *uchuq'a'* [**ʔ**ut͡ʃuɠ̥aʔ] 'strength'
b. *ruchuq'a'* [r-ut͡ʃuɠ̥aʔ] 'his/her strength'
c. **r'uchuq'a'* [r-**ʔ**ut͡ʃuɠ̥aʔ]

(8) Verbal agreement prefixes (Patal Majzul 2007: 175–6)
a. *-il* /-ɪl/ 'to find'
b. *ilib'äl* [**ʔ**il-i-ɓ̥əl̥] 'spyglass'
c. *xawil* [ʃ-aw-ɪl̥] 'you found it'
d. **xaw'il* [ʃ-aw̥-**ʔ**ɪl̥]

There are at least three arguments for treating these [ʔ] ~ ∅ alternations as epenthesis rather than deletion of an underlying glottal stop /ʔ/ (see also Bennett 2016). First, native speakers of most Mayan languages reportedly have the intuition that [ʔ] is non-phonemic (and therefore not underlying) in initial position, even though it contrasts with other consonants in non-initial environments (e.g. England 1983: 34–6, 41–2; Kaufman 2015). Consequently, word-initial glottal stop is not represented in the official orthography of any modern Mayan language, though it is written as ⟨'⟩ in other positions (9), cf. (5)–(8).

(9) Orthographic ⟨V'⟩ = /Vʔ/ (Patal Majzul 2007: 18, 104–5, 276)
a. *meb'a'il* [meɓ̥**aʔ**il̥] 'poverty'
b. *nub'aqil* [nuɓ̥**aq**il̥] 'my bone'

c. *meb'a'* [meɓ̥**aʔ**] 'poor'
d. *yeb'e* [jeɓ̥**e**] 'they went'

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[4] [ʔ]-epenthesis is not the only hiatus resolution strategy in Kaqchikel; see García Matzar et al. (1999: 36–9) and Heaton (2016), and Bennett (2016) on Mayan languages more generally. Apart from Kaqchikel, some Mayan languages have regular word-initial [ʔ]-epenthesis but also allow word-medial onsetless syllables under hiatus (Bennett 2016).

Second, [ʔ] ~ ∅ alternations occur even when retention of an underlying /ʔ/ would result in a phonotactically permissible consonant cluster. For example, some varieties of Kaqchikel have roots with a true, underlying initial /ʔ/, derived through debuccalization of historical /ɓ̥/ (e.g. *-b'ij* /-ʔiχ/ 'to say'; Patal Majzul et al. 2000: 25). When the verbal aspect prefix /ʃ-/ attaches to such roots it results in an initial [ʃʔ] cluster (e.g. Comalapa Kaqchikel *x'e* [ʃ-ʔe] '(s)he went'). This contrasts with underlyingly vowel-initial roots, which show a [ʔ] ~ ∅ alternation under prefixation of /ʃ-/ (e.g. *xok* [ʃ-okʰ] '(s)he entered', *[ʃ-**ʔ**okʰ]; see (6)). It follows that [ʔ] ~ ∅ alternations must reflect epenthesis rather than deletion, since underlying /ʔ/ does not in fact delete after [#ʃ] or in other relevant contexts.

This argument is perhaps clearest for those dialects which have root-initial /ʔ/ in some verbs, but all dialects have medial clusters that make similar points (e.g. *ox'öx* [ʔoʃ-ʔɔʃ] 'three-by-three' vs. *yixok* [j-iʃ-okʰ], *[j-iʃ-**ʔ**okʰ] 'y'all enter'; Brown et al. 2010: 236). It also bears mentioning that the typical resolution for illicit word-initial clusters in Kaqchikel is vowel epenthesis, not consonant deletion, e.g. *niwär* /n-wər/ → [niwəɾ̥] '(s)he sleeps' (Brown et al. 2010: 29, 49).

Third, morphological evidence establishes that these [ʔ] ~ ∅ alternations owe to epenthesis and not deletion of underlying /ʔ/. Ergative and absolutive agreement markers in Kaqchikel show suppletive allomorphy conditioned by the initial segment of their stem. The 3SG.ERG marker, for instance, is *r-* /r-/ before vowel-initial stems (7), and *ru-* /ru-/ before consonant-initial stems (e.g. ***ru**tz'i'* [ru-t͡sˀiʔ] 'his/her dog'). The deletion analysis of [ʔ] ~ ∅ alternations presumes that [ʔ] is present in underlying forms; this wrongly predicts that *all* words should take the pre-consonantal allomorphs of the ergative and absolutive markers (e.g. *aq'om* [**ʔ**aɠ̥om] 'medicine' vs. ***r**aq'om* [r-aɠ̥om] 'his/her medicine', ****ru**'aq'om* [ru-**ʔ**aɠ̥om]). This point is further underscored by the fact that some words (particularly recent borrowings from Spanish) contain an underlying, non-alternating initial [ʔ], and these forms take the pre-consonantal allomorphs of agreement morphology as expected (e.g. historically Spanish *ru'alambre* [ru-ʔalambre] 'his/her wire', or native Kaqchikel *nu'oj* [nu-ʔoj] 'my avocado'; García Matzar et al. 1999: 116; Patal Majzul et al. 2000: 46–7).

So far, we've established that (i) vowel-initial words surface with an epenthetic glottal stop, and (ii) certain prefixes bleed initial [ʔ]-insertion. Matters are different with a second class of prefixes, which do *not* bleed [ʔ]-insertion, and instead co-occur with a following epenthetic glottal stop (10)–(11).

(10) Initial [ʔ]-epenthesis with derivational prefixes (García Matzar et al. 1999: 31; Patal Majzul 2007: 59, 67, 565; Brown et al. 2010: 217)
- a. *aj-* /aχ=/ AGT
  - (i) *ajejqa'n* [ʔaχ=**ʔ**eχqaʔn] 'porter'
  - (ii) Cf. *rejqa'n* [r-eχqaʔn] 'his/her cargo'
- b. *ix-* /iʃ=/ FEM
  - (i) *Ixajaw* [ʔiʃ=**ʔ**aχaw̥] 'female leader'
  - (ii) Cf. *rajaw* [r-aχaw̥] 'his/her lord'
- c. *ach-* /at͡ʃ=/ COM
  - (i) *achamaq'* [ʔat͡ʃ=**ʔ**amaɠ̥] 'federation'
  - (ii) Cf. *ramaq'* [r-amaɠ̥] 'his/her nation'
- d. *yaj-* /jaχ=/ 'related by marriage'
  - (i) *yajal* [jaχ=ʔal̥] 'stepchild (of a woman)'
  - (ii) Cf. *ral* [r-al̥] 'her daughter'

(11) Initial [ʔ]-epenthesis with absolutive agreement on non-verbal predicates[5] (Patal Majzul 2007: 87, 182)
   a. *oj aq* [ʔoχ = **ʔ**aqˣ] 'we are pigs'
   b. Cf. *raq* [r-aqˣ] 'his/her pig'

   c. *in iyom* [ʔin = **ʔ**ijom] 'I'm a midwife'
   d. Cf. *qiyom* [q-ijom] 'our midwife'

As noted above, [ʔ]-insertion in Kaqchikel is a general strategy for avoiding onsetless syllables. Given this, the prefixes which co-occur with epenthetic glottal stop in (10)–(11) must be syllabified separately from their stems. Otherwise, the final consonant in each of these prefixes should be parsed as an onset to the following stem vowel, bleeding [ʔ]-insertion as in (6)–(8).

Prefixes in Kaqchikel are thus split as to whether or not they are syllabified together with their stems. This contrast can be rooted in the phonology of prosodic words. Syllable-sensitive phonotactics indicate that syllabification is word-bounded in Kaqchikel. Along with [ʔ]-insertion in onsetless syllables, syllable boundaries can be diagnosed by the devoicing of approximants in coda position (Bennett 2016 and references there). Both of these processes apply at junctures between words in phrases like (12), suggesting that each word is syllabified separately (12b), rather than jointly (12c).

(12) a. *ralk'wal Ixkamey* /ralkˀwa**l** # **i**ʃkamej/ 'Ixkamey's child'
   b. [ral̥.ˈkˀwa**l̥.ʔi**.ʃka.ˈmej]
   c. *[ral̥.ˈkˀwa.**li**.ʃka.ˈmej̥]

Such patterns support the claim that syllabification is word-bounded in Kaqchikel. For formal explicitness, I assume that resyllabification across prosodic word boundaries is blocked by a MATCH constraint (13), which is undominated and inviolable in Kaqchikel.

(13) MATCH (X^0, ω)
   (Selkirk 2009; 2011; see too McCarthy & Prince 1993; Itô & Mester 1999; Elfner 2012; Tyler Submitted)
   Assign one violation for every morphological word (= terminal node X^0 in the syntax) M_x such that the segments belonging to M_x are not *all* dominated by the same prosodic word ω_y in the output.

The observation that syllabification is word-bounded in Kaqchikel provides a means of understanding syllabification contrasts between prefixes. The prefixes in (6)–(8) syllabify together with their stems, bleeding [ʔ]-epenthesis and giving rise to [ʔ] ~ ∅ alternations. I assume that these prefixes are prosodically *low-attaching*: they are parsed into the same ω as their stem, [$_{\omega}$ LOWPREF-STEM]. Given this structure, low-attaching prefixes should syllabify together with their stems, eliminating the need for [ʔ]-insertion to apply.

In contrast, the prefixes in (10)–(11) must be prevented from syllabifying together with their stems. This suggests that a prosodic word boundary intervenes between these prefixes and their stems, as in the WORD-WORD junctures in (12). I assume that these prefixes are prosodically *high-attaching*: they are parsed outside of the ω corresponding to their stems, [HIGHPREF = [$_{\omega}$ STEM]]. Given this structure, high-attaching prefixes should *not*

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[5] Absolutive agreement markers are written as independent words in non-verbal predicate constructions in Kaqchikel, but are morpho-syntactically affixes (Bennett et al. 2018). This orthographic fact reflects the prosodic variability of these morphemes: absolutive markers behave as high-attaching prefixes (co-occurring with epenthetic [ʔ]) when hosted by a non-verbal predicate, but as low-attaching prefixes (bleeding [ʔ]-epenthesis) when hosted by an aspect-marked verb. See Bennett et al. (2018) for extensive discussion.

syllabify together with their stems, and so are expected to co-occur with epenthetic [ʔ] as in (10)–(11). (In section 5 I argue against morphologically-oriented explanations for the failure of resyllabification with high-attaching prefixes.)

The prosodic structures assumed for these two prefix classes are justified and defended in greater detail below. Initial [ʔ]-insertion will be an important structural diagnostic for prosodic recursion (section 3); it should be borne in mind throughout what follows that the (non-)application of initial [ʔ]-insertion with certain prefixes owes to different patterns of prefix-stem syllabification.

Bennett et al. (2018) show that high-attaching prefixes really are affixal—their prosodic behavior cannot be accounted for by assuming that they are morpho-syntactic clitics, or part of a morphological compound (footnote 12). For example, low-attaching inflectional prefixes, such as ergative agreement markers (7), can appear outside of high-attaching prefixes like agentive *aj-* /aχ=/ (14). This demonstrates that *aj-* must itself be a prefix rather than a morpho-syntactic clitic, under the standard diagnostic that affixes may not attach to clitic material (e.g. Zwicky 1977; Zwicky & Pullum 1983; van Riemsdijk 1999; Anderson 2005).

(14) Ordering of high- and low-attaching prefixes (Patal Majzul 2007: 75)
a. *rajto'öl* [r-aχ=toʔ-ɔl̥]
3SG.ERG-AGT=help-NMLZ
'his/her helper'

b. *wajt'is* [w-aχ=tˀis]
1SG.ERG-AGT=sew
'my tailor'

The morphology of prefixation in Kaqchikel is discussed further in section 4.

2.1.2 Degemination

Convergent evidence that prefixes attach at different prosodic levels in Kaqchikel comes from patterns of degemination. Low-attaching prefixes, such as verbal absolutive markers, trigger degemination when adjacent identical consonants arise across a morpheme boundary. There are no phonemic geminates in Kaqchikel, so degemination is more-or-less expected in this context (see Hayes 1986; McCarthy 1986; Odden 1988).

(15) Low-attaching verbal absolutive agreement
a. *xojjote'* /ʃ-o**χ-χ**ot-eʔ/ → [ʃo**χ**oteʔ]
CPL-1PL.ABS-elevate-INTR.POS
'we climbed'

b. *yixxule'* /j-i**ʃ-ʃ**ul-eʔ/ → [ji**ʃ**uleʔ]
INCPL-2PL.ABS-lower-INTR.POS
'y'all descended'

High-attaching prefixes, such as agentive *aj-*, do not trigger degemination:

(16) High-attaching /aχ=/ AGT (Patal Majzul 2007: 69)
a. *ajjuku'* [ʔa**χ**=**χ**ukuʔ]
AGT=boat
'boatman'

b. *ajjach'öl* [ʔa**χ**=**χ**at͡ʃˀɔl̥]
AGT=shuck
'corn-shucker'

(17) High-attaching /jaχ = / ‘related by marriage’ (Patal Majzul 2007: 565)
yajjite’ [ja**χ** = **χ**iteʔ]
RELATED.BY.MARRIAGE = mother.in.law.of.man
‘second wife of a father-in-law of a man’

Bennett et al. (2018) report that degeminated clusters in Kaqchikel may be intermediate in length between singletons and doubled consonants. However, that study wasn’t designed to assess whether shortening involves the complete neutralization of consonant length, so it’s difficult to tell if shortening is total or partial in these contexts. The crucial point is that low-attaching prefixes trigger substantially more degemination than high-attaching prefixes, even if degemination is less than complete.

The duration of derived geminates has been shown to be sensitive to boundary strength in other languages, particularly English (e.g. Inkelas 1990: 97; Hammond 1999; Martin 2007; Oh & Redford 2012). Against this backdrop, the fact that high-attaching prefixes resist degemination (16)–(17) supports the claim that such affixes are followed by a relatively strong prosodic boundary, consistent with the patterns of [ʔ]-insertion discussed in section 2.1.1. Indeed, these facts seem to provide fairly direct evidence for a ω boundary in this position since degemination, unlike [ʔ]-insertion, does not involve any conditioning by syllable structure (see section 3.2 for more on this point).

For present purposes, I take degemination in Kaqchikel to be a categorical phonological process which leads to full neutralization between singletons and derived geminates (though I emphasize that the claims I make about prosodic structure here do not depend on that assumption). Degemination in this sense can be implemented with an OCP constraint (18):

(18) OCP(X)$_\omega$
(McCarthy 1986; Myers 1997; Suzuki 1998)
Assign one violation for every pair of adjacent identical segments […XX…], unless those segments are separated by a prosodic boundary at least as strong as ω.

I assume that consonant shortening in Kaqchikel reflects the fusion of adjacent identical consonants into a single, short segment (Myers 1997). In OT terms, fusion is penalized by the constraint UNIFORMITY (McCarthy & Prince 1995). Shortening is therefore driven by the ranking OCP(X)$_\omega$ ≫ UNIFORMITY. As OCP(X)$_\omega$ does not apply across ω boundaries, it will correctly affect low-attaching prefixes [$_\omega$ LOWPREF-STEM], but not high-attaching prefixes [HIGHPREF = [$_\omega$ STEM]] (on the existence of such “proximity effects” in OCP-related phenomena, see Suzuki 1998; Zymet 2014; Stanton 2017).

3 Recursion vs. strict layering

To recap, only low-attaching prefixes are integrated into the same prosodic word as their stems. High-attaching prefixes, in contrast, are external to the ω containing their stems.

This raises the question of what prosodic category dominates high-attaching prefixes in the nested structure [HIGHPREF = [$_\omega$ STEM]]. Here there are two options: either high-attaching prefixes form a recursive prosodic word with their stems (19a); or they are dominated by a different level of the prosodic hierarchy, such as the CLITIC GROUP (19b) (also known as the COMPOSITE GROUP or PROSODIC WORD GROUP).

(19) a. [$_\omega$ HIGHPREF = [$_\omega$ STEM]]
b. [$_{\text{CLGR}}$ HIGHPREF = [$_\omega$ STEM]]

How can we distinguish between these two structures? An important first observation is that some high-attaching prefixes are themselves vowel-initial, and undergo [ʔ]-epenthesis like their stems:

(20) a. *ajik'* [**ʔ**aχ = **ʔ**ikˀ] 'domestic worker' (AGT-month)
b. Cf. *rajik'* [r-aχ = **ʔ**ikˀ] 'his/her domestic worker'
c. Cf. *rik'* [r-ikˀ] 'his/her month'

d. *achsamaj* [**ʔ**at͡ʃ = samaχ] 'obligation'
e. Cf. *rachsamaj* [r-at͡ʃ = samaχ] 'his/her obligation'

The presence of epenthetic [ʔ] at the left edge of these forms is consistent with (19a): if high-attaching prefixes are initial in *ω*, they should be eligible for [ʔ]-epenthesis just like any other vowel-initial word, *ω* being the domain of syllabification in Kaqchikel (section 2.1.1). Stated differently, high-attaching prefixes like (20) cannot acquire an onset consonant by resyllabifying with a preceding word at the phrase level, because syllabification is bounded by *ω*—hence [ʔ]-epenthesis applies as a regular repair for ONSET violations.

However, the forms in (20) are also compatible with the structure in (19b). If syllabification is blocked across *ω* boundaries, we might expect syllabification to be blocked across higher prosodic boundaries too, such as the boundary of a CLITIC GROUP. This reflects the common (though often implicit) view that processes blocked across a prosodic boundary of level κ are also blocked across stronger boundaries of level $\kappa + n$ (e.g. Selkirk 1980a; 1984: Ch.6; Wagner 2011; 2012; see also Edwards et al. 1991; Fougeron & Keating 1997; Cho 2004; Flack 2009). In that case, prefixes which are initial in the CLITIC GROUP would be equally expected to undergo [ʔ]-insertion, syllabification being blocked across the edge of a CLITIC GROUP as well as the edge of *ω*.

Empirically speaking, then, the forms in (20) do not yet allow us to decide between the two parses in (19). There are nonetheless conceptual reasons to favor the recursive parse (19a). There is no independent evidence for the CLITIC GROUP as a distinct prosodic category in Kaqchikel: there appear to be no categorical phonotactics which target a domain bigger than the morphological word, but smaller than the phrase. In contrast, the prosodic word is needed to determine the domain of other phonotactic processes beyond [ʔ]-insertion (e.g. stress assignment, stop aspiration, glide hardening, etc.; see Bennett 2016 and descriptive sources cited there). While these observations do not provide conclusive evidence in favor of *ω*-recursion over the CLITIC GROUP, they do clarify the analytical dilemma posed by the forms in (20): we must either accept recursion of *ω* (19a), or adopt a prosodic category (the CLITIC GROUP) (19b) which has a dubious and at best marginal status in Kaqchikel.

3.1 High-attaching prefixes in composition

The force of this objection increases when we consider the fact that multiple high-attaching prefixes can co-occur in Kaqchikel (21). When such prefixes are vowel-initial, each of them undergoes a separate instance of [ʔ]-insertion.

(21) Multiple high-attaching prefixes (Patal Majzul 2007: 59, 67, 82)
a. *in ajik'* [**ʔ**in = **ʔ**aχ = **ʔ**ikˀ]
1SG.ABS = AGT = month
'I am a domestic worker'

b. *öj achali'* [**ʔ**ɔχ = **ʔ**at͡ʃ = **ʔ**aliʔ]
1PL.ABS = COM = daughter.in.law
'we are co-parents-in-law (Spanish *consuegros*)'

Up to three high-attaching prefixes can be stacked in Kaqchikel, yielding in principle four loci for [ʔ]-insertion (three vowel-initial prefixes and a vowel-initial root/stem) (22).

(22) Multiple high-attaching prefixes (Patal Majzul 2007: 59)
at achajmak [**ʔ**at = **ʔ**at͡ʃ = **ʔ**aχ = makʰ]
2SG.ABS = COM = AGT = sin
‘You are an accomplice’

It’s clear that affix- and stem-initial [ʔ] is epenthetic in these cases because it alternates with zero, e.g. *achali’* [**ʔ**at͡ʃ = **ʔ**aliʔ] ‘co-parents-in-law’ vs. *wachali’* [w-at͡ʃ = **ʔ**aliʔ] ‘my co-parents-in-law’, *wali’* [w-aliʔ] ‘my daughter-in-law’.

The multiple application of [ʔ]-insertion in (21)–(22) is completely expected under the assumption that high-attaching prefixes induce a recursive *ω* structure: each high-attaching prefix will be initial in some *ω*, and so all such prefixes will be subject to the same patterns of *ω*-level phonology.[6]

(23) Prosodic structure of (22):
a. $[_{\omega}$ ABS = $[_{\omega}$ COM = $[_{\omega}$ AGT = $[_{\omega}$ ROOT]]]]
b. $[_{\omega}$ **ʔ**at = $[_{\omega}$ **ʔ**at͡ʃ = $[_{\omega}$ **ʔ**aχ = $[_{\omega}$ ˈmakʰ]]]]

To account for the three loci of epenthesis in (22) without prosodic recursion, we would need to assume *four* distinct prosodic categories, which must all be co-present in the same morphological word (24). This goes well beyond the number of distinct prosodic categories (two) which are standardly assumed to condition word-level phonology cross-linguistically in theories which reject prosodic recursion (e.g. *ω* and the Clitic Group; Nespor & Vogel 1986; Vogel 2009a; b; Vigário 2010).

(24) $[_{???}$ ABS = $[_{???}$ COM = $[_{\text{CLGR}}$ AGT = $[_{\omega}$ ROOT]]]]

As with the Clitic Group, I am not aware of any independent evidence for these additional prosodic categories in Kaqchikel, apart from [ʔ]-insertion itself. Nor is there any evidence that high-attaching prefixes are stratified into different prosodic levels, e.g. the comitative prefix *ach-* /at͡ʃ = / shows no indication of being systematically associated with a higher prosodic type than the agentive prefix *aj-* /aχ = /, as (24) would seem to suggest. Lastly, of these four prosodic categories, only one—the prosodic word *ω*—is grounded in morpho-syntactic structure, being mapped from morphological words and/or syntactic X^0 terminals (e.g. Nespor & Vogel 1986; Selkirk 2011; see Vogel 2009a; Itô & Mester 2013 for related discussion). The other three putative categories in (24) lack this important connection to constituency in other grammatical domains.

In sum, the phonological patterning of high-attaching prefixes in Kaqchikel can be straightforwardly modeled using recursion of the prosodic word *ω*. Without recursion, we are forced to accept an explosion of otherwise unmotivated word-level prosodic categories

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[6] A reviewer suggests that (23) could involve recursion of the Clitic Group rather than the prosodic word *ω*. This is logically possible, but unlikely: the prosodic domain at issue here is always word-sized or smaller, and often nothing more than a bare root, even in morphologically complex forms (e.g. *ik’* /ikˀ/ ‘month’ in (21a)). Standard practice in prosodic phonology would be to identify this category with the prosodic word *ω*.

Furthermore, the available evidence suggests that at most one word-level prosodic category is employed in Kaqchikel. Theoretically speaking, the status of the Clitic Group is much more tenuous than the status of the prosodic word *ω*. Indeed, recursion of *ω* is sometimes taken to obviate the need for the Clitic Group even in languages which show evidence of multiple word-level domains (e.g. Inkelas 1990; Selkirk 1995; Guzzo To appear; see section 6). For this reason too, it seems more likely that structures like (23) involve recursion of the prosodic word rather than the Clitic Group or any other higher category. As the reviewer acknowledges, the argument for recursion of *some* prosodic category goes through in any case.

to account for the same data. Though empirically successful, this is a Pyrrhic victory: the invocation of such *ad hoc* prosodic categories makes it basically impossible to falsify the Strict Layer Hypothesis, revealing the inadequacy of a theory of prosodic structure which does without recursive adjunction (i.e. unbalanced recursion) (2).

3.2 Against alternative parses

Patterns of [ʔ]-insertion provide strong evidence for recursion of the ω layer in Kaqchikel. However, there are at least two other parses for high-attaching prefixes which correctly generate [ʔ]-insertion without assuming either ω recursion or the overly-rich prosodic hierarchy rejected above. In this section I show that these two alternative parses make incorrect predictions about other aspects of the phonology of Kaqchikel.

The first alternative is to assume that high-attaching prefixes are themselves full prosodic words (25a) (as in the Sino-Tibetan language Chintang; Bickel et al. 2007), rather than being recursively adjoined to their stems (25b). The flat, non-recursive structure (25a) correctly predicts that [ʔ]-insertion should occur at the left edge of every high attaching prefix, because each such prefix introduces a new, independent prosodic word ω.

(25) a. [$_{\text{CLGr}}$ [$_{\omega}$ HighPref] = [$_{\omega}$ Stem]]
b. [$_{\omega}$ HighPref = [$_{\omega}$ Stem]]

However, (25a) wrongly predicts that high-attaching prefixes should behave like full ωs in other respects. In particular, the domain of stress in Kaqchikel is the prosodic word, but high-attaching prefixes are uniformly *unstressed* (stress is basically restricted to word-final position in Kaqchikel; see Bennett 2016 and references there). This suggests that high-attaching prefixes do not constitute prosodic words of their own.[7]

One could try to rescue this analysis by assuming that the domain of stress in Kaqchikel is the Clitic Group rather than the prosodic word ω. The lack of stress on high-attaching prefixes would then reflect the fact that stress is assigned only to the rightmost ω in the Clitic Group (25a).

This proposal runs into difficulties with compound stress. It has been argued that the Clitic Group is the unit which subsumes prosodic words belonging to the same morphological compound; for this reason it is also known as the Composite Group or Prosodic Word Group (e.g. Vogel 2009a; Vigário 2010 and references there). If stress is only assigned to the rightmost ω of the Clitic Group in Kaqchikel, it follows that morphological compounds should contain at most one stress. This prediction is not borne out: compounds may consist of multiple ωs, each bearing an independent stress prominence (26). (Some compounds carry just a single stress, but these compounds do not distinguish between the structures in (25); see footnote 12.)

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[7] Secondary stress has never been reported for Kaqchikel, and is only sporadically attested in Mayan languages more broadly (e.g. Bennett 2016; England & Baird 2017; DiCanio & Bennett To appear). There are two phonotactic patterns which diagnose stress in Kaqchikel: the presence of lax vowels, and the presence of a [ʔC] cluster. These are absolutely limited to stressed, word-final syllables, leading to alternations like *ninjäch'* [n-in-χ**ə**t͡ʃˀ] 'I shuck (corn)' vs. *jach'ab'äl* [χ**a**t͡ʃˀ-a-ɓ̥əl̥] 'corn shucker', and *ch'u'j* [t͡ʃˀu**ʔχ**] 'crazy' vs. *xich'ujïr* [ʃ-i-t͡ʃˀu**χ**-ɪr̥] 'I went crazy' (García Matzar et al. 1999: 18, 32–41; Patal Majzul 2007: 161–2, 185–6). Were there secondary stresses in Kaqchikel, we might expect lax vowels and [ʔC] clusters to occur in non-final positions, but they do not. There is thus no positive phonotactic evidence for secondary stress in Kaqchikel. Given the lack of such evidence, and recent skepticism over many purported cases of secondary stress in other languages (e.g. de Lacy 2007; 2014; Blaho & Szeredi 2011; Newlin-Łukowicz 2012; Gordon 2014; Tabain et al. 2014), it seems safest to assume that there is no word-level secondary stress at all in Kaqchikel.

(26) Some compounds in Kaqchikel (Patal Majzul 2007: 99–101; Brown et al. 2010: 153)
a. *b'anöy ch'akät* [ɓ̥a.ˈnɔj # t͡ʃˀa.ˈkətʰ] 'chair maker'
b. *meqeb'äl ya'* [me.qe.ˈɓ̥əl̥ # ˈjaʔ] 'water heater'

The presence of stress on the initial member of the compounds in (26) is confirmed by segmental evidence. The lax vowels /ə ɛ ɪ ɔ ʊ/ are restricted to stressed, ω-final syllables in Kaqchikel. In other positions, lax vowels neutralize with their tense counterparts /a e i o u/ (e.g. Chacach Cutzal 1990; García Matzar et al. 1999: 18, 36–41; Bennett To appear). The presence of a lax vowel thus indicates the presence of stress. The left-hand members of the compounds in (26) contain lax vowels, and so they must be stressed. This entails that there must be more than one stress per Clitic Group, contradicting the premise that stress is assigned *only* to the rightmost ω in the Clitic Group. I conclude from this inconsistency that the Clitic Group is not the domain of stress in Kaqchikel.[8] Together, these arguments show that high-attaching prefixes do not constitute full prosodic words of their own, falsifying the structure in (25a).[9]

A second possibility is that the high-attaching prefixes are not independent ωs, but rather independent *syllables* (σ):

(27) [$_\omega$ {$_\sigma$ HighPref}.{$_\sigma$ Stem}]

As discussed in section 2.1.1, initial [ʔ]-epenthesis is a special case of a general process which inserts [ʔ] into onsetless syllables in Kaqchikel. Now, if each high-attaching prefix must be separated from its stem by a syllable boundary (27), we correctly predict the presence of a word-medial epenthetic glottal stop whenever a high-attaching prefix combines with a vowel-initial stem (28).[10]

(28) *ajitz* 'witch' /aχ = it͡s/ (Patal Majzul 2007: 69)
a. [**ʔ**aχ.ˈ**ʔ**it͡s]
b. *[**ʔ**a.ˈχit͡s]

The downfall of this analysis is that it fails to account for the patterns of degemination discussed in §2.1.2. Low-attaching prefixes (29a) induce degemination, while high-attaching prefixes do not (29b).

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[8] One could of course deny that these compounds form a Clitic Group, but then the proposal that stress is assigned to the rightmost prosodic word in the Clitic Group becomes basically impossible to test: there are few, if any additional contexts where we might expect multiple prosodic words to be grouped into the same Clitic Group.

[9] There is a potential exception to this generalization. In non-verbal predicate constructions, high-attaching absolutive markers are sometimes transcribed with a lax vowel, suggesting that they are indeed full, stress-bearing ωs (e.g. *öj winaqi'* [ʔɔχ = winaqiʔ] 'we are people'; Patal Majzul 2007: 50). However, the facts here are somewhat unclear: sources differ in the transcription of vowel quality for these prefixes (compare e.g. Patal Majzul et al. 2000: 49–51 with Brown et al. 2010: 61), and they do not sound stressed to my ears (I am a native English speaker and second-language learner of Kaqchikel; on the phonetics of stress in K'ichean languages, see Baird 2014a; b). In any case, the core arguments presented here go through even if these absolutive prefixes constitute full prosodic words, since the other high-attaching prefixes are clearly unstressed, dependent elements.

[10] A number of mechanisms could be used to ensure that a syllable boundary follows the high-attaching prefixes: morpheme-specific alignment (e.g. McCarthy & Prince 1993; Kim 2010), prosodic prespecification (e.g. Idsardi 1992; Halle & Idsardi 1995; Özçelik 2014), and cyclic derivation (e.g. Kiparsky 1979; 1982; §5.1) are just some of the possibilities. The choice is of course immaterial, since the analytical claim involved—that high-attaching prefixes are followed only by syllable boundaries, and not ω-boundaries—is false.

(29) Degemination in the prefixal field (Patal Majzul 2007: 565)
a. Low-attaching prefix: degemination
xojjilijo' /ʃ-o**χ**-**χ**iliχoʔ/ → [ʃo.**χ**i.li.ˈχoʔ], *[ʃo**χ**.**χ**i.li.ˈχoʔ]
CPL-1PL.ABS-slip
'we slipped'

b. High-attaching prefix: no degemination
yajjinam [ja**χ**.**χ**i.ˈnam]
RELATED.BY.MARRIAGE = father.in.law.of.man
'second husband of a mother-in-law of a man'

This contrast cannot be due to syllable structure alone: if derived geminates are permitted across syllable boundaries, as with the high-attaching prefix *yaj-* /jaχ = / in [ja**χ**.**χ**i.ˈnam] (29b), why do low-attaching prefixes induce shortening (29a)? The faithful (but unattested) form *[ʃo**χ**.**χ**i.li.ˈχoʔ] (29a) also has syllable boundary between the two adjacent instances of [χ], but degemination applies regardless. (This contrast cannot be reduced to stress either, because both high- and low-attaching prefixes are unstressed; see the discussion above, and footnote 7.)

These patterns of consonant shortening indicate that something stronger than a syllable boundary intervenes between high-attaching prefixes and their stems, inhibiting degemination across the prefix-stem juncture. This is, of course, exactly the recursive *ω* structure proposed earlier, in which high-attaching prefixes differ from low-attaching prefixes in standing outside the prosodic word of their stem, [$_{\omega}$ HighPref = [$_{\omega}$ Stem]].

4 High-attaching prefixes as prosodic subcategorization

Glottal stop epenthesis and degemination jointly suggest that prefixes in Kaqchikel fall into two distinct prosodic classes. We might reasonably ask whether this phonological split in the prefix system can be reduced to some independent fact(s) about the morpho-syntax of Kaqchikel. In many languages, there is a correlation between the syntactic independence of morphemes and their prosodic independence (though see Zec 2005; Bennett et al. 2018; Tyler Submitted for counterexamples). In European Portuguese, for instance, pronominal enclitics form a close-knit phonological unit with the verb, but proclitics do not. Vigário (2003: Ch.5) attributes this contrast to the syntax: pronominal enclitics—but not proclitics—form a syntactic constituent with the verb. In this case, prosodic differences among morphemes need not be stipulated, being a direct reflection of differences in the underlying morpho-syntax.

The prefixal phonology of Kaqchikel cannot be reduced to morpho-syntactic structure in this way (see also section 5.1). The problem is simple: prefixes in Kaqchikel are *all* closely integrated with their stems in the morpho-syntax, but they do not show the same prosodic behavior (Bennett et al. 2018). Both high- and low-attaching morphemes have the morphological properties of regular affixes: they are bound morphemes which cannot occur in isolation; they are syntactically dependent on a following stem; and they must appear in a fixed, invariant position relative their stems.[11] These parallels cast doubt on the notion that high-attaching prefixes are somehow less tightly connected with their stems in the morpho-syntax than low-attaching prefixes.

As we've seen, low-attaching morphemes form a cohesive phonological unit with their stems—another indication that they are just normal affixes. Recall, too, that high-attaching

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[11] On affixes which *do* show mobility relative to their stems in Mayan languages, see Aissen (1987: 44–5); Woolford (2011), and Heaton (2016).

prefixes can occur closer to the root than low-attaching prefixes, e.g. *qajq'ïj* [q-aχ = ɠ̥iχ] 'our shaman (lit. day-keeper)' (Patal Majzul 2007: 73; sections 2.1.1, 5.1). This is a compelling indication that high-attaching morphemes must be true prefixes, and not morpho-syntactic clitics: affixes cannot in general attach to bases which already contain clitic material (Zwicky 1977; Zwicky & Pullum 1983; van Riemsdijk 1999; Anderson 2005). If the low-attaching morphemes are prefixes, then the high-attaching morphemes must be prefixes too.

The high-attaching prefixes *aj-* AGT and *ix-* FEM are nominalizers: they can combine with noun, verb, and adjective roots to produce nouns. The fact that these morphemes are category-defining is again strong evidence that *aj-* and *ix-* are affixes, not clitics. Nouns formed with *aj-* also differ, unpredictably, with respect to pluralization: some, but not all nouns derived by combining *aj-* with a root can be pluralized with the suffix *-a'* (Brown et al. 2010: 152). Other nominalizers, such as the suffix *-el* NMLZ, are more regular with respect to pluralization. The attachment of *aj-* to a stem thus feeds (and conditions) further affixation, indicating once again that *aj-* must be a prefix rather than a clitic (a point reinforced by the lexical idiosyncrasy of this pattern). Lastly, Bennett et al. (2018) point out that the high-attaching agentive prefix *aj-* may have an idiomatic, semi-compositional interpretation with certain stems, another property which is characteristic of affixes rather than clitics (e.g. *ajch'ak* [ʔaχ = t͡ʃˀakʰ] 'hawk' < AGT + 'meat'). These standard diagnostics for affixhood converge on the conclusion that both low- and high-attaching prefixes have a close morphological relationship with their stems.

Other morphological criteria also fail to explain why prefixes are divided into different prosodic classes. In particular, the distinction between high- and low-attaching prefixes cannot be reduced to the difference between inflection and derivation (section 5.1). All low-attaching prefixes are inflectional, and most high-attaching prefixes are derivational. However, absolutive agreement on non-verbal predicates is phonologically high-attaching, but inflectional, e.g. *in ula'* [ʔin = ʔulaʔ] 'I am a foreigner' (Patal Majzul 2007: 509) (Bennett et al. 2018; section 5.1). It follows that the phonological distinction between high- and low-attaching prefixes cannot be equated with the distinction between inflection and derivation.

The morpho-syntax of Kaqchikel thus fails to shed light on why prefixes fall into two distinct phonological classes. We might instead appeal to differences in the segmental phonology of these prefixes, but it turns out that no single segmental property reliably distinguishes the high-attaching prefixes from the low-attaching ones. To illustrate, consider the contrast between *awikäq'* [ʔaw-ikəqˀ] 'your slingshot' and *ajikäq'* [ʔaχ = **ʔ**ikəqˀ] 'a slingshot user' (Brown et al. 2010: 204, 216; Patal Majzul 2007: 175). The high-attaching agentive prefix *aj-* [ʔaχ =] conditions [ʔ]-epenthesis in the stem [ikəqˀ] 'slingshot', while the low-attaching 2SG.ERG prefix [ʔaw-] does not. These prefixes are segmentally quite similar, but nonetheless show different patterns of prosodic integration with their stems. This comparison suggests that the distinction between high- and low-attaching prefixes does not owe to segmental factors; similar comparisons between other high- and low-attaching prefixes yield the same result (e.g. /iʃ = / FEM vs. verbal /-iʃ-/ 2PL.ABS, or non-verbal /in = / 1SG.ABS vs. verbal /-in(w)-/ 1SG.ERG). Lastly, both high- and low-attaching prefixes are stressless, so their different prosodic behavior cannot be attributed to inherent differences in stressability either (i.e. high-attaching prefixes are not independent prosodic words; section 3.2).

Taken together, these facts suggest that there is no independent synchronic basis for the prosodic distinction between high- and low-attaching prefixes. Consequently, it appears that the division of prefixes into two prosodic classes must simply be stipulated.[12] For the sake of explicitness, I assume that high-attaching prefixes are lexically associated with the prosodic subcategorization frame in (30) (on prosodic subcategorization, see Inkelas 1990; 1993; Zec & Inkelas 1991; Chung 2003; Zec 2005; Paster 2006; Bickel et al. 2007; Yu 2007; Kabak & Revithiadou 2009; and Bennett et al. 2018).

(30) Prosodic subcategorization frame for high-attaching prefixes in Kaqchikel:
[$_\omega$ HighPref [$_\omega$]]

This subcategorization frame states that the stem for a high-attaching prefix must itself be a full prosodic word (the outer ω is actually predictable, being required by the constraint Match (X^0, ω) (13)). Simple lexical specification is thus responsible for inducing the recursive ω structure associated with high-attaching prefixes in Kaqchikel. Following Inkelas (1990: Ch.5) I assume that the subcategorization frame (30) plays an active role in determining the prosodic structure of complex words, and is essentially unviolated in surface forms (see also Kabak & Revithiadou 2009; Bennett et al. 2018).[13]

In words with the recursive structure (30), the outermost ω corresponds to a full morphological word, but the inner ω does not because it excludes at least one prefix. Recursion of ω with high-attaching prefixes therefore leads to violations of Match (ω, X^0), the constraint which prohibits prosodic words that do not correspond to morphological words (Selkirk 2009; 2011). The constraint enforcing the subcategorization frame (30) must therefore outrank Match (ω, X^0): SubCat $\gg$ Match (ω, X^0) (see Bennett et al. 2018; Tyler Submitted for discussion).

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[12] There is a probable *diachronic* source for the distinction between high-attaching and low-attaching prefixes in Mayan languages like Kaqchikel. Kaufman (2015) points out that the high-attaching prefixes *aj*- AGT and *ix*- FEM were historically independent roots; forms like *ajq'ij* [ʔaχ = ɠ̥iχ] 'shaman (lit. day-keeper)' were thus originally compounds (presumably the same was true for high-attaching *yaj*- 'related by marriage' and *ach*- COM). The historical morphological independence of these prefixes is thus reflected in their synchronic prosodic structure. Absolutive prefixes in Kaqchikel were originally morpho-syntactic clitics (and still are in some languages; Robertson 1992; Coon et al. 2014; Coon 2016), which may also account for their prosodic independence with non-verbal predicates in the modern language (see too Bennett et al. 2018).

There is little to no evidence that high-attaching morphemes like *aj*- AGT are *synchronically* roots in Kaqchikel: distributionally, they only occur in the prefixal constructions described here. Futhermore, even if these morphemes were roots, that alone would not account for their prosodic behavior, because there are various root-root compounds which pattern as single, non-recursive prosodic words, e.g. *Iximulew* [$_\omega$ ʔiʃim-ulew̥] 'Guatemala' < *ixim* 'corn' + *ulew* 'land' (note the lack of [ʔ]-insertion on the righthand member of the compound, and cf. *ulew* [**ʔ**ulew̥] 'land'; Patal Majzul 2007: 509; Brown et al. 2010: 154, 275). Some item-by-item prosodic specification would thus seem to be necessary even if morphemes like *aj*- AGT were taken to be roots rather than affixes.

There are some compounds which show initial [ʔ]-epenthesis in the right-hand member, e.g. *ch'amajij* [t͡ʃˀam-ʔaˈχiχ] 'bitter cane' (Patal Majzul 2007: 147, 164). Many of these compounds have only a single stress, falling on the final syllable. The lack of stress in the left-hand member of the compound can be diagnosed by the fact that underlying lax vowels become tense in this position (e.g. *ch'äm* [t͡ʃˀəm] 'bitter'; see section 3.2). Words with high-attaching morphemes could be root compounds of this prosodic type, though as stated above I believe they are more likely to be prefixes. The argument for prosodic recursion goes through in either case, because the recursive ω structures diagnosed by [ʔ]-insertion in section 3.1 do not depend on the morphological status of high-attaching morphemes in Kaqchikel.

[13] Subcategorization frames are necessarily item-specific, which means that the subcategorization frame in (30) must be independently specified for each high-attaching prefix. I believe that this synchronic redundancy reflects the parallel historical development of these prefixes (footnote 12), which were all morpho-syntactically independent at earlier stages of the language, but became more closely integrated with their stems over time (see also Condoravdi & Kiparsky 2002; Himmelmann 2014; Tyler Submitted).

One reason to believe that the subcategorization frame (30) is specified on an item-by-item basis comes from a comparison with other Mayan languages. In Poqomam, for instance, the completive aspect marker *x*- is low-attaching (i.e. bleeds epenthetic [ʔ]), but the incompletive aspect marker *n*- which co-occurs with 3SG.ABS arguments is high-attaching (i.e. co-occurs with epenthetic [ʔ]; Santos Nicolás & Benito Pérez 1998: 182-3; Bennett 2016: §2.4.3). This is in contrast with Kaqchikel, where all aspect prefixes appear to be low-attaching (see also Patal Majzul et al. 2000: 51–2).

The prosody of low-attaching prefixes requires no additional machinery: being regular affixes, and lacking special subcategorization frames like (30), they are prosodically integrated into a single ω with their stems. This mapping is again driven by the constraint Match (X^0, ω), which requires correspondence between morphological words and prosodic words (Selkirk 2009; 2011; see Bennett et al. 2018 for further details).

5 Against morpho-phonological alternatives

To fully defend the claim that the prefixal phonology of Kaqchikel provides evidence for prosodic recursion, I now consider two alternative analyses which rely on morpho-phonological mechanisms—level ordering and OO-Faithfulness—to account for the same data. As these mechanisms make no reference at all to abstract prosodic structure, their success would undercut the conclusion that Kaqchikel makes use of prosodic recursion at the ω level. In the following sections I argue that these two approaches are incompatible with the actual word-level morphology of Kaqchikel, and are therefore untenable.

5.1 Level ordering

The phonological differences between high-attaching and low-attaching prefixes could in principle be generated by level ordering, in the spirit of Lexical Phonology and Morphology (LPM) and its successors (e.g. Kiparsky 1982; 2000; Kaisse & Shaw 1985; Mohanan 1986; Bermúdez-Otero 2018, and many others; see also Wolf 2008). The central assumption of LPM and related frameworks is that morphology and phonology are cyclically interleaved: morphologically complex words are built incrementally, and phonological processes may apply at each intermediate derivational stage. In this way phonological processes may apply after some instances of affixation, but before others.

By way of illustration, consider some facts from English. Word-final [mb#] is disallowed in English, and is repaired by deletion of /b#/. This yields transparent alternations like *bomb* [bɑm] ~ *bombard* [bɑm.bɑɹd] under suffixation. However, in suffixed forms like *bombing* [bɑ.mɪŋ], word-final /b#/-deletion opaquely *over*applies.

A standard account of this contrast takes affixation and phonology to be serially interleaved (e.g. Borowsky 1993; Bermúdez-Otero 2011) (Figure 1). Assume, first, that affixation of *-ard* precedes all phonological computation. This suffix should then transparently bleed final /b#/-deletion. In contrast, if *-ing* is added to its stem *after* that stem has undergone some phonological processing—specifically, /b#/-deletion—we derive the fact that deletion opaquely overapplies in forms like *bombing*.

Further evidence for this approach comes from affix ordering: the word *bombarding* shows that *-ard* is morphologically closer to the root than *-ing*, just as expected if the affixation of *-ard* occurs earlier in the derivation of complex words than the affixation of *-ing*.

Can serial ordering between phonology and morphology account for the prefixal phonology of Kaqchikel? To begin, observe that low-attaching prefixes interact transparently with

<table>
<tr><th>/UR/</th><th>→</th><th><i>-ard</i> [-ɑɹd] affixation</th><th>→</th><th>Phonology</th><th>→</th><th><i>-ing</i> [-ɪŋ] affixation</th><th>→</th><th>[SR]</th></tr>
<tr><td></td><td></td><td><i>Bleeds</i></td><td></td><td>/b#/-deletion</td><td></td><td><i>Fails to bleed</i></td><td></td><td></td></tr>
<tr><td>/bɑmb/</td><td></td><td>|bɑmb-ɑɹd|</td><td></td><td></td><td></td><td></td><td></td><td>[bɑmbɑɹd]
<i>bombard</i></td></tr>
<tr><td>/bɑmb/</td><td></td><td></td><td></td><td>|bɑm|</td><td></td><td>|bɑm-ɪŋ|</td><td></td><td>[bɑmɪŋ]
<i>bombing</i></td></tr>
</table>

Figure 1: Level ordering architecture for English /b#/-deletion.

the word-level phonology of Kaqchikel, bleeding [ʔ]-insertion and feeding degemination as expected. High-attaching prefixes, for their part, interact opaquely with the word-level phonology, *failing* to bleed [ʔ]-insertion or to feed degemination. As in the case of English /b#/-deletion, this contrast naturally suggests an analysis in terms of serial ordering between affixation and phonological computation.

If the low-attaching prefixes enter the derivation at an early stage, prior to the first application of phonological processes, we correctly predict that they should bleed [ʔ]-epenthesis and feed degemination (Figure 2). If high-attaching prefixes are inserted later in the derivation, after the first phonological cycle, we correctly predict that they should pattern differently with respect to these same phonotactic generalizations (opaquely counter-bleeding [ʔ]-epenthesis and counter-feeding degemination). By sandwiching phonological processes between two stages of affixation in this way, level ordering can generate the observed phonological differences between high- and low-attaching prefixes.

There are at least two arguments against this counter-analysis. The first concerns its predictions for affix ordering in Kaqchikel. All of the low-attaching prefixes in Kaqchikel are inflectional, and most of the high-attaching prefixes in Kaqchikel are derivational (with the exception of absolutive agreement on non-verbal predicates, which is inflectional, (11)). The level ordering architecture in Figure 2 therefore predicts that inflectional prefixes should occur closer to the root than derivational prefixes, as they supposedly undergo affixation at an earlier stage. This is clearly a faulty prediction: it is a truism, perhaps a morphological universal, that derivational affixes are structurally closer to the root than inflectional affixes (e.g. Greenberg 1963). More to the point, this is incorrect for Kaqchikel: low-attaching inflectional prefixes like ergative *r*- 3SG.ERG are always farther away from the root than high-attaching derivational prefixes, when they co-occur (31).[14]

(31) *rajeyaj* [r-aχ = ʔej-aχ] (Patal Majzul 2007: 67)
3SG.ERG-AGT = tooth-UNPOSSESSED
LOW-HIGH = ROOT-SUFF
'his/her dentist'

/UR/	→	LOW-ATTACHING PREFIXES	→	**Phonology**	→	HIGH-ATTACHING PREFIXES	→	[SR]
		Bleed		[ʔ]-insertion		*Fail to bleed*		
		Feed		Degemination		*Fail to feed*		
/əkˀ/		|r-əkˀ|						[rəkˀ] *räk'* 'his/her chicken'
/oqˀeχ/				|ʔoqˀeχ|		|aχ = ʔoqˀeχ|		[ʔaχ = ʔoqˀeχ] *ajoq'ej* 'crybaby'

Figure 2: Possible level ordering architecture for phonology of Kaqchikel prefixes.

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[14] Treating high-attaching morphemes as morphological infixes rather than prefixes would not resolve the ordering issue. Consider (31): the derivation {*r*-prefixation} → {[ʔ]-insertion} → {*aj*-infixation} wrongly predicts that (31) should lack epenthetic glottal stop, since [ʔ] -insertion would have been blocked by the early addition of the low-attaching prefix *r*- 3SG.ERG, prior to the later addition of *aj*- (cf. (30)). This order of affixation would also violate Greenberg's (1963) generalization that inflection is normally further from the root, morphologically speaking, than derivation.

A second argument against the level ordering hypothesis in Figure 2 comes from the observation that both low-attaching prefixes and high-attaching prefixes may combine with bound roots. This is illustrated again with ergative markers and the agentive prefix *aj-* in (32).

(32) a. *chi'aj* [t͡ʃiʔ-aχ]
mouth-UNPOSSESSED
'(a) mouth'
b. *nuchi'* [nu-t͡ʃiʔ] (low-attaching)
1SG.ERG-mouth
'my mouth'
c. *ajchi'* [ʔaχ=t͡ʃiʔ] (high-attaching)
AGT-mouth
'chatty person'
d. **chi'* [-t͡ʃiʔ]
'mouth'

In stratal, level ordering frameworks like LPM, there is no morphological level prior to the level at which affixes attach to bound roots (e.g. Siegel 1974; Kiparsky 1982). We must therefore conclude that high-attaching and low-attaching prefixes enter morphological structure at the same early stage of the derivation (or at least may do so), given that both may attach to bound roots. The upshot is that level ordering cannot predict the distinct phonological patterning of low-attaching and high-attaching prefixes in Kaqchikel.[15] Prosodic structure—specifically recursive ω structure—is therefore indispensable for an adequate treatment of these facts.

To close, I note that other derivational approaches fail on similar grounds. In Distributed Morphology and related frameworks, it has been proposed that certain morphemes (often understood to be syntactic heads) are responsible for triggering the application of phonological processes (Halle & Kenstowicz 1991; Halle & Marantz 1993; 1994; Harley & Noyer 1999; Marvin 2002; Marantz 2007; Embick & Noyer 2007, etc.). Category-defining affixes are commonly singled out as morphemes which induce a cycle of rule application in their stems (see Embick 2010; 2014 for discussion). While some high-attaching, derivational prefixes are indeed category-defining—agentive *aj-*, for example, can derive nouns from verbal roots (14b)—we cannot simply say that category-defining/derivational morphemes trigger a cycle of phonological application, inducing glottal stop epenthesis in their stems. The reason is that category-defining *suffixes* like the nominalizer *-il* do not trigger glottal stop insertion (33).

(33) [ʔ]-epenthesis with derivational suffixes (Cojtí Macario et al. 1998: 394; Patal Majzul 2007: 380)
a. *ütz* [ʔʊt͡s] 'good (ADJ)'
b. *rutzil* [r-ut͡s-il̥] / **r(u)'utzil* [r(u)-ʔut͡s-il̥]
3SG.ERG-good-NMLZ
'his/her/its favor, goodness, improvement (NOUN)'

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[15] Given that regular inflection is typically assumed to occur at the final stage of a morphological derivation (e.g. Halle & Mohanan 1985; Halle & Mohanan 1985), it is perhaps surprising that ergative marking, a case of regular inflection, seems to apply at an early derivational level in Kaqchikel. Given the typically outermost positioning of inflection in this language, it does seem that regular inflection probably occurs at a fairly late stratum of word-formation. The difficulty lies in reconciling this observation with the fact that regular inflection satisfies the morphological requirements of bound roots, under the assumption that bound roots cannot proceed to the next morphological level until they are affixed (e.g. Siegel 1974; Allen 1979; Kiparsky 1982).

Additionally, high-attaching abs in non-verbal predicates (11) is clearly inflectional rather than derivational. This further undermines the connection between [ʔ]-insertion and derivational or category-defining behavior.

More generally, the phonology of high-attaching prefixes cannot be explained by assuming that these morphemes idiosyncratically trigger the application of phonological rules to their stems. High-attaching prefixes are resistant to degemination (§2.1.2); this fact cannot be attributed to a special cycle of rule application, precisely because degemination *does not apply* to these prefixes. Furthermore, the rule of [ʔ]-epenthesis shows no independent evidence of morphological conditioning—it is a completely general phonological rule, targeting onsetless syllables in all positions and contexts. This, too, suggests that the application of [ʔ]-epenthesis should not be tied too closely to the specific morphological structure of a given word.

5.2 Transderivational faithfulness

The theory of transderivational faithfulness (Benua 2000), also known as Output-Output Faithfulness, provides a different perspective on the phonological behavior of high- and low-attaching prefixes.[16] Within this theory, opaque interactions between affixation and phonology are attributed not to serial ordering, but to constraints which require phonological uniformity between stems and the complex words built on those stems (i.e. OO-Faith constraints).

To illustrate, Spanish has a process which neutralizes palatal consonants to coronal place word-finally (e.g. *desdén* /desdeɲ/ → [des.ˈðen] ‘disdain (noun.sg)’; Harris 1983: Ch.3.3; Lloret & Mascaró 2007, and references there). As expected, this process fails to apply when certain suffixes are added, such as adjectival *-oso* in *desdeñoso* [des.ðe.ˈɲo.so] ‘disdainful’. But depalatalization also *overapplies* when certain other suffixes are added, such as plural */-es/* in *desdenes* [des.ˈðe.nes] ‘disdains (noun.pl)’. Here, there is no phonological motivation for depalatalization to occur, as the stem-final nasal is no longer in final position in the word.

The overapplication of depalatalization in such forms can be understood as a case of OO-Faithfulness (Lloret & Mascaró 2007): the derived plural [des.ˈðe.nes] has a coronal nasal so as to stand in phonological conformity with the stem (or ‘base’) [des.ˈðe.nes] which it is built on. This pattern of base-derivative identity can be enforced with the constraint OO$_I$-Ident[place], which requires that all segments in the input substring /desdeɲ/ have the same place of articulation in the derivative [des.ˈðe.nes] as in the base [des.ˈðen]. This constraint is indexed to apply to words formed with certain affixes but not others, thereby deriving the contrast between plural /-es/ (34a) (opaque) and adjectival /-oso/ (34b) (transparent).[17]

(34) Spanish depalatalization as OO-Faithfulness

a.

		/desdeɲ-es$_I$/ Base: [des.ˈðen]	OO$_I$-Ident[place]	*ɲ#	IO-Ident[place]
a.		des.ˈðe.ɲes	W*!		L
b.	☞	des.ˈðe.ɲes			*

desdenes ‘disdains (noun.pl)’

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[16] I thank Sam Zukoff for raising the issues discussed in this section.

[17] Tableaux are given in the ‘mixed’ format recommended by Prince (2002); McCarthy (2008).

b.

/desdeɲ-oso/ BASE: [des.ˈðen]	OO$_I$-IDENT[PLACE]	*ɲ#	IO-IDENT[PLACE]
a. ☞ des.ðe.ˈɲo.so			
b. des.ðe.ˈno.so			W*!

desdeñoso ‘disdainful’

Such patterns of morphological misapplication are sometimes known as *closure effects* (e.g. Halle & Kenstowicz 1991; Benua 2000): in some complex words, the phonology of the base seems to be computed in isolation, without taking into account the presence of an outer affix (34a). The phonology of high-attaching prefixes in Kaqchikel is clearly a kind of closure effect, in that these prefixes do not interact phonologically with their stems in the expected, transparent way. The question is whether this closure effect is prosodic in nature, as I have argued, or whether it is conditioned morphologically (as under both cyclic/derivational approaches and OO-FAITHFULNESS).

We’ve already seen that a cyclic, level ordering analysis of the high-attaching prefixes makes incorrect predictions about the morphology of Kaqchikel. But what about OO-FAITHFULNESS? Is it possible that opaque forms like *ajoyowal* [ʔaχ = **ʔ**ojowal̥] ‘hothead’, with overapplication of [ʔ]-insertion, are generated under faithfulness to transparent bases like *oyowal* [**ʔ**ojowal̥] ‘anger’ (Patal Majzul 2007: 72, 300)?

It appears that the answer is no. The Achilles heel of OO-FAITHFULNESS is the stipulation that the base must be a “licit output word [and] morphologically well-formed” (Benua 2000: 5, 29–30, 200–5, 236, etc.). This stipulation is motivated, in part, by the long-standing observation that bound roots do not appear to be phonological domains of their own, and do not show closure effects like (34) (e.g. Kiparsky 1982; Inkelas 1990; 1993; Bermúdez-Otero 2011; 2012; 2018, etc.). For example, the Spanish bound root *puñ-* /puɲ-/—unlike the free root *desdén* /desdeɲ/ (34)—never undergoes depalatalization in any derived form (compare (34a) with *puños* [puɲ-os] ‘fists’, *puñar* [puɲ-aɾ] ‘to assault’, *puñal* [puɲ-al] ‘dagger’, etc.). Under OO-FAITHFULNESS, the lack of opaque closure effects with bound roots can be reduced to the fact that bound roots are not well-formed, independent words—there is no standalone word *[pun], with the transparent application of depalatalization, to be faithful to.

Kaqchikel presents an interesting empirical problem for both OO-FAITHFULNESS and cyclic/stratal frameworks: bound roots *do* show closure effects when hosting high-attaching prefixes (35)–(37).

(35) [ʔ]-insertion with *ach-* /at͡ʃ = / on bound root *-ali’* /-aliʔ/ (Patal Majzul 2007: 59, 81)

a. *achali’* [**ʔ**at͡ʃ = **ʔ**aliʔ]
COM = daughter.in.law
‘co-parents-in-law’

b. *rali’* [r-aliʔ]
3SG.ERG-daughter.in.law
‘her daughter-in-law’

c. *-*ali’* [-(**ʔ**)aliʔ] ‘daughter-in-law’

(36) [ʔ]-insertion with *yaj-* /jaχ = / on bound root *-al* /-al/ (Brown et al. 2010: 263; Patal Majzul 2007: 82, 348)

a. *yajal* [jaχ = **ʔ**al̥]
RELATED.BY.MARRIAGE = child.of.woman
‘stepchild (of a woman)’

b. *ral* [r-al̥]
3SG.ERG-child.of.woman
‘her child’

c. *-*al* [-(ʔ)al̥] ‘child of a woman’

(37) No degemination with *aj-* /aχ = / on bound root *-jïtz’* /-χɪt͡sˀ/[18] (Brown et al. 2010: 205; Patal Majzul 2007: 197; Cojtí Macario et al. 1998: 107)

a. *ajjitz’* [ʔa**χ** = **χ**it͡sˀ]
AGT = tie
‘mat maker’

b. *xjitz’* [ʃ-**χ**it͡sˀ]
COMPL = tie.PASS
“(s)he was tied’

c. *-*jïtz’* [-**χ**ɪt͡sˀ] ‘to tie’

This presents a “missing base” problem of the sort previously identified by Kiparsky (2000); Bermúdez-Otero (2011); Mascaró (2016), and others: OO-FAITHFULNESS cannot produce the opaque closure effects in (35)–(37) because there is no independent base *word* for the derived words to be faithful to.

This problem was anticipated by Benua (2000: Chs.4.2, 6.3), who proposes that in languages with rich, obligatory inflection the base may in fact consist of a bound stem (in its surface form) with inflectional affixes stripped away (see also Steriade 2008; To appear and references there). However, this strategy fails for forms like *yajal* [jaχ = **ʔ**al̥] (36), because inflected forms of the bound stem *-al* /-al/ also lack glottal stop, epenthesis being bled by the addition of a low-attaching prefix (e.g. *qal* [q-al̥] ‘our daughter’, (36b)).

Now, there are some cases where reference to a specific, affixed form of a bound root could help account for closure effects. For example, the stem *-ali’* /-aliʔ/ ‘daughter-in-law’ can surface with an epenthetic glottal stop when suffixed, i.e. *alib’ätz* [**ʔ**aliɓ̥-ət͡s] ‘daughter-in-law (UNPOSSESSED)’. It is at least logically possible that the opaque form *achali’* [ʔat͡ʃ = **ʔ**aliʔ] ‘co-parents-in-law’ (35) contains a phonologically gratuitous medial [ʔ] under pressure from an OO-FAITH relation to the form [**ʔ**aliɓ̥-ət͡s].

This analysis runs into two problems. First, as mentioned above, it simply fails in some cases: closure effects also occur for bound roots which never appear in word-initial position. The noun root *-al* /-al/ (36), for instance, never occurs without a prefix (either inflectional or derivational). The overapplication of [ʔ]-epenthesis in *yajal* [jaχ = **ʔ**al̥] (36a) cannot be driven by faithfulness to a base in which epenthesis applies transparently (i.e. *[-**ʔ**al̥]), because no such form exists anywhere in the paradigm. Epenthetic, stem-initial [ʔ] on *-al* /-al/ *only* occurs in the presence of high-attaching prefixes: this undermines the core premise of the OO-FAITHFULNESS approach, which attributes the misapplication of phonological processes in complex words to the influence of morphological bases with regular, transparent phonology.

Second, this analysis is profoundly opportunistic. It is certainly true that e.g. the medial glottal stop in [ʔat͡ʃ = **ʔ**aliʔ] could be conditioned by faithfulness to [**ʔ**aliɓ̥-ət͡s], which is built on the same root. But why should this particular form serve as the base for [ʔat͡ʃ = **ʔ**aliʔ], as opposed to any other word containing the same root? Inflected forms like *wali’* [w-aliʔ] ‘my daughter-in-law’, which lack epenthetic glottal stop, should be equally eligible to function as the base for [ʔat͡ʃ = **ʔ**aliʔ]. With no predictive theory of base

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[18] I do not know why the lax /ɪ/ in *-jïtz’* is reported to be tense /i/ in the derivative *ajjitz’* (Brown et al. 2010: 205).

selection, OO-Faithfulness lacks the explanatory power provided by prosodic recursion, which accounts for the same closure effects in a less stipulative fashion.[19] (See Bermúdez-Otero 2011: §6 for essentially the same argument in a different context, and Steriade To appear for related discussion.)

I conclude that the OO-Faithfulness account of closure effects in Kaqchikel prefixation should be dispreferred to prosodic recursion on both empirical and conceptual grounds.

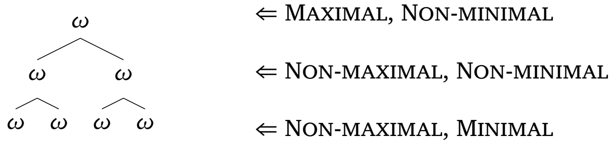
6 Discussion

In this article I have defended the claim that prosodic categories (particularly the prosodic word ω) can be recursively nested to a potentially unbounded depth of embedding (for related discussion, see Ladd 2008: Ch.8; Wagner 2010 and references there). This conclusion holds only for a specific kind of recursion, namely unbalanced recursion $[_\kappa\ [_{\neg\kappa}\ldots]\ [_\kappa\ldots]]$ (a.k.a. recursive adjunction; section 1). It remains to be seen whether balanced recursion $[_\kappa\ [_\kappa\ldots][_\kappa\ldots]]$, involving the recursive nesting of two sister nodes of the same category type, can be justified along similar lines (i.e. by means of categorical phonotactic patterning).

It's worth considering why some previous authors have rejected prosodic recursion, including unbalanced recursion, even while embracing the use of prosodic categories to define phonotactic domains. Here I focus on arguments against unbalanced recursion, the form of recursive embedding supported by the Kaqchikel data outlined above. Vogel (2009a; b) argues against prosodic recursion of any kind on the grounds that it predicts (wrongly, in her view) that each recursive level should be associated with the same phonotactic phenomena.[20] This is of course exactly what we've seen for Kaqchikel: each ω-level associated with a high-attaching prefix conditions exactly the same phonotactic patterns. But what of the cases where this prediction fails to hold? It seems that we're forced to the conclusion that (i) each ω in a recursive prosodic word can condition the same phonotactic patterns, and (ii) some ωs in a recursive prosodic word can condition different phonotactic patterns. How can we reconcile these apparently conflicting observations?

A promising answer comes from research on *recursive prosodic sub-categories* (e.g. Itô & Mester 2007; 2009; 2012; 2013; Elfner 2012; 2015; Bennett 2012; 2013; Martínez-Paricio 2012; 2013; Martínez-Paricio & Kager 2015, and others). The key idea shared by this line of work is that different levels of a recursive structure can be distinguished by their dominance relations (38). A minimal category κ_{MIN} is one that does not dominate any other instances of κ; a maximal category κ_{MAX} is one that is not dominated by another instance of κ (on the predicates "non-maximal" and "non-minimal", see Elfner 2015; Martínez-Paricio & Kager 2015).

(38) Recursive prosodic sub-categories (e.g. Itô & Mester 2007; 2009; Elfner 2015)



If phonotactic patterns can be sensitive to these relational properties, distinguishing between e.g. minimal prosodic words ω_{MIN} and maximal prosodic words ω_{MAX}, we can

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[19] An additional complication here is that high-attaching prefixes are mostly derivational rather than inflectional. This makes base selection even more complicated, since we cannot make reference to paradigmatic organization as a means of choosing the base, a strategy that has been exploited for opacity effects in inflectional morpho-phonology (e.g. Steriade To appear and references there).

[20] Vigário (2010) raises this same objection against balanced recursion, while arguing extensively in favor of unbalanced recursion elsewhere (Vigário 1999; 2003).

recapture the observation that different levels of a recursive prosodic structure may be associated with categorically distinct phonological phenomena (a point argued by the authors cited above).

To illustrate, let's consider a phonotactic restriction discussed by Vogel (2009a; b). In Italian, prosodic words (which correspond roughly to lexical words) cannot begin with the palatal lateral [ʎ] (39). Preverbal clitics like *gli* /ʎi/ 'to him', in contrast, may begin with [ʎ]. These clitics also stand outside the domain of stress assignment for the following verb (Peperkamp 1997: Ch.5). This suggests that preverbal clitics are external to the prosodic word containing their hosts, as they are not subject to the categorical phonotactics which hold in that domain.

(39) Italian: *[$_{\omega}$ ʎ…]
  a. *libro* [$_{\omega}$ libɾo] 'book'
  b. **glibro* [$_{\omega}$ ʎibɾo]
  c. *gli leggevo* [$_{\text{CLGR}}$ ʎi [$_{\omega}$ legːevo]] 'I was reading to him'

Assuming that pre-verbal dative clitics like *gli* /ʎi/ nonetheless form some kind of prosodic constituent with the following verb, what might that constituent be?[21] Vogel (2009a; b) suggests that it must be the Clitic Group (39c), since the unit in question seems to impose qualitatively different phonotactic restrictions than the prosodic word ω.

While I have argued that the Clitic Group is neither necessary nor desirable for an analysis of prefixal phonology in Kaqchikel, it is at least logically possible that *both* the Clitic Group and recursion of the prosodic word ω are needed to capture the full range of prosodically-conditioned phonotactics attested cross-linguistically (e.g. Guzzo To appear). The question, then, is whether the Clitic Group is in fact necessary to account for patterns like (39) which appear to implicate two distinct, and roughly word-sized prosodic domains.

An alternative analysis draws on the notion of recursive prosodic subcategories described above. Let's assume, first, that preverbal clitics form a recursive prosodic word with their hosts (40b). If the domain of stress assignment in Standard Italian is the minimal prosodic word ω_{MIN}, we will correctly exclude such clitics from the stress domain of the verb. Similarly, we can ban the palatal lateral [ʎ] from occurring at the beginning of lexical words, while still permitting it to occur as the first segment of a clitic, if we take ω_{MIN} to be the domain of this phonotactic restriction as well.

(40) Italian: *[$_{\omega\text{–MIN}}$ ʎ…]
  a. **glibro* [$_{\omega\text{–MIN}}$ ʎibɾo]
  b. *gli leggevo* [$_{\omega\text{–MAX}}$ ʎi [$_{\omega\text{–MIN}}$ legːevo]]

The advantage of this approach is that it accomodates both languages like Italian, in which there appear to be multiple word-level prosodic domains, but also languages like Kaqchikel, which provide strong evidence for a single, recursively-nested prosodic word ω. If recursion is included in our theory of prosodic phonology, as I have argued it must be, then recursive prosodic subcategories (38) should be further explored as a means of analyzing data that has previously eluded an adequate treatment in terms of recursive prosodic structure.

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[21] Cf. Peperkamp (1997: Ch.5), who argues that clitics in Standard Italian directly attach to the ϕ-phrase rather than forming a close prosodic unit with the verb. Vigário (2003) analyzes these and similar facts by assuming that clitics are introduced post-lexically, after word-level stress assignment and other lexical phonotactic processes have already applied (see also Anderson 2005).

To close, I want to emphasize that the CLITIC GROUP and the recursive prosodic word ω are not extensionally equivalent in their predictions. Only the recursive prosodic word predicts that dependent morphemes (affixes, clitics, etc.) could show the hallmarks of ω-level phonotactics while still remaining outside of the ω of their host or stem. Determinative evidence against the CLITIC GROUP would therefore come from any language in which (i) affixes or clitics provide this kind of evidence for prosodic recursion, and (ii) different levels of the recursive prosodic word ω behave differently with respect to some phonotactic properties, thereby implicating recursive prosodic subcategories over the CLITIC GROUP (see Itô & Mester 2009; Kabak & Revithiadou 2009 for discussion of possible cases of this sort).

Abbreviations

1 = first person; 2 = second person; 3 = third person; SG = singular; PL = plural; ABS = absolutive; ERG = ergative; ASP = aspect; INCPL = incompletive aspect; CPL = completive aspect; INTR = intransitive; POS = positional; NMLZ = nominalizer; AGT = agentive; FEM = feminine; COM = comitative; ADJ = adjective; SLH = Strict Layer Hypothesis; OT = Optimality Theory; ω = prosodic word; σ = syllable

Ethics and Consent

Fieldwork involving human subjects was conducted with the approval of the Yale University Human Subjects Committee, under Institutional Review Board Protocol #1305011957.

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Competing Interests

The author has no competing interests to declare.

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