[t]-epenthesis revisited. The case of Apurucayali

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Abstract
This paper proposes a new deletion analysis of [t]-zero alternations in Ajyíninka Apurucayali (often cited as 'Axininca Campa'). It is argued that the analysis assuming /t/-deletion fares better than an insertion analysis in two respects. First, the insertion analysis predicts an unattested stem type for verbs. Second, the insertion analysis fails to capture a generalization about hiatus resolution whereby vowel sequences undergo deletion, shortening, long vowel formation, or diphthong formation in a set of morphologically unrelated environments. The deletion analysis relies on the notion of preservation of the marked (de Lacy, 2006) and utilizes an independently motivated stratal organization of Apurucayali phonology in accounting for restrictions on verbal stems. The proposed analysis has important implications for the typology of epenthesis.

Keywords: epenthesis, insertion, coronal consonant, markedness, optimality theory, preservation of the marked, Ajyíninka Apurucayali, Axininca Campa

1. Introduction

This paper presents a new deletion analysis of [t]-zero alternations in Ajyíninka Apurucayali, a Maipurean language of Peru (Payne, 1981; Payne *et al.*, 1982). Although the language is known to phonologists as 'Axininca Campa', this name is considered pejorative (Lewis *et al.*, 2013), and therefore I will be referring to the language as Ajyíninka Apurucayali or AA.

Apurucayali has attracted considerable attention in the phonological literature (Yip, 1983; Levin, 1985; Itô, 1986, 1989; Spring, 1990a; b; c, 1992; Black, 1991; McCarthy & Prince, 1993), and its [t]-zero alternation has often served as a prime example of epenthesis (Rosenthall, 1997b; Casali, 1998, 2011; de Lacy & Kingston, 2013; Morley, 2015). Moreover, the AA [t]-zero alternation has served as important evidence for a particular view of place markedness among consonants (de Lacy, 2002, 2006; Lombardi, 2002).

The important implications of the [t]-zero alternation in AA only hold if this alternation is indeed an example of phonological epenthesis. However, the original sources (Payne, 1981; Payne *et al.*, 1982) mention that the alternation could in principle be analyzed as deletion (see also Spring, 1990b). More recently, Morley (2015) argues that a deletion rule could capture the AA data, based on the count of suffixes undergoing vs. those not undergoing [t]-zero alternations.

However no complete deletion analysis of Apurucayali [t]-zero alternations has been proposed to date, and therefore the implications of AA for the theory of markedness and for Optimality Theory remain somewhat blurred. This paper argues that a deletion analysis is possible for AA but the relative (un)markedness of coronals does not hinge on analyzing the AA pattern as insertion. On the proposed deletion analysis the constraints requiring preservation of the marked (de Lacy, 2006) ensure that [t] undergoes deletion while other stem-final consonants are protected from ending up in a coda via vowel epenthesis.

The paper shows that the deletion analysis is not just possible, but may be preferable for AA. Several novel arguments in favor of the deletion analysis and against the epenthesis analysis are presented. First, the epenthesis approach predicts an unattested type of verb stems in AA: such stems would have a final [t] before vowel-initial suffixes, and a final [ta] before consonant-initial suffixes. On the deletion account this unattested stem type is excluded. Second, a detailed examination of all AA suffixes shows that hiatus is resolved via the same strategies across multiple suffixal environments: diphthong formation, long vowel formation, and vowel deletion. The deletion analysis is compatible with a general account of AA hiatus resolution, while the insertion account has to treat the different instances of the same process as a coincidence.

The proposed analysis is framed within Optimality Theory (Prince & Smolensky, 2004), and it relies on preservation-of-the-marked constraints (de Lacy, 2006). Furthermore, my analysis assumes that AA phonology has several strata with different rankings, in line with Stratal OT (Bermúdez-Otero, forthc.; Kiparsky, forthc., 2000). This latter assumption is independently motivated in the alternations of AA velar glide (Black, 1991; Spring, 1992; McCarthy & Prince, 1993).

The rest of the paper is structured as follows. Section 2 presents some background on AA. Section 3 introduces the deletion and insertion analyses, and assesses their predictions with respect to verbal stem-suffix boundaries. Section 4 considers the predictions of these analyses for other environments, and section 5 concludes.

2. Apurucayali basics

The principal source on AA is Payne (1981). Page references in the text and examples are abbreviated as ‘P’ for Payne (1981) and ‘Pea’ for Payne *et al.* (1982). The texts collected in Payne (1981) have glosses and transcriptions on different pages. Therefore the examples coming from texts are referred to by abbreviated text name and the number of sentence. The following abbreviations are used for text names: ‘B’ for *Beetle*, ‘C’ for *Conversation*, ‘Cn’ for *Canoe,* ‘RB’ for *Red bird.*

The segment inventory of AA is given in (1). Following Payne (1981), I adopt a phonemic transcription, which abstracts away from the allophonic processes. Some of the relevant instances of allophonic variatiuon are described below (see Payne *et al.* (1982) for a complete survey).

(1) Ajyíninka Apurucayali inventories

a. Consonants

p	t, t^h		k	
	ts, ts^h	tʃ, $tʃ^h$		
	s	ç		h
m	n	ɲ		
	r	r^j		
ʋ		j	ɰ	

b. Vowels

i iː		
		o oː oi
	a aː ai	

The bilabial approximant /ʋ/ is realized as [w] after /o/, which in this environment changes to [u], so /oʋ/ is pronounced [uw]. /ʋ/ also appears as a fricative [β] in the environments #_i and i_i, where [i] is tense. In addition to the consonants in (1a), Payne

(1981) uses the symbol 'N' for an underlying unspecified nasal which always appears before consonants and undergoes place assimilation. Surface [ŋ] may result from /N/, but it is never contrastive. The analysis of NC clusters is further discussed in section 3.1. /s/ is realized as [ʃ] before /i/ (and /i/ may be subsequently deleted in this context if unstressed).

Vowels are devoiced utterance-finally. Stress is predictable and involves a complicated pattern based on vowel length, and the quality of the onset. The stress rules are described in Payne *et al.* (1982, chapter 10). Stressed /i/ is realized as [ɨ] after dental fricatives and affricates /s ts tsʰ/, except if followed by /j/. Unstressed /i/ is deleted in this environment, although its presence is recoverable phonetically at least for /s/ which is realized as [ʃ] in this environment.[1]

Word-medial syllables are of the form CV(:). Onsetless syllables are allowed, but only word-initially. The only possible coda is an assimilated nasal which only occurs before obstruents and which may also be treated as prenasalization on a following segment. Word-final consonants are not allowed.

3. /t/ after verb stems in Ajyíninka Apurucayali

This section first presents the core data on AA [t]-zero alternations at stem-suffix boundaries in verbal morphology (section 3.1). The deletion analysis is described in 3.2. Section 3.3 compares the deletion analysis to the existing *insertion* analyses, and formulates the predictions that differentiate the two analyses.

3.1 Core data: stem-suffix boundaries in verbs

The bulk of [t]-zero alternations in AA happens at a boundary between a verbal stem and a suffix. In what follows, the underlying shape of verbal stems is analyzed in accordance with the deletion analysis in 3.2 – hence the underlying forms in the examples differ from those in the original sources.

The verb stems attested in my data corpus may end in any consonant with the exception of aspirates and /ts/. As illustrated in (2a)[2] the final consonant of the verb stem always appears before vowel-initial suffixes. Before a consonant, a stem-final dental /t/ is deleted (2b), while other consonants survive and the cluster is resolved via [a]-insertion (2c). Some of the surface forms in (2) show the effects of vowel lengthening which applies after /ç/ and before the subjunctive suffix /ta/.

(2) Vowel insertion and consonant deletion after verbal stems

a. V-initial suffixes (P: 238, unless noted)

/i-N-komat-i/	[iŋkomati] 'he will paddle' (P: 108)
'3PM-FUT-paddle-FUT'	
/i-N-tʃʰik-i/ '3PM-FUT-cut-FUT'	[iɲtʃʰiki] 'he will cut' (P: 108)
/oNpoh-ak-i-na-ʋi/	[ompohakinaʋi]
'bump_head-PRF-NFUT-1P-EXCL'	'yes, I bumped my head (excl.)' (P: 29)

[1] Note that /ts tsʰ/ are not reported to become alveopalatal before /i/.

[2] Abbreviations used: 123 (person); 3pm/f (3rd person masculine and feminine); 1pi (1st person inclusive); ARR(ival); CAUS(ative); CNT(continuative); DIM(inutive); EXCL(amative) FUT(nonreflexive future); NFUT(nonreflexive nonfuture); NOMZ.M/F(masculine/feminine nominalization); NPS (non-possessive); PL(ural); PRF(perfect); RES(olved); RFL(reflexive); VER(ity), SBJ(subjunctive)

/no-pij-ak-i-ro/	[nopijakiro]
‘1P-lose-PRF-NFUT-3PF’	‘I have lost (to her, it)’
/no-miç-ak-i-ro/	[nomiça:kiro]
‘1P-peel-PRF-NFUT-3PF’	‘I have peeled (to her, it)’
/no-kis-ak-i-ro/	[nokisakiro]
‘1P-be_angry-PRF-NFUT-3PF’	‘I have been angry (to her, it)’
/no-kin-ak-i/	[nokinaki]
‘1P-go_about-PRF-NFUT’	‘I have gone about’
/no-ir-ak-i/ ‘1P-drink-PRF-NFUT’	[niraki] ‘I have drank’

b. [t]-final stems with C-initial suffixes (P: 55)

/i-N-komat-pirot-i/	[iŋkomapiroti]
‘3PM-FUT-paddle-VER-FUT’	‘he will paddle well’
/i-N-pisit-pirot-i/	[impisipiroti]
‘3PM-FUT-sweep-VER-FUT’	'he will really sweep'

c. Other stems with C-initial suffixes (P: 242 unless noted)

/i-N-tʃ^{h}ik-pirot-i/	[iɲtʃ^{h}ikapiroti]
‘3PM-FUT-cut-VER-FUT’	‘he will cut it well’ (P: 108)
/h-oNpoh-ʋait-ak-a/	[hompohaʋaitaka]
‘3PM-bump_head-CNT-PERF-NFUT.RFL’	‘he bumped his head’ (B 174)
/o-N-pij-ʋait-i-ta/	[ompijaʋaiti:ta]
‘3PF-FUT-lose-CNT-FUT-SBJ’	‘she might lose continually’
/o-N-miç-ʋait-i-ro-ta/	[omiça:ʋaitiro:ta] ‘she might
‘3PF-FUT-peel-CNT-FUT-3PF-SBJ’	peel continually (to her, it)’
/o-N-kis-ʋait-i-ro-ta/	[oŋkisaʋaitiro:ta] ‘she might
‘3PF-FUT-be_angry-CNT-FUT-3PF-SBJ’	be angry continually (to her, it)’
/o-N-kin-ʋait-i-ta/	[oŋkinaʋaiti:ta]
‘3PF-FUT-go_about-CNT-FUT-SBJ’	‘she might go about continually’
/o-ir-ʋait-i-ta/	[iraʋaiti:ta]
‘3PF-drink-CNT-FUT-SBJ’	‘she might drink continually’

The only reported consonant sequences of Apurucayali consist of a nasal followed by a homorganic stop. Thus verb stems may end it NC, and these stems always retain their final consonant, even if it is coronal (3).[3] The NC 'sequences' behave as single consonants in all relevant respects, and they can be treated as prenasalized stops (cf. Duanmu, 2009). In what

[3] The data on NC-final stems is somewhat limited. Thus there are stems ending in /^{n}k/ such as /t^{h}o^{n}k-/ ‘finish’, but I could not locate any examples of such stems before consonant-initial suffixes. The final consonant is trivially retained before vowels.

follows, I transcribe NC as prenasalized segments, in accordance with the monosegmental interpretation.

(3) Verb stems ending in prenasalized coronals (P: 113)

/i-N-ka^{n}t-i-ro/ '3PM-FUT-say-FUT-3PF' [i^{ŋ}ka^{n}tiro] 'he will say to her'

/ka^{n}t-pirot-aː^{n}ts^{h}i/ 'say-VER-INF' [ka^{n}tapirotaː^{n}ts^{h}i] 'to say well'

To summarize, on the deletion analysis all AA verbal stems end in a single consonant, but /t/-final stems are special in that they lose their final consonant before consonant-initial suffixes, rather than triggering [a]-epenthesis.

3.2 Deletion analysis

The deletion analysis rests on two main assumptions. First, it is assumed that all AA verbal stems end in a consonant. Second, the special behavior of /t/-final stems is attributed to the preservation of the marked. These assumptions are explored in detail and implemented in what follows.

The restrictions on AA verbal stems are not accidental, but phonologically motivated in this analysis. I propose that these restrictions arise at an early stratum in AA phonology. I will refer to the relevant stratum as 'stem level', roughly corresponding to the 'prefix level' of McCarthy & Prince (1993). This account assumes that the phonology of AA is organized in strata, with different constraint ranking, as in Stratal OT (Bermúdez-Otero, forthc.; Kiparsky, forthc., 2000). This premise is shared by most existing approaches, and it is independently motivated by the alternations of AA velar glide (Black, 1991; Spring, 1992; McCarthy & Prince, 1993; Staroverov, 2014).

In AA, the stem-level ranking requires all verbs to end in a consonant. This is enforced by a version of the constraint FINAL-C (McCarthy, 1993) which is indexed to verbal stems (4).

(4) FINAL-C_{VB}: assign a violation for a word which is a verb and which does not end in a consonant

This particular formulation of AA morpho-phonological restrictions relies on the theory of indexed constraints (Pater, 2000, 2006), but other approaches to morphology-phonology interface (Inkelas *et al.*, 1997; Bermúdez-Otero, 2012) can be used to produce a similar result, see Trommer (2013) for an analysis of a similar pattern in Albanian.

The stem-level restrictions enforced by FINAL-C_{VB} allow any consonant to occur at the end of a verbal stem. However, the aspirated consonants [t^h, ts^h, tʃ^h] never end up in stem-final position. This restriction can be captured by assuming that AA stem level neutralizes laryngeal specifications of obstruents in the coda. In addition, no verbal stems end in /ts/ – this has to be treated as an accidental gap on any analysis.

Codas are not allowed in AA on the surface, but verbal stems are required to end in a coda consonant at the stem level. Thus, the stem level must differ from later strata in the relative ranking of and FINAL-C_{VB} and NOCODA in (5) . While verbal stem restrictions are more important than NOCODA at the stem level (FINAL-C_{VB} >> NOCODA), at later strata codas are strictly prohibited (NOCODA >> FINAL-C_{VB}).

(5) NOCODA: assign a violation for a every syllable which ends in a consonant

At the stem level, FINAL-C_{VB} must also dominate some faithfulness constraint, so that the underlyingly vowel-final verb stems do not survive unchanged. However, the exact ranking of faithfulness constraints and the repair strategies triggered by FINAL-C_{VB} at the stem level are hard to ascertain based on the available data. Crucially the high ranking of FINAL-C_{VB} at the stem level is compatible with other processes which are assumed to apply at this level (McCarthy & Prince, 1993; Staroverov, 2014).

At the word level (the 'suffix level' of McCarthy & Prince (1993)), codas are no longer allowed, and the consonant-final verb stems have to be repaired when attaching a consonant-initial suffix. In this context, the /t/-final stems delete their last segment, whereas all other stems trigger [a]-insertion.[4] The different behavior of /t/ and other consonants in clusters can be attributed to *preservation of the marked*. De Lacy (2006) argues extensively that marked consonants tend to be preserved in neutralization and assimilation processes, and therefore it is no surprise that they resist deletion.[5]

The preservation of the marked hypothesis can be implemented for deletion by assuming that each markedness hierarchy projects a stringent hierarchy of MAX-C constraints, defined by the constraint schema in (6).

(6) Max-C{*F-Place*}: assign a violation mark for every input consonant C such that C is specified for a place feature belonging to {*F-Place*} and C has no correspondent in the output

For example, the place hierarchy projects: MAX-C{Dorsal}; MAX-C{Dorsal,Labial}, MAX-C{Dorsal,Labial,Coronal}, MAX-C{Dorsal,Labial,Coronal,Glottal}. Each of these constraints assigns a violation mark if a consonant specified for a particular place has no correspondents in the output. Similarly, on the continuancy hierarchy the [–continuant] stops are less marked than [+continuant] segments (de Lacy, 2006), and therefore the schema in (6) projects the constraints MAX-C{+continuant} and MAX-C{+continuant,–continuant}, the latter constraint being equivalent to the general Max-C.

Note that the preservation-of-the-marked version of MAX-C in (6) does not necessarily imply that features stand in correspondence (McCarthy, 1995; Pulleyblank, 1998; Lombardi, 1999, 2001; Howe & Pulleyblank, 2004), since violations of these constraints are assessed based on segments, rather than on features.

Consonant deletion competes with vowel insertion in AA consonant cluster resolution. This latter strategy is penalized by the constraint DEP-V in (7), adapted from McCarthy & Prince (1995, 1999).

(7) DEP-V: assign a violation for every output segment in a syllable nucleus that does not have a correspondent in the input

On the deletion analysis, /t/ is deleted in Apurucayali clusters precisely because it is the relatively unmarked consonant. The analysis of [t]-deletion is presented in (8) for the form [i^{ŋ}komapiroti] ‘he will paddle well’ (2b). Throughout the paper, I will use the comparative tableau format of Prince (2002) while noting the number of violations with integers.

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[4] The velar glide /ɰ/ undergoes deletion in a superficially similar environment, but this process applies at a later stratum. At the word level /ɰ/ behaves just like other non-coronals in triggering [a]-insertion (Black, 1991; Spring, 1992; McCarthy & Prince, 1993; Staroverov, 2014).

[5] De Lacy (2006: 397-8) finds no clear cases where the least marked segment is preferentially deleted, but his theory leads us to expect such cases.

(8) /t/ deletion in Ajyíninka Apurucayali

/i-N-komat-pirot-i/	NoCoda	Dep-V	Max-C {Dor,Lab,Cor}	Max-C {+cont,–cont}
☞ a. i.ᵑko.ma.pi.ro.ti			1	1
b. i.ᵑko.ma.ta.pi.ro.ti		W1	L	L
c. i.ᵑko.mat.pi.ro.ti	W1		L	L

The fully faithful candidate (8c) would create a coda, and this is not allowed by the high-ranked NoCoda at the relevant stratum in AA phonology. On the other hand, simplifying the input /tp/ cluster by inserting a vowel is impossible because Dep-V dominates all the Max-C constraints protecting /t/ from deletion (8b). Thus the candidate which deletes the stem-final coronal stop (8a) emerges as the winner.

On the other hand, all consonants but [t] are preserved in consonant clusters because they have more marked feature values than [t]. The tableau in (9) analyzes the fact that stem-final continuants are not deleted. This is illustrated for stems in /h/ such as /oNpoh/ in [hoᵐpohaʋaitaka] 'he bumped his head' (2c).

(9) Preservation of the marked in AA: fricative-final stems

/h-oNpoh-ʋait-ak-a/	NoCoda	Max-C {+cont}	Dep-V	Max-C {+cont,–cont}
☞ a. ho.ᵐpo.ha.ʋai.ta.ka			1	
b. ho.ᵐpo.ʋai.ta.ka		W1	L	W1
c. ho.ᵐpoh.ʋai.ta.ka	W1		L	

The tableau (9) illustrates the effects of preservation of the marked. The stem-final continuant /h/ does not undergo deletion (9b), because it is protected by the constraint Max-C{+cont} which dominates Dep-V. Just as in (8), the faithful candidate (9c) loses because it has a coda.

Stem-final stops other than /t/ are preserved because of their marked place. The tableau in (10) illustrates this for the /k/-final stem /tʃʰik-/ in [iⁿtʃʰikapiroti] 'he will cut it well' (2c).

(10) Preservation of the marked in AA: stems ending in dorsal consonants

/i-N-tʃʰik-pirot-i/	NoCod	Max-C {Dor,Lab}	Dep-V	Max-C {Dor,Lab,Cor}
☞ a. i.ⁿtʃʰi.ka.pi.ro.ti			1	
b. i.ⁿtʃʰi.pi.ro.ti		W1	L	W1
c. i.ⁿtʃʰik.pi.ro.ti	W1		L	

The evaluation in (10) is largely parallel to the one in (9). Stem-final /k/ cannot be deleted because it is protected by the constraint Max-C{Dor,Lab} which preservs dorsal and labial consonants and which dominates Dep-V (10b). In a similar fashion, the stem-final coronal sonorant /n/ is preserved because it has a marked value [+sonorant] while the stem-final aspirated /tʰ/ survives deletion because it has a marked specification [+spread glottis].

In sum, although the constraint Dep-V is dominated by Max constraints responsible for the preservation of marked consonants, Dep-V dominates all Max constraints pertaining to the unmarked coronal stop, e.g. Max-C{Dor,Lab,Cor} and Max-C{+continuant, –continuant}. Thus coronal deletion is a preferred cluster resolution strategy in AA.

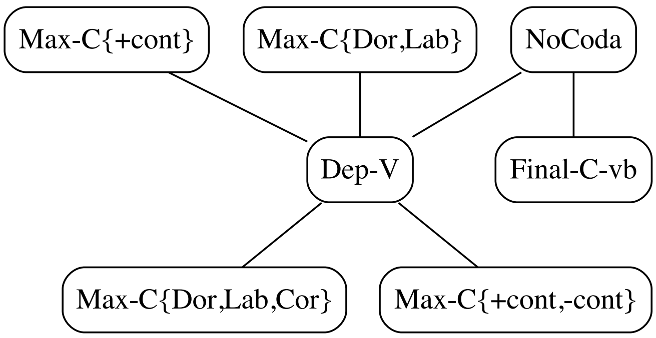
The analysis presented so far also makes a prediction about /t/-initial suffixes: these suffixes should lose their initial /t/ when attached to consonant-final stems, at least if the stem does not end in /t/. None of the constraints introduced so far impose any restrictions on whether the first or the second consonant of an underlying cluster should be deleted, the proposed ranking only dictates that the unmarked /t/ is deleted. Furthermore, /t/-deletion is preferred over vowel insertion (8), and thus if the stem /tʃʰik-/ 'cut' combined with a hypothetical suffix /-ti/ to form /tʃʰik-ti/, the output of the grammar developed so far would be [tʃʰiki]. Unfortunately, the /t/-initial suffixes are only recorded after vowel-final stems in AA, and therefore this prediction cannot be tested with actual data. In the typology, deletion of the first consonant is reported to be a preferred strategy for resolution of C_1C_2 clusters (Wilson, 2000; McCarthy, 2008b), and the existing accounts of this generalization could in principle be extended to the AA data, if AA was found to conform.

(11) provides a summary of AA grammar established so far by listing all the necessary ranking conditions.

(11) Apurucayali constraint hierarchies

a. Stem-level: Final-C_{VB} >> NoCoda

b. Word-level



The proposed stem-level ranking ensures that all verbal stems end in a consonant. The word-level ranking of Apurucayali in turn avoids codas in two ways: stem-final /t/ is deleted before consonant-initial suffixes, while all other consonants trigger [a]-insertion in this context. The next section compares this proposal to the insertion analysis of McCarthy & Prince (1993), Lombardi (2002), and de Lacy (2006), and highlights the different predictions.

3.3 The insertion analysis contrasted with the deletion analysis

The deletion analysis presented above contrasts with the *insertion* or *epenthetic* analysis (Payne, 1981; Payne *et al.*, 1982; Spring, 1990b; McCarthy & Prince, 1993; Lombardi, 2002; de Lacy, 2006). The two approaches differ dramatically in the underlying forms that they assume, and to distinguish between the two I will symbolize the URs on the insertion analysis with "//$_e$", and use the /(t)/ notation to represent morphemes in a way which is neutral to /t/-zero alternations.

In the epenthetic approach, the data in (2) stem from two insertion processes, rather than [a]-insertion and /t/-deletion. The consonant [t] is inserted between two vowels, and [a] is inserted between two consonants. Thus the verb stem 'to paddle' would underlyingly be /koma/$_e$, and it would alternate as in (12).

(12) Epenthesis analysis: [t]-insertion after verbal stems

/i-N-koma-i/$_e$ '3PM-FUT-paddle-FUT'	[i^{ŋ}komati] 'he will paddle' (P: 108)
/i-N-koma-piro-i/$_e$	[i^{ŋ}komapiroti]
'3PM-FUT-paddle-VER-FUT'	'he will paddle well' (P: 55)

This example also illustrates an alternating suffix /piro(t)/ 'VERITY'. The alternations arising at suffix boundaries will be discussed in detail in section 4.

In many respects the deletion and insertion analyses are mirror images of each other. However, unlike the deletion approach, the insertion analysis assumes no restrictions on verbal stems. Thus, verb stems may in principle end in any vowel or consonant. Given the OT's assumption of Richness of the Base (Prince & Smolensky, 2004), this predicts that there should be /t/-final stems, such as hypothetical /pat/$_e$ in (13). This stem would surface as [pat] before vowel-initial suffixes and as [pata] before consonant-initial suffixes.

(13) Epenthesis analysis: predicted /t/-final stems

/i-N-pat-i/ '3PM-FUT-PAT-FUT'	*[i^{m}pati] 'he will PAT'
/i-N-pat-pirot-i/ '3PM-FUT-PAT-VER-FUT'	*[i^{m}patapiroti] 'he will PAT well'

No stems of this type are reported in Payne (1981). The gap is rather surprising, and it seems unlikely to be accidental. For all we know, if a language has [t] in the inventory, the sound will occur frequently in all types of morphemes (Maddieson, 1984; Paradis & Prunet, 1991).

In contrast, the deletion analysis correctly predicts the absence of verbs which would alternate as in (13). The verbal stems which end in /t/ would undergo deletion, while vowel-final verb stems are principally ruled out by a stem-level restriction. Thus the absence of verb stems which alternate as in (13) supports the deletion analysis over the insertion analysis.

To summarize, I have examined the AA alternations arising at the stem-suffix boundary in verbal morphology. While the existing surface forms can be derived on both deletion and insertion accounts, the deletion analysis is more accurate in ruling out the stems which would alternate as in (13).

A number of verbal suffixes induce or undergo idiosyncratic morpheme-specific alternations when attached to verbal stems. The alternations of these suffixes are discussed and exemplified in detail by Morley (2015).[6] Thus the interruptive /-imat/ and the non-future /-i/ turn a preceding /t/ intro an affricate [ts]. The modal plural /-aij/ involves optional deletion of stem-final segments /Vt/ preceding it. Similarly, the distributive suffix occurs as /ts^{h}it/ after vowel-final stems and triggers deletion of a preceding /t/. After the consonant-final stems the distributive surfaces as [its^{h}it]. Finally, the reflexive future /ia/ induces affrication or palatalization of any preceding consonant. The alternations of these suffixes do not accord with the rest of the phonology, and therefore both deletion and insertion accounts of AA /t/-zero alternations have to treat these suffixes as exceptional. However, the number

6 Another apparently exceptional suffix /-iti/ 'recently' occurs in only two words, where the suffix-stem segmentation is questionable: [tshirini:ti:ni] 'at night' (Cn: 13) and [itʃa:ʊi:ti:ni] '(sun) was getting low' (B: 142). Yet other suffixes that Morley (2015) discusses occur in the nominal domain and support deletion analysis over insertion. These suffixes will be discussed in section 4.

of such suffixes is small, and overall the /t/-zero alternations appear fairly productive in AA (Morley, 2015).

The two analyses also differ in their predictions in other domains. The insertion analysis postulates that [t]-epenthesis is a general hiatus resolution strategy of AA. Therefore we expect to see [t]-insertion when two vowels come together at other kinds of boundaries and in nominal morphophonology. On the other hand, the deletion analysis assumes that when /t/ ends up in the coda it gets deleted. Therefore we expect to see /t/-zero alternations not only before consonants (where both insertion and deletion story yields the same predictions) but also word-finally. Importantly, the deletion analysis makes no predictions about hiatus resolution in AA. Indeed, on this approach vowel sequences never arise at the boundary of verb stem + suffix because all verb stems end in a consonant. Therefore on the deletion approach, we do *not* expect to see /t/-zero alternations in other contexts which involve hiatus.

In what follows, these predictions will be examined in greater detail. I will argue, that the data in Payne (1981) and Payne et al. (1982) provide no evidence of [t]-zero alternations in hiatus environments. In fact, all cases where vowels come together, both in nominal and in verbal morphophonology, involve vowel deletion or diphthong formation. On the other hand, there is some evidence that word-final /t/ is indeed deleted, as predicted by the deletion account.

4. Further predictions of the two analyses

This section examines /t/-zero alternations in the positions other than verbal stem-suffix boundaries. In addition, hiatus and coda alternations are considered, since these can provide independent evidence in favor of either deletion or insertion analysis. It will be argued that alternations in all of these domains support the deletion analysis over the insertion analysis.

Nominal stem-suffix boundaries are considered in section 4.1. In this environment there is no evidence of /t/-zero alternations, and potential hiatus is resolved via diphthongization, long vowel formation, and vowel deletion. On the insertion account, the absence of [t]-epenthesis after nouns is a mystery, while the deletion accounts provides a plausible analysis of the facts.

The deletion analysis is further supported by the fact that the hiatus alternations between suffixes involve precisely the same repairs as they do at nominal stem-suffix boundaries: diphthongization, long vowel formation, and vowel deletion (see section 4.2). Furthermore, there is at least one suffix for which /t/ alternates with zero word-finally – precisely as expected if coda /t/ is deleted, but unaccounted for on the insertion story.

Section 4.3 shows how the hiatus alternations can be captured on the deletion account, and why they are incompatible with the insertion account of AA /t/-zero alternations. Section 4.4 considers the other boundaries which do not provide evidence to draw apart the deletion and insertion analysis. Section 4.5 provides a summary.

4.1 Stem-suffix boundaries in nouns

In this section, I examine the syllabic alternations arising at the stem-suffix boundaries in nouns. According to Payne (1981: 75) all noun stems end in a vowel, either long or short. Within the deletion account, this restriction can be attributed to the relatively high ranking of NoCoda at the stem level. Thus while verbal stems are required to end in a consonant by a special constraint Final-C_{VB}, noun stems exhibit the default codaless pattern.

Given that all nouns end in a vowel, the two accounts in section 3 make different predictions with respect to the alternations at nominal stem-suffix boundaries. The deletion analysis predicts that we will not find any /t/-zero alternations in this environment, because these alternations only arise after morphemes which end in /t/. On the other hand, the insertion analysis predicts that we should see [t]-insertion after nominal stems and before a vowel-initial suffix.

The relevant test case is provided by the alternations of the suffixes /-iriki/ 'pluralizing diminutive' and /-ini/ 'diminutive',[7] illustrated in (14) and (15). Apurucayali allows surface long vowels and the diphthongs [ai oi]. Not surprisingly, when two identical vowels come together across a morpheme boundary, the result is a long vowel, and /a+i, o+i/ surface as diphthongs (14). No [t]-insertion is found in this environment, contrary to the prediction of the insertion approach.

(14) Hiatus alternations at stem-suffix in nouns

/t^{h}oNki-iriki/ 'ant-DIMP'	[t^{h}o^{ŋ}kiːriki] 'small ants' (P: 47)
/hito-iriki/ 'spider-DIMP'	[hitoiriki] 'little spiders' (P: 110)
/ana-iriki/ 'black_dye-DIMP'	[anairiki] 'small black dye plants' (P: 110)
/ir^{j}ani-ini/ 'small-DIM'	[ir^{j}aniːni] 'small' (RB: 6)

The examples of diphthong formation in (14) show that surface diphthongs in AA may come from underlying vowel sequences. In fact, the existing OT analyses of diphthong formation derive surface diphthongs from underlying vowel sequences (Rosenthall, 1997a; b; Casali, 1998). Thus the existence of stem-internal diphthongs may be taken as additional evidence that underlying vowel sequences are not resolved via [t]-insertion in AA. See section 4.3 for a detailed analysis along these lines.

When a long vowel or a diphthong comes together with another vowel, the sequence cannot surface faithfully, since this would yield a trimoraic nucleus. In such cases, shortening occurs if it can lead to a surface diphthong, and otherwise one of the vowels is deleted (15).

(15) Trimoraic sequences simplified via deletion/shortening

/maniː-iriki/ 'ant (izula)-DIMP'	[maniːriki] 'little ants (izula)'
/saNpaː-iriki/ 'balsa-DIMP'	[sa^{m}pairiki] 'little balsas'
/ts^{h}iʋoː-iriki/ 'cane_box-DIMP'	[ts^{h}iʋoiriki] 'little cane boxes'
/no-pai-iriki/ '1p-grey_hair-DIMP'	[nopairiki] 'my little grey hairs'

To summarize, the alternations arising at the attachment of diminutives to nominal stems go against the predictions of the insertion approach: no [t] epenthesis is attested in this environment. These facts can be reconciled with the insertion approach if we assume that [t]-epenthesis is limited to verbs (Payne, 1981). However, the next section argues that the alternations arising at suffix boundaries in both nouns and verbs involve the same hiatus resolution strategies as (14-15).

4.2 Alternations at suffix-suffix boundaries

This section examines the alternations arising at boundaries between two suffixes, as well as the alternations of word-final suffixes. Suffixes do not go through the stem level and their phonological shape is not restricted in a way that affects verbal and nominal stems. Therefore we expect that in principle suffixes may end in any vowel or consonant. Both deletion and insertion accounts would thus predict that some of the suffixes (the /t/-final ones on the

[7] The diminutive /-ini/ only occurs twice in the dataset, both times in the text 'Red Bird'. In addition to these suffixes /-^{j}a/ with palatalization of a preceding consonant derives drink names from four noun stems. This latter suffix is "fairly unproductive" in Payne's words (Payne, 1981: 128).

deletion account, and equivalently the vowel-final ones on the insertion account) will give rise to /t/-zero alternations before other suffixes. The predictions of the two accounts differ in at least two respects.

First, [t]-insertion is a general hiatus repair on the insertion analysis, and therefore these accounts predict that all cases of hiatus arising at suffix boundaries will be resolved via [t]-insertion. On the other hand, the deletion account makes no specific predictions about the hiatus environments, and on this view we would expect that hiatus between suffixes is resolved via the strategies illustrated in (14) – (15). It will be shown that the prediction of the deletion account is borne out.

Second, on the deletion account /t/ is deleted in all coda environments, and therefore a /t/-final suffix may lose its final consonant if it ends up in word-final position. This is not expected on the insertion analysis, since no /t/-deletion is postulated. I will argue that at least one AA affix behaves as predicted by the deletion account.

Payne (1981) states that /t/-zero alternations apply at suffix boundaries (in verbs), but provides no detailed exemplification for this environment. For the present study, all available examples of the relevant suffixes were considered, and the results deviate from the original description. Most suffixes which could show the alternation before another suffix are not documented in sufficiently diverse environments. Many suffixes for which we have sufficient data show vowel deletion, precisely as predicted by the alternations in (14) – (15). Furthermore, one suffix shows a final /-t/ in prevocalic environments, which is lost word-finally (the suffix is not recorded before consonants). The rest of this section details the survey of AA suffixes, and illustrates the results.

A suffix which would exhibit /t/-zero alternations must occur both before vowel-initial and consonant-initial morphemes. The original description (Payne 1981) presents an insertion account, and therefore all potentially alternating suffixes are recorded as underlyingly vowel-final. Every suffix which could potentially show /t/-zero alternations was searched for throughout Payne (1981), including the texts and paradigms. The search was performed on the digital version of Payne (1981), which is available from Summer Institute of Linguistics. Adobe Acrobat search utility was used. It is in principle possible that the search did not match some of the relevant examples because of the errors in text recognition or occasional inconsistencies in glossing.

Most relevant morphemes are not recorded in sufficiently diverse environments to show the /t/-zero alternation. For example, in the available dataset the climax marker /-tsiː(t)/ appears either in word-final position or before a suffix starting with a consonant – hence there are no available examples where it would be expected to show up as [tsiːt]. Such examples would arise if the climax marker was recorded e.g. before the vowel-initial 1st person inclusive non-subject marker /-ai/, where it can, in principle, occur (Payne 1981: 30-35). In a similar way, the continuative suffix /-ʋai(t)/ only occurs before vowels where it has the surface form [-ʋait]. The distribution of each relevant suffix is described in the Appendix, and all suffixes which are recorded in sufficiently diverse environments are considered below.

(16) illustrates the alternations of all non-reduplicative vowel-final suffixes which occur both before a vowel and before a consonant. These suffixes include nominalizers /-ri/ (masculine) and /-ro/ (feminine), the nominal location marker /-ki/ and the verbal marker /-i/

which marks non-reflexivity in both future and non-future.[8] All of these suffixes have a final vowel before a consonant-initial suffix and word-finally (16a).

(16) Hiatus resolution at suffix boundaries

a. Vowel-final suffixes surface before a consonant or word-finally

/o-N-miç-ʋait-i-ro-ta/	[omiça:ʋaitiro:ta] 'she might
'3PF-FUT-peel-CNT-FUT-3PF-SBJ'	peel continually (to her, it)' (P: 242)
/no-nat-ak-i-ro/ '1P-carry-PRF-NFUT-3PF'	/nonatakiro/ 'I have carried it' (P: 109)
/i-N-tʃʰik-i/ '3PM-FUT-cut-FUT'	[iⁿtʃʰiki] 'he will cut' (P: 108)
/no-pok-i/ '1P-come-NFUT'	[nopoki] 'I came' (P: 32)
/aNtami-ki/ 'jungle-LOC'	[aⁿtamiki] 'in the jungle' (P: 48)
/maNtsʰija-ri-tsʰi/ 'be_sick-NOMZ.M-NPS'	[maⁿtsʰijaritsʰi] 'sickness' (RB: 13)
/i-ʋai-ro/ '3PM-name-NOMZ.F'	[iʋairo] 'when (he) said names' (B: 182)
/a-ʋai-ro-ki/ '1PI-name-NOMZ.F-LOC'	[aʋairoki] 'when (they) said names' (B: 191)

b. Vowel-final suffixes undergo hiatus resolution before a vowel (P: 37)

/i-tʃʰik-i-ai/ '3PM-cut-NFUT-1PI'	[itʃʰikai] 'he cut us' (P: 37)
/i-N-tʃʰik-i-ai/ '3PM-FUT-cut-FUT-1PI'	[iⁿtʃʰikai] 'he will cut us' (P: 37)
/i-N-tʃʰik-ak-i-ai/	[iⁿtʃʰikakai]
'3PM-FUT-cut-PRF-FUT-1PI'	'he will have cut us' (P: 37)
/hiɲo-ki-ini/	[hiɲoki:ni]
'above-LOC-DIM'	'right up there (in the tree branches)' (RB: 14)
/no-kimit-ri-iriki/	[nojimiri:riki]
'1P-scrape-NOMZ.M-DIMP'	'my little scraped maniocs' (P: 111)
/no-komat-ro-iriki/	[nojomaʋoiriki]
'1P-paddle-NOMZ.F-DIMP'	'my little paddle' (P: 111)

However, when these suffixes occur before a vowel-initial suffix, the hiatus resolution strategies familiar from section 4.1 apply. The vowel sequence surfaces faithfully if the vowels can form a long vowel or a diphthong together, and otherwise one of the vowels is deleted (16b). Finally observe that the nominalizer /-ro/ is subject to a general gliding alternation in some of the examples.

The examples in (14-16) show that hiatus in AA is resolved via the same strategies after nominal stems and between nominal and verbal suffixes. Importantly, hiatus is not resolved via [t]-insertion in these domains, and thus the predictions of the insertion accounts are not supported. On the other hand, the hiatus alternations in (14-16) are compatible with the deletion analysis.

Both accounts also predict that [t] should alternate with zero at suffix boundaries: after /t/-final affixes on the deletion account and after all vowel-final affixes on the epenthesis view. However, so far we have no clear evidence of /t/-zero alternations at affix boundaries.

[8] Non-reflexive marker is glossed as either 'FUT' or 'NFUT' following Payne (1981), since future and non-future are distinguished for reflexive verbs. The non-reflexive has the allomorph [a] after the progressive /-atʃ/ and before the 1st person suffix.

Examples of these alternations arise in suffixing reduplication, i.e. when the stem itself so to speak serves as a suffix. The reduplicant shows the same /t/-zero alternations, as the stem, as illustrated in (17) where the surface reduplicant is underlined.

(17) /t/-zero alternations between a reduplicant and a following suffix (P: 144)

a. [t] before a vowel-initial suffix

/kiNt^{h}a(t)-aːNts^{h}i/ 'tell-INF'	[ki^{n}t^{h}ataː^{n}ts^{h}i] 'to tell'
/kaʋosi(t)-aːNts^{h}i/ 'bathe-INF'	[kaʋositaː^{n}ts^{h}i] 'to bathe'

b. No [t] after the reduplicant and before a consonant-initial suffix

/kiNt^{h}a(t)-RED-ʋait-ak-i/	[ki^{n}t^{h}aki^{n}t^{h}aʋaitaki]
'tell-RED-CNT-PRF-NFUT'	'he has continued to tell more and more'
/kaʋosi(t)-RED-ʋait-ak-a/	[kaʋosikaʋosiʋaitaka]
'bathe-RED-CNT-PRF-NFUT.RFL'	'he has continued to bathe more and more'

The examples in (17) equally support the insertion and the deletion account. They show that the unavailability of /t/-zero alternations between non-reduplicant suffixes is a lack of data issue, rather than a systematic gap.

Pointing to the same conclusion, at least one /t/-final affix does lose its final consonant word finally. The verity marker /-pirot/ appears word-finally as [piro], but is recorded before vowels as [pirot] (18). No examples of this suffix appearing before a consonant-initial suffix are available.

(18) Alternations of the verity suffix /pirot/

/i-N-tʃ^{h}ik-pirot-i/ '3PM-FUT-cut-VER-FUT'	[i^{n}tʃ^{h}ikapiroti] 'he will cut it well' (P: 108)
/mapi-piro/ 'rock-VER'	[mapipiro] 'a real rock' (P: 44)

The alternations of the verity suffix in (18) are fully in line with the deletion account: /t/ is deleted in a coda. However, the insertion accounts would have to postulate /t/-deletion in this case and would require additional stipulations to explain why there is no general /t/-deletion pattern. Finally, the behavior of this cross-category affix is the same with nouns and verbs, suggesting that /t/-zero alternations apply regardless of the category of the stem.

To summarize, the suffix-suffix boundaries and stem-suffix boundaries in nouns provide evidence that hiatus in AA is resolved via diphthongization, long vowel formation, and vowel deletion. Crucially, these contexts provide no evidence of /t/-inseriton between vowels. Furthermore, the behavior of the verity suffix /pirot-/ supports coda deletion of /t/, but is unexpected on the epenthesis analysis. Finally, perhaps surprisingly, evidence of /t/-zero alternations between suffixes is not abundant in AA. Both accounts would have to attribute this to the limitations in the data.

4.3 Analysis of hiatus alternations

This section illustrates in greater detail that the deletion account provides for a straightforward analysis of AA hiatus alternations, whereas on the insertion account these alternations are problematic.

4.3.1 Hiatus alternations under the deletion analysis

On the deletion analysis, all verbal stems end in a consonant, hence we do not expect to see hiatus alternations at verbal stem-suffix boundaries. On the other hand, noun stems are different from verb stems in that they are not subject to the stem-level requirements of FINAL-C_{vb}. It is assumed here (following Payne 1981) that all nominal stems end in a vowel, in satisfaction of NOCODA which is sufficiently high-ranked at the stem level.

AA hiatus alternations happen at the word level where stems are combined with suffixes. The attested hiatus alternations can be summarized as in (19) where the cells with no available data are left blank. The second vowel of the sequences is limited to /i/ and /ai/, since these are the only suffix-initial vowels.

(19) Ajyíninka Apurucayali hiatus resolution

V2 \ V1	i	a	o	iː	aː	oː	ai	oi
i	iː	ai	oi	iː	ai	oi	ai	
ai	ai	ai						

The table in (19) represents both the alternations arising at morpheme boundaries and those within stems. In both contexts, long vowels and diphthongs arise whenever possible, and vowel deletion/shortening is applied otherwise, to bring the sequence to an allowed long vowel or diphthongal shape.

The analysis of AA hiatus patterns below is based on Casali (1998) and Rosenthall (1997a; b). Word-medial hiatus is penalized by the constraint NOHIATUS in (20) (after Ola Orie & Pulleyblank (1998)).

(20) NOHIATUS: assign a violation for every pair of heterosyllabic vowels

Assuming moraic theory of Hyman (1985), shortening is conceived of as deleting a mora, in violation of MAX-μ (21).

(21) MAX-μ: assign a violation for each input mora which does not have a correspondent in the output

Long vowels and diphthongs are marked, and prohibited by the constraints *LONG (22) and *DIPH (23) respectively (Rosenthall, 1997a; b; Itô & Mester, 1999; McCarthy, 2008a).

(22) *LONG: assign a violation for every long vowel
(23) *DIPH(THONG): assign a violation for every diphthong

When two monomoraic vowels come together, the outcome is either a diphthong or a long vowel, as in /ana-iriki/ [anairiki] 'small black dye plants'; /thoNki-iriki/ [tho^{ŋ}kiːriki] 'small ants' (14). The analysis of these forms in (24) indicates that NOHIATUS dominates both *DIPH and *LONG (24): creating a long vowel or a diphthong is better than having hiatus.

(24) Diphthongs and long vowels from vowel sequences in AA

a. Diphthongs

	/ana-iriki/	NoHiatus	Max-μ	*Long	*Diph
☞	anairiki				1
	ana.iriki	W1			L
	aniriki		W1		L
	ana:riki			W1	L

b. Long vowels

	/t^hoNki-iriki/	NoHiatus	Max-μ	*Long
☞	t^ho^{ŋ}ki:riki			1
	t^ho^{ŋ}ki.iriki	W1		L
	t^ho^{ŋ}kiriki		W1	L

The number of input moras is faithfully preserved in both (24a) and (24b) – hence Max-μ dominates both *Diph (24a) and *Long (24b).

When an input contains more than two vocalic moras in a row, the number of input moras cannot be faithfully preserved. Such sequences normally are resolved by shortening, as illustrated in (25) for the forms /ts^{h}iʋo:-iriki/ [ts^{h}iʋoiriki] ‘little cane boxes’ and /mani:-iriki/ [mani:riki] ‘little ants (izula)’ (15). In (25b) it is assumed that the features of all input vowels are preserved, so the only difference between the input and output is the number of moras.

(25) Treatment of trimoraic sequences I

a. Vowels of different quality

	/ts^{h}iʋo:-iriki/	NoHiatus	Max-μ	*Long	*Diph
☞	ts^{h}iʋoiriki		1		1
	ts^{h}iʋo:.iriki	W1	L	W1	L
	ts^{h}iʋo:riki		1	W1	L

b. Vowels of the same quality

	/mani:-iriki/	NoHiatus	Max-μ	*Long
☞	mani:riki		1	1
	mani:.iriki	W1	L	1

Trimoraic sequences are thus generally reduced by shortening one of the vowels, indicating that NoHiatus must dominate Max-μ. The failure of the last candidate in (25a) is indicative of the ranking *Long >> *Diph which will be further substantiated in (26) below.

Finally in some cases shortening cannot yield a well-formed output syllable. In these cases, vowel deletion occurs, as illustrated in (26) for the forms /no-pai-iriki/ [nopairiki] ‘my little grey hairs’ (15) and /i-tʃ^{h}ik-i-ai/ [itʃ^{h}ikai] ‘he cut us’ (16).

(26) Treatment of trimoraic sequences II

a. Diphthong + vowel

	/no-pai-iriki/	NoHiatus	Max-V	Max-μ	*Long	*Diph
☞	nopairiki		1	1		1
	nopai.iriki	W1	L	L		1
	nopaːriki		1	1	W1	L

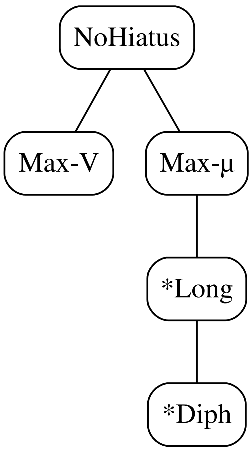
b. Vowel + diphthong

	/i-tʃʰik-i-ai/	NoHiatus	Max-V	Max-μ	*Long	*Diph
☞	itʃʰikai		1	1		1
	itʃʰiki.ai	W1	L	L		1
	itʃʰikiː		1	1	W1	L

Since vowel deletion is possible as a last resort, NoHiatus must dominate Max-V (26). However Max-V itself cannot be ranked with respect to other constraints, since its violations always cooccur with violations of Max-μ or *Long. In all cases of vowel deletion, an output with a diphthong is preferred over a long vowel output indicating that *Long is ranked over *Diph (26).

To summarize, the theory of hiatus resolution and diphthongs outlined in Casali (1998) and Rosenthall (1997a; b) can be used to account for AA hiatus resolution, under the deletion analysis of /t/-zero alternations. The ranking conditions implied by hiatus resolution patterns are given in (27). Crucially, hiatus resolution imposes no additional rankings on the constraints relevant to /t/-deletion (see 11). The two phenomena are thus completely independent on this account.

(27) Constraint hierarchy for Apurucayali hiatus resolution (word level)



This hierarchy ensures that vowel sequences in AA are realized as diphthongs and long vowels whenever possible, or else they are resolved via vowel deletion. These strategies apply consistently within stems, between stems and suffixes, and between suffixes.

4.3.2 Hiatus alternations under the insertion analysis

Unlike the deletion analysis, the insertion account has to present a much more complex story about AA hiatus resolution. This account has to reconcile the data showing vowel deletion, shortening, long vowel and diphthong formation, e.g. /ana-iriki/ → [anairiki] 'small black dye plants' (14) with what is assumed to be [t]-insertion in the same phonological environment, e.g. /i-N-koma-i/$_e$ → [iⁿkomati] 'he will paddle' (12). The two hiatus processes cannot be analyzed by the same ranking. Thus [t]-insertion between vowels after verbal stems requires that MAX-V dominates DEP-C (consonant insertion is *better* than vowel deletion). On the other hand, the examples of vowel deletion and other alternations in (14-16) require the opposite, since in those cases consonant insertion is *worse* than vowel deletion.

The insertion account then has to stipulate that the two hiatus processes are distributed morphologically. Thus Payne (1981) assumes that [t]-insertion only happens with verbs, whereas the nominal alternations are handled by a different set of rules. Furthermore, to account for the instances of vowel deletion in the verbal paradigm (16), an ad hoc '1/PERSON/INCLUSIVE CONSTRAINT' is proposed which states that tense suffixes do not occur with the 1st person inclusive suffix Payne (1981: 37).

These additional stipulations are unnecessary under the deletion account. Moreover, only the deletion account is able to capture the generalization that all suffixal environments where two vowels come together trigger the same hiatus repairs, as described in 4.3.1 above.

Finally, the alternations of the verity suffix /piro(t)-/ are also problematic for the insertion accounts. This suffix loses its final /t/ when it occurs word finally, hence /t/-deletion has to be postulated in some cases anyway. Moreover, the verity suffix occurs with both nouns and verbs, and thus the alternations of this suffix contradict the assumption that [t] alternates with zero only in verbal morphophonology (Payne, 1981).

On the deletion account, the alternations of the verity suffix simply follow from the fact that /t/ is deleted in the coda. No additional stipulations are needed, and all instances of /t/-zero alternations are captured with one and the same mechanism.

4.4 Other boundaries

This section briefly examines the other contexts where [t]-zero alternations and hiatus repairs occur in AA. It is argued that none of these contexts provide evidence for either deletion or insertion account.

[t] alternating with zero occurs in subminimal word augmentation. All these instances of alternating [t] occur after a verbal stem, and both insertion and deletion analyses of /t/-zero alternations account for these data equally well.

As illustrated in (28), suffixes (including the reduplicant suffix) attach to a minimally bimoraic base in AA (McCarthy & Prince, 1993). Coda consonants are not moraic, and verb stems which are shorter than two moras augment with [a] (for CVC stems) or [aː] (for C stems) before a suffix.

(28) Subminimal verb stems

/i-N-tʃʰik-pirot-i/	[iⁿtʃʰikapiroti]
'3PM-FUT-cut-VER-FUT'	'he will cut it well' (P: 108)
/tʃʰik-RED-ʋait-ak-i/	[tʃʰika<u>tʃʰika</u>ʋaitaki]
'cut-RED-CNT-PRF-NFUT'	'he has continued to cut more and more'
/ɲ-pirot-aːntsʰi/ 'feed-VER-INF'	[ɲaːpirotaːntsʰi] 'to really see'
	(Spring, 1990c: 149)

/na(t)-pirot-aːntsʰi/ ‘carry-VER-INF’ [natapirotaːntsʰi] ‘to carry well’ (P: 145)
/na(t)-RED-ʋait-ak-i/ [natanataʋaitaki]
‘carry-RED-CNT-PRF-NFUT’ ‘he has continued to carry more and more’

Subminimal verb roots may also end in an alternating /t/, e.g. /na(t)/ 'carry'. The final /t/ is part of the stem on the deletion account. However stem-final /t/ is not deleted before consonants in this case, since the base [na] would violate the minimality requirements of suffixation. On the insertion account, surface [t] is part of the minimality augment.

Evidence for the underlying shape of subminimal verb stems comes from their behavior before vowel-initial suffixes. In this case, no vowel augment appears, since it would create a hiatus sequence with the suffix-initial vowel.

(29) Subminimal verb stems before vowel-initial suffixes
/na(t)-aːntsʰi/ ‘carry-INF’ [nataːntsʰi] ‘to carry’ (P: 79)
/p-aːntsʰi/ ‘feed-INF’ [paːntsʰi] ‘to feed’ (P: 238)
/tʃʰik-aːntsʰi/ ‘cut-INF’ [tʃʰikaːntsʰi] ‘to cut’ (P: 238)

As argued by McCarthy & Prince (1993), NOHIATUS (or ONSET in their analysis) is ranked higher than the requirement for suffix bases to be prosodic words. Therefore, with vowel-initial suffixes the base can not be properly augmented, and it remains smaller than bimoraic.

Finally, the prefix-stem boundaries show no /t/-zero alternations and exhibit a special set of hiatus repairs. The prefixes preserve their final vowel before a consonant. However, vowel deletion happens before vowel-initial stems, even if a diphthong or a long vowel would be possible. This is illustrated in (30) for the prefixes /no/ '1st person signular'; /pi/ '2nd person singular' and /a/ '1st person plural'.

(30) Vowel deletion after personal prefixes

Stem	/no-/ ‘my _’; ‘I will _’	/pɪ-/ ‘your _’; ‘you will _’	/a-/ ‘our _’; ‘we will _’	Gloss
mapi	nomapini	pimapini	amapini	rock (N)
saik	nosaiki	pisaiki	asaiki	sit
iNki	niᵑkini	piᵑkini	aᵑkini	peanut
ana	nanani	panani	anani	black dye

The patterns of hiatus resolution with prefixes do not involve [t]-zero alternation, but clearly do not match the general patterns described in 4.1 – 4.2 either.

There is independent evidence that prefix attachment happens at an earlier stratum than suffix attachment. Prefixed stems satisfy the minimality requirement and do *not* trigger augmentation, as they do in (28). Rather, the behavior of prefixed subminimal stems is entirely parallel to that of longer stems, as illustrated in (31).

(31) Prefixes satisfy the minimality requirement
/no-na(t)-ʋait-i/ [nonaʋaiti]
‘1P-carry-CNT-FUT’ ‘I will continue to carry’ (P: 145)

/ir-N-p-ʋait-i-ro-ta/ [i^{m}paʋaitirota]
'3PM-FUT-feed-CNT-FUT-3PF-SBJ' 'He might continue feeding her?' (P: 149)

The final /t/ of /na(t)/ 'carry' does alternate with zero when this stem appears with a prefix containing a vowel. Similarly, the prefixed single consonant stem /p/ triggers insertion of a short, not a long vowel before a consonant-initial suffix.

Thus it appears that prefixes, unlike suffixes, count for the calculation of suffixal base minimality. On both the insertion and the deletion account, prefixes can be analyzed as attaching at the stem level (McCarthy & Prince, 1993). Thus prefixes are not subject to [t]-insertion/deletion and to the general word-level hiatus resolution strategies. The morphophonology of prefixes then does not provide any evidence with regard to the analysis of /t/-zero alternations.

To summarize, minimality alternations and prefix morphophonology do not bear on the analysis of /t/-zero alternations in AA as insertion vs. deletion. Both the deletion and the insertion analysis can account for these alternations equally well.

4.5 Summary

In this section, I have examined the /t/-zero alternations and hiatus resolution at boundaries other than the verbal stem-suffix boundary. I have argued that nominal stem-suffix boundaries and suffix-suffix boundaries in both nouns and verbs provide additional evidence in favor of the deletion analysis of /t/-zero alternations. The hiatus environments arising in these contexts do not show [t]-insertion, instead they are subject to diphthongization, long vowel formation, and vowel deletion. Furthermore, the process of coda /t/ deletion applies to the verity suffix /pirot/ word-finally, where it is predicted by the deletion account.

To account for these facts, the insertion analysis has to resort to additional stipulations. In particular, the hiatus resolution strategies of AA have to be analyzed as restricted morphologically, in which case their consistent application across different boundaries (stem-suffix in nouns, suffix-suffix in nouns and verbs) is unaccounted for. On the other hand, the deletion approach simply analyzes diphthong formation, long vowel formation, and vowel deletion as the general hiatus resolution strategies of AA.

Finally, subminimal stem augmentation and prefix morphophonology provide no data to tease the two approaches apart.

5. Conclusion and implications

This paper has proposed a deletion analysis of /t/-zero alternations in Ajyíninka Apurucayali, based on two key assumptions. First, all verb stems in AA end in a consonant, while other stems end in a vowel. Second, stem-final /t/ is preferentially targeted for deletion because all other consonants are protected by the preservation-of-the-marked constraints.

Deletion and insertion analyses of AA /t/-zero alternations are not equally adequate (pace Spring, 1990b; Staroverov, 2014; Morley, 2015). The deletion analysis fares better than the insertion analysis in several domains. First, the insertion analysis predicts that verb stems should be able to end in /t/$_{e}$, triggering vowel insertion before a consonant, but such stems are unattested. Second, the insertion analysis has to resort to additional stipulations to explain why [t]-insertion does not happen in other hiatus environments. Postulating [t]-insertion as a general hiatus resolution strategy in AA leads to a loss of generalization: diphthongization, long vowel formation, and vowel deletion are captured by different mechanisms in different domains. The fact that these strategies consistently apply in the same preferential order in the different morphological environments is thus treated as a coincidence. Finally, the insertion account has to postulate restricted /t/-deletion anyway, to account for the word-final shape of the verity marker.

Interestingly, the proposed deletion analysis does not imply a reconsideration of universal markedness, which was often associated with AA /t/-zero alternations (Paradis & Prunet, 1991; Morley, 2015). The reason why /t/ is preferentially targeted for deletion is the same as the reason for inserting [t] on insertion accounts: [t] has relatively unmarked place and other features.

However the fact that the deletion analysis is possible, and probably even preferable for AA leads to a reconsideration of epenthetic typology. While a detailed investigation of other cases of reported [t]-epenthesis would take a separate article, the existing typological literature generally describes these cases as less robust than AA (Lombardi, 2002; Staroverov, 2014; Morley, 2015). Thus the reportedly most robust case of [t]-insertion admits, and probably favors, a deletion analysis. This result goes against the approaches which treat epenthetic quality as stemming from pure markedness in some cases (Lombardi, 2002; de Lacy, 2006). The doubtful attestation of [t]-epenthesis is consistent with the theories where epenthesis does not have a special status with respect to markedness (Rice, 2000; Hume, 2011; Staroverov, 2014), as well as with the theories where markedness does not exist or is language-specific (Hume & Tserdanelis, 2004; Blevins, 2008; Morley, 2015).

6. Appendix: Ajyíninka Apurucayali suffixes

To examine the existing /t/-zero and hiatus alternations at suffix boundaries, all potentially alternating suffixes were searched throughout Payne (1981). All suffixes which end in a vowel in Payne's (insertion) analysis were considered potentially alternating. The table in (32) lists the environments where each of these suffixes occurs. Excluded are the future/reflexivity markers which undergo deletion before vowel-initial suffixes. These markers present a complex set of allomorphs and are discussed in section 4.2.

The table in (32) gives the underlying form of the relevant AA suffixes under the deletion account. The surface form is the same as underlying form in a vast majority of cases. The table also lists the environment where these suffixes occur, and a page reference for an example of each suffix.

(32) Ajyíninka Apurucayali potentially alternating suffixes

Suffix	Gloss	Environment	Example page ref.
-ra	adverbial	_#, _C	Conversation 12, 19
-mats^{h}it	affectionate	_V	p. 46
-t^{h}ori	classificatory	_#, _C	p. 52
-tsiː	climax	_#, _C	p. 33
-taki	comparative	_#	p. 47
-ʋait	continuative	_V	paradigms
-akot	dative	_V	p. 11
-iriki	diminutive	_#	p. 47
-(i)ts^{h}it	distributive	_V	p. 45
-ma	dubitative	_#	p. 29
-tʃa	emphatic	_#	p. 28
-ʋi	exclamatory	_#	p. 29

-ʊit	frustrative	_V	Canoe 7; Beetle 44
-ka	indefinite	_#	p. 11
-aːnts^{h}i	infinitive	_#	paradigms
-imat	interruptive	_V	p. 123
-ki	location	_#, _V	p. 48
-ts^{h}i	non-possessive	_#, _C	p. 50
-ait	passive	_V	p. 40
-pait	nominal plural	_C	p. 27
-ni	plural	_#	paradigms
-ri,-ni, ti	possessive	_#	p. 51
-asit	purpose	_V	p. 43
-ri	relative	_#, _C	p. 27, 29
-aːt	repetitive	_V	p. 108
-ts^{h}i	stative	_#, _C	p. 30
-ta	subjunctive	_#	paradigms
-akit	there/and/back	_V	p. 47
-pirot	verity	_V, _#	p. 44, 55

References

Bermúdez-Otero, R. (forthc.). *Stratal Optimality Theory*. Oxford: OUP.

Bermúdez-Otero, R. (2012). The architecture of grammar and the division of labour in exponence. In: Trommer, J. (Ed) *The phonology and morphology of exponence*. pp 8–83. Oxford: OUP.

Black, A. (1991). The phonology of the velar glide in Axininca Campa. *Phonology*, 8, pp 183–217.

Blevins, J. (2008). Consonant epenthesis: natural and unnatural histories. In: Good, J. (Ed) *Linguistic Universals and Language Change*. Oxford: OUP.

Casali, R. (1998). *Resolving Hiatus*. New York: Taylor & Francis.

Casali, R. (2011). Hiatus resolution. In: Van Oostendorp, M., Ewen, C. J., Hume, E., & Rice, K. (Eds) *The Blackwell Companion to Phonology*. Malden, MA: Blackwell.

Duanmu, S. (2009). *Syllable structure. The limits of variation*. Oxford: OUP.

Howe, D. & Pulleyblank, D. (2004). Harmonic scales as faithfulness. *Canadian Journal of Linguistics*, 49(1), pp 1–49.

Hume, E. (2011). Markedness. In: Van Oostendorp, M., Ewen, C. J., Hume, E., & Rice, K. (Eds) *The Blackwell companion to phonology*. Malden, MA: Wiley-Blackwell.

Hume, E. & Tserdanelis, G. (2004). Labial unmarkedness in Sri Lankan Portuguese Creole. *Phonology*, 19, pp 441–458.

Hyman, L. M. (1985). *A theory of phonological weight*. Dordrecht: Foris.

Inkelas, S., Orgun, C. O. & Zoll, C. (1997). The implications of lexical exceptions for the nature of grammar. In: Roca, I. (Ed) *Derivations and constraints in phonology*. pp 393–418. Oxford: Oxford University Press.

Itô, J. (1986). *Syllable theory in prosodic phonology*. PhD dissertation, Umass Amherst.

Itô, J. (1989). A prosodic theory of epenthesis. *NLLT*, 7(2), pp 217–259.

Itô, J. & Mester, A. (1999). Realignment. In: Kager, R., van der Hulst, H., & Zonneveld, W. (Eds) *The prosody-morphology interface*. pp 188–217. Cambridge: CUP.

Kiparsky, P. (forthc.). *Paradigm Effects and Opacity*. Stanford: CSLI Publications.

Kiparsky, P. (2000). Opacity and cyclicity. *The Linguistic Review*, 17(2-4), pp 351–366.

De Lacy, P. (2002). *The Formal Expression of Markedness*. PhD dissertation, Umass Amherst.

De Lacy, P. (2006). *Markedness: Reduction and Preservation in Phonology*. Cambridge: CUP.

De Lacy, P. & Kingston, J. (2013). Synchronic explanation. *NLLT*, 31(2), pp 287–355.

Levin, J. (1985). *A metrical theory of syllabicity*. PhD dissertation, MIT.

Lewis, M. P., Simons, G. F. & Fenning, C. D. (Eds) (2013). *Ethnologue: languages of the world, seventeenth edition* [online]. Dallas, TX: SIL. Available from: http://www.ethnologue.com.

Lombardi, L. (1999). Positional faithfulness and voicing assimilation in optimality theory. *NLLT*, 17, pp 267–302.

Lombardi, L. (2001). Why place and voice are different: constraint interactions and feature faithfulness in Optimality Theory. In: Lombardi, L. (Ed) *Segmental phonology in Optimality Theory: constraints and representations*. pp 13–45. Cambridge: CUP.

Lombardi, L. (2002). Coronal epenthesis and markedness. *Phonology*, 19(02), pp 219–251.

Maddieson, I. (1984). *Patterns of sounds*. Cambridge: Cambridge University Press.

McCarthy, J. J. (1993). A case of surface constraint violation. *Canadian Journal of Linguistics*, 38, pp 169–195.

McCarthy, J. J. (1995). Extensions of faithfulness: Rotuman revisited. Ms, UMass Amherst. Available from: http://roa.rutgers.edu/article/view/121.

McCarthy, J. J. (2008a). *Doing optimality theory: applying theory to data*. Malden, MA ; Oxford: Blackwell Pub.

McCarthy, J. J. (2008b). The gradual path to cluster simplification. *Phonology*, 25(2), pp 271–319.

McCarthy, J. J. & Prince, A. (1993). Prosodic morphology: constraint interaction and satisfaction. Ms, UMass Amherst and Rutgers University.

McCarthy, J. J. & Prince, A. (1995). Faithfulness and Reduplicative Identity. Ms, UMass Amherst and Rutgers University.

McCarthy, J. J. & Prince, A. (1999). Faithfulness and identity in Prosodic Morphology. In: Kager, R., van der Hulst, H., & Zonneveld, W. (Eds) *Prosody-morphology interface*. Cambridge: CUP.

Morley, R. (2015). Deletion or epenthesis? On the falsifiability of phonological universals. *Lingua*, 154, pp 1–26.

Ola Orie, O. & Pulleyblank, D. (1998). Vowel elision is not always onset-driven. Ms, Tulane University and University of British Columbia. Available from: http://roa.rutgers.edu/article/view/300.

Paradis, C. & Prunet, J.-F. (1991). Introduction: asymmetry and visibility in consonant articulations. In: Paradis, C. & Prunet, J.-F. (Eds) *The Special status of coronals: internal and external evidence*. pp 1–28. San Diego: Academic Press. (Phonetics and phonology; v. 2).

Pater, J. (2000). Non-uniformity in English secondary stress: the role of ranked and lexically specific constraints. *Phonology*, 17(02), pp 237–274.

Pater, J. (2006). The locus of exceptionality: Morpheme-specific phonology as constraint indexation. In: Bateman, L., O'Keefe, M., Reilly, E., & Werle, A. (Eds) *Papers in Optimality Theory III*. pp 259–296. Amherst, Mass: GLSA.

Payne, D. L. (1981). *The Phonology and Morphology of Axininca Campa* [online]. Arlington: SIL & UTA. Available from: http://www.sil.org/acpub/repository/16298.pdf.

Payne, D. L., Payne, J. K. & Sanchez Santos, J. (1982). *Morfología, fonología y fonética del Ashéninca del Apurucayali (Campa Arawak preandino)*. Lima, Peru: SIL.

Prince, A. (2002). Arguing optimality. In: Coetzee, A., Carpenter, A., & De Lacy, P. (Eds) *UMOP 26. Papers in Optimality Theory II*. Amherst, Mass: GLSA.

Prince, A. & Smolensky, P. (2004). *Optimality Theory. Constraint Interaction in Generative Grammar*. Malden, Mass: Blackwell.

Pulleyblank, D. (1998). Yoruba vowel patterns: deriving asymmetries by the tension between opposing constraints. Ms, UBC. Available from: http://roa.rutgers.edu/article/view/280.

Rice, K. (2000). Featural markedness in phonology: variation. In: Cheng, L. & Sybesma, R. (Eds) *The Second Glot International State-of-the-Article Book: The Latest in Linguistics*. pp 389–429. Berlin: Mouton de Gruyter.

Rosenthall, S. (1997a). The Distribution of Prevocalic Vowels. *Natural Language & Linguistic Theory*, 15(1), pp 139–180.

Rosenthall, S. (1997b). *Vowel/Glide Alternation in a Theory of Constraint Interaction*. Taylor & Francis.

Spring, C. (1990a). How many feet per language? In: Halpern, A. L. (Ed) *Proceedings of WCCFL 9*. Stanford: CSLI Publications.

Spring, C. (1990b). *Implications of Axininca Campa for prosodic morphology and reduplication*. Tuscon, AZ: PhD dissertation, University of Arizona.

Spring, C. (1990c). Unordered morphology: the problem of Axininca reduplication. *Proceedings of BLS 16*. pp 137–157. Berkeley, CA: University of California.

Spring, C. (1992). The velar glide in Axininca. *Phonology*, 9, pp 329–352.

Staroverov, P. (2014). *Splitting theory and consonant epenthesis*. PhD dissertation, Rutgers University.

Trommer, J. (2013). Stress Uniformity in Albanian: Morphological Arguments for Cyclicity. *Linguistic Inquiry*, 44(1), pp 109–143.

Wilson, C. (2000). *Targeted constraints: an approach to contextual neutralization in Optimality Theory*. PhD dissertation, Johns Hopkins University.

Yip, M. (1983). Some problems of syllable structure in Axininca Campa. In: Sells, P. & Jones, C. (Eds) *Proceedings of NELS 13*. pp 243–251. Amherst, Mass: GLSA.