Chapter 10

Prokaryotic syllables and excrescent vowels in two Yuman languages

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Excrescent vowels in two Yuman languages (Cocopa and Jamul Tiipay) and the phonotactic restrictions for their occurrence show that vowels that fulfil some criteria of excrescent vowels are not always a phonetic reflex without repercussions for syllabification (Hall 2006), but rather signal the presence of an additional, albeit non-canonical, syllable. They are inserted in syllables without a nucleus/mora, which renders them inaccessible for higher level prosodic computation. Degenerate, minor or semisyllables, i.e., syllables without a nucleus, have elsewhere been postulated for stray consonants that add a beat/mora accessible to foot construction. The two Yuman languages discussed here add to the typology of minor syllables by contributing minor syllables with an onset and an optional coda, but without a nucleus or a mora. They also provide evidence for a second type of intrusive vowel.

1 Introduction

Long sequences of consonants defying the Sonority Sequencing Generalisation (Selkirk 1984, Zec 1988, 2007, Clements 1990) are attested in a number of languages. They have been analyzed in a range of ways from syllabic, moraic to unsyllabified or in an appendix position (Bagemihl 1991, Lin 1997, Ridouane 2008, Vaux & Wolfe 2009, Zimmermann 2013 among others). Some of the consonant sequences in Cocopa (Yuman; Crawford 1966) are described as interrupted by excrescent vocalic offglides. This matches descriptions of similar sequences in other languages with alleged syllabic obstruents, such as Tashlhiyt Berber or Georgian (see Easterday 2019 for an overview). Crawford (1966) analyzes these

as syllables that just contain an onset or an onset and a coda but no phonological nucleus. Such syllables without a nucleus have independently been proposed by McCarthy & Prince (1990), Broselow (1992), Shaw (1994) and Repetti (1994). New arguments for this analysis for Cocopa come from recent insights into the distinction between excrescent and epenthetic vowels. Excrescent vowels are determined in their quality by surrounding consonants, and are shorter and less prominent than epenthetic and lexical, i.e., phonologically present vowels (Hall 2006, 2011; see also the discussion in Easterday 2019).

If Crawford's analysis is adopted, the schwa vowels or vocalic offglides are excrescent vowels without a phonological affiliation. Hall (2006)'s assertion that such intrusive vowels are not accompanied by additional syllable structure cannot be upheld (see also **chapters/08.Hall**, for further refinement of the typology). The excrescent vowels in Cocopa and Jamul Tiipay, which do not have a prosodic association or even a root node, are placed in and signal the presence of an additional syllable – albeit one without a nucleus or mora, a prokaryotic syllable. I present data from Cocopa and its sister language Jamul Tiipay in evidence of the presence of an additional syllable containing the consonant(s) separated from a cluster by an apparently excrescent vowel and conclude that the prosodic invisibility of such syllables must be caused by the lack of a nucleus and mora rather than the lack of a syllable.

Cocopa displays sonority sequencing defying sequences that are not broken up by excrescent vowels, such as presented in (1a), as well as those that receive such a vocalic offglide (1b) and (1c). The choice is determined by the presence of intervening sonorants that then serve as codas of the prokaryotic syllables, in avoidance of syllable-internal sonority roller coaster rides, as in (1c) or other phonological criteria, such as the avoidance of sequences of identical manner.

(1) Cocopa consonant clusters (Crawford 1966; accent indicates stress)[1]

   a. ps̻kʷá   'I gossip about him'
      ksca.ʔárk   'dry!'
      scxuʔá:k   'she hangs up several (things)'

   b. ɬʲpᵃm.wák   'you are to ride him'
      rʲxúp   'tin can'

   c. pᵃmʲnt̻ʲmá:k   'we abandon them'

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[1]Transcriptions from both sources, Crawford (1966) and Miller (2001), are adapted to IPA by the author. The excrescent vowels are transcribed as superscript vowels also indicating their quality as transcribed end described by Crawford in Cocopa examples. In examples from Jamul Tiipay, the excrescent vowels are transcribed as schwa, corresponding to the <e> used in Miller's orthographic transcriptions.

The presence of uninterrupted clusters as well as those broken up by vocalic offglides suggests that Cocopa employs both appendixes/complex onsets as well as degenerate syllables to prosodify its consonant sequences.

The situation is similar in the related language Jamul Tiipay (Miller 2001), even though Miller does not claim that they signal the presence of prokaryotic syllables. Jamul Tiipay displays optional as well as obligatory vowel insertion. Vowel insertion is obligatory if sonorants are involved (2a) and optional between obstruents (2b), suggesting that the sonority requirements on onsets of degenerate syllables are stricter than on full syllables. Sequences of sibilant and stop are never broken up (2c), suggesting that Tiipay also permits appendixes/complex onsets, though in a much more restricted fashion than Cocopa.

(2)   Jamul Tiipay consonant clusters

a.	/m-ʃ-ja:j/	məʃəja:j	'to be afraid'
	/kʷ-n-ma:w/	kʷənəma:w	'his/her father's mother'
b.	/x-t̯at̯/	xt̯at̯ /xət̯at̯	'(someone's) back'
	/k-ʃ-u:-pit/	kʃu:pit / kəʃu:pit	'close it!'
	/t̯-t̯-k-ju:t̯/	t̯ət̯əkju:t̯	'to greet (pl)'
c.	/ʃ-puk/	ʃpuk	'to lay head on pillow'
	/s-pir/	spir	'to be strong'
	/s-t̯u/	st̯u	'to pick up, gather, get'
	/s-kan/	skan	'to flee'

Tiipay inserted schwa, described as a "non-organic vowel" by Miller (2001), is also not stressable, as is claimed to be typical for excrescent vowels.

The excrescent vowels in Yuman are a phonetic side effect of adjustments in syllabic structure to integrate excess consonants into syllables and they are present in non-canonical or prokaryotic syllables. Unstressability is either an effect of the absence of a nucleus (and accordingly a mora) or just the absence of a mora and thus a unit that can receive stress or can be recognized in mora or syllable counting for foot formation.

The paper is organized as follows. In Section 2 I provide the theoretical background by first summarizing the state of the art of degenerate syllables, concluding that the more appropriate term is prokaryotic, and then discussing the distinction between excrescent and epenthetic vowels. Section 3 first provides relevant background information on Cocopa and Jamul Tiipay phonology and morphology. It continues with a more detailed discussion of the nature and location of excrescent vowels and argues for strict phonotactics of prokaryotic syllables in Cocopa and more strict phonotactics of prokaryotic syllables in Jamul

Tiipay. Section 4 puts the degenerate syllables proposed for Yuman into a larger typological and theoretical context and Section 5 concludes.

2 Theoretical background

2.1 Degenerate syllables

Degenerate, minor or semisyllables have been proposed in several empirical contexts. McCarthy & Prince (1990) propose to re-analyze superheavy syllables at the right word edge in Arabic as a heavy maximally bimoraic syllable plus an extrametrical syllable consisting of a consonant only. Broselow (1992) adds to this by postulating degenerate syllables with an onset and those with a rhyme. A moraic consonant in a degenerate consonantal syllable is detected by Repetti (1994) at the end of some words in Friulian. Discussing syllable phonotactics and reduplication in Mon Khmer languages, Shaw (1994) proposes to enrich the impoverished model of the syllable in Moraic Theory (Hayes 1989, Zec 1995) by reintroducing the nucleus constituent. In full syllables this constituent is obligatory and associated with at least one mora (Figure 1a). In minor syllables, that is, stray consonants or consonant sequences, the nucleus is missing (Figure 1b) or both nucleus and mora are absent (Figure 1b').

(a) Full syllable

(b) Minor syllable with missing nucleus

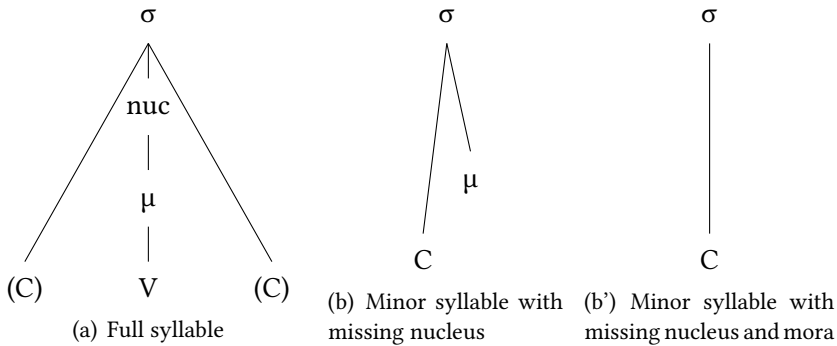(b') Minor syllable with missing nucleus and mora

Figure 1: Full and minor syllables (Shaw 1994)

These defective syllables can be referred to as templates in reduplication processes, as well as the prosodification of excess consonants that do not fit into regular syllables for violating Sonority Sequencing (Clements 1990), or because they show properties such as compensatory lengthening or otherwise unexpected stress placement that justify their analysis as a separate syllable.

Cho & King (2003) propose the term semisyllable, defined as a syllable without a mora and without a coda. They list the following properties of semisyllables.

(3) Properties of semisyllables (Cho & King 2003: 187)

   a. No nucleus

   b. No codas

   c. No stress/accent/tone

   d. Prosodically invisible

   e. Well-formed onset clusters (observing SSP)

   f. Restricted to morpheme peripheral positions

What all these proposals have in common is that the syllable types proposed lack a nucleus, which is why the term *prokaryotic syllable* is more appropriate than the familiar terms *degenerate, minor* or *semisyllable*. To my knowledge, the term prokaryotic has not been proposed before. Given that the consonants in such a syllable are subject to different phonotactic restrictions, as are the onset and the coda of major or full syllables, i.e., those that have a nucleus, it can be assumed that some more subsyllabic structure is present. This goes beyond what Shaw so carefully proposed and is also more than what Cho & King propose, since, as I will show, prokaryotic syllables may have a coda. Cho & King listed the absence of codas as one of the characteristics of minor syllables. Accordingly, the constituents rime and coda are given in parentheses in Figure 2 to indicate their optionality.
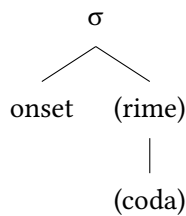

Figure 2: Prokaryotic syllable

2.2 Epenthetic and excrescent vowels

chapters/08.Hall observes that predictable or inserted vowels behave differently in different contexts and languages. Furthermore, some are invisible to phonological processes such as stress placement or tone assignment. The differences

line up into properties that are typical of what she calls intrusive vowels on the one side, and epenthetic vowels on the other. Epenthetic vowels are phonological in the sense that they are affiliated with phonological structure, such as a mora or a syllable nucleus, while excrescent vowels are not. She gives the following catalogue of properties.

(4) Properties of phonologically invisible inserted vowels (intrusive vowels) (Hall 2006: 391)

  a. The vowel's quality is either schwa, a copy of a nearby vowel or influenced by the surrounding consonants.

  b. If the vowel copies the quality of another vowel over an intervening consonant, that consonant is a sonorant or guttural.

  c. The vowel generally occurs in heterorganic clusters.

  d. The vowel is likely to be optional, have a highly variable duration or disappear in fast speech rates.

  e. The vowel does not seem to have the function of repairing illicit structures. The consonant clusters in which the vowel occurs may be less marked, in terms of sonority sequencing, than clusters which surface without vowel insertion in the same language.

According to Hall, intrusive vowels are not stressable/do not affect stress placement and do not participate in other phonological processes. This is why they are assumed to be devoid of syllable structure. She contrasts these properties with those she attributes to properly phonological epenthetic vowels:

(5) Properties of phonologically visible inserted vowels (epenthetic vowels) (Hall 2006: 391)

  a. The vowel's quality may be fixed or copied from a neighboring vowel. A fixed-quality epenthetic vowel does not have to be schwa.

  b. If the vowel's quality is copied, there are no restrictions as to which consonants may be copied over.

  c. The vowel's presence is not dependent on speech rate.

  d. The vowel repairs a structure that is marked, in the sense of being cross-linguistically rare. The same structure is also likely to be avoided by means of other processes within the same language.

Furthermore, phonologically visible inserted vowels occupy a syllable nucleus, usually are moraic and participate in stress assignment and other phonological processes (e.g., vowel harmony).

I will show in the following sections that the excrescent vowels of Cocopa and Jamul Tiipay have most of the properties of intrusive vowels, including phonological invisibility, but do signal the separate syllabification of a consonant sequence that would be an illicit tautosyllabic cluster. Consonants are separated by an intrusive vowel when they cannot coinhabit an onset. The separate syllables created for these consonants are not stressable, are ignored in reduplication, but are subject to constraints of syllable phonotactics. We are thus dealing with prokaryotic syllables of the type outlined in Section 2.1 that consist of an onset and optionally a coda but no nucleus or mora.

3 Excrescent and epenthetic vowels in Yuman

The two languages Cocopa and Jamul Tiipay both belong to the Yuman family. Cocopa is spoken by around 400 people who live north and south of the borders between Mexico, California and Arizona. Jamul Tiipay or just Tiipay is spoken in a neighboring area west of the Cocopa area. For 2007, Ethnologue reported approximately 100 remaining speakers. Diegueño or Kumeyaay, which will be discussed briefly at the end of Section 3.1, is spoken north of Tiipay north and south of the border between California and Mexico. In the 1990s there were an estimated 50 native speakers. All Cocopa and Jamul Tiipay data used here come from Crawford (1966) and Miller (2001), respectively. The inventories of contrastive segments of the two languages are extremely similar, which is why I will present them together in section 3.1. In this section I also discuss relevant aspects of syllable phonotactics, stress and affixation as well as reduplication. Section 3.2 presents the details of vowel intrusion in Cocopa and their analysis. Section 3.3 presents the vowel intrusion patterns of Jamul Tiipay. Section 3.4 summarizes the section.

3.1 Background

To understand the role of excrescent vowels in these two Yuman languages it is essential to first learn about the basic facts of their phonology and morphology. I will first discuss their segment inventories, with special focus on the phonetics of the vowels, consonant cluster phonotactics and stress and close this subsection with a short discussion of reduplication.

Table 1 displays the Cocopa consonants as described by Crawford.

Cocopa has a slightly larger consonant system than Jamul Tiipay, which lacks the uvular stops and does not distinguish between two rhotics. Crawford also describes an additional coronal stop and fricative for Cocopa.

Table 1: Cocopa consonants (adapted from Crawford 1966: 25)

	Labial	Dental	Alveol.	Alveo-palatal	Velar	Labio-velar	Uvular	Labio-uvular	Glottal
Stops	p	t̪	t	c	k	kʷ	q	qʷ	ʔ
Nasals	m	n̪			ɲ				
Affric.				t͡ʃ					
Fricat.		s̪	s	ʃ	x	xʷ			
Lat. fric.			ɬ	ɮʲ					
Lateral			l		ʎ				
Rhotic		r̪	r						
Glides					j	w			

Table 2 is adapted from Miller (2001: 39ff). Neither language has a laryngeal contrast, but nevertheless both have a sizeable consonant inventory.

Table 2: Jamul Tiipay consonants (adapted from Miller 2001: 39)

	Labial	Dental	Alveol.	Alveo-palatal	Velar	Labio-velar	Glottal
Stops	p	t̪			k	kʷ	ʔ
Nasals	m	n̪			ɲ		
Affricate				t͡ʃ			
Fricatives		s̪		ʃ	x	xʷ	
Lat. fric.			ɬ	ɮʲ			
Lateral			l		ʎ		
Rhotic			r				
Glides					j	w	

Crawford describes three contrastive vowels for Cocopa and Miller discusses the status of a fourth one. Some schwas, she claims, are not predictable and therefore have to be analyzed as present in the lexicon. Table 3 is adapted from Miller (2001: 12).

Crawford (1966: 13) discusses two additional vowels. /e/ occurs in Spanish loans and is consistently mid to upper-mid unrounded, unless it is replaced by Cocopa /i/, which many speakers do. The other vowel, /o/, is only found in one interjection that expresses "frustration or disappointment".

In both languages, the realization of the three contrastive vowels depends considerably on their environment. In Cocopa, the front high vowel is a bit central-

Table 3: Cocopa and Jamul Tiipay vowels (Crawford 1966, Miller 2001)

Front	Central	Back
i, iː		u, uː
	ə	
	a, aː	

ized when preceded or followed by an alveolar consonant. The long front vowel is a bit higher than the short one. This difference is not reported for the back high vowels. These vary in height and are lowered slightly when followed by another vowel with only one intervening consonant or when followed by a sibilant. Crawford only gives examples with following low vowels for the first condition. There might actually be some kind of height harmony operative here. The low vowel is lowest when preceding the stressed vowel, only separated from it by one consonant, and slightly raised and fronted when preceded by a palatal consonant and even more so when surrounded by palatals. Elsewhere, it is a central low vowel with the long one a bit lower than the short.

The intrusive vowel is described as a vowel similar to /u/ when followed by a labiovelar consonant, including /w/, an /i/-like vowel when followed or preceded by a palatal or dental before any consonant except the labiovelars, and as a schwa-like vowel in all other environments (Crawford 1966: 38, see also **chapters/03.Mansfieldetal**, for similar environmental colouring of inserted vowels). He transcribes them as superscript *i*, *u* and *a*, respectively.

Miller (2001: 20) gives a similar description of what she calls "inorganic" schwa, the vowel that "is inserted between consonants to break up clusters" in Tiipay: it is never long and never stressed. Its quality is determined by surrounding consonants, resulting in [ɪ], [ʊ], [ə]. Whenever two conditions overlap schwa may be realized as any of the available options, e.g., [ɬʲəxʷiːw] 'skunk'; this vowel could be realized as [ɪ] or [ə] because it is preceded by a palatal consonant (a palatal voiceless lateral fricative) or it can be realized as [ʊ] because it is followed by a labialized velar [xʷ]. If schwa is only separated from the following vowel by a glottal stop, it may be realized as a copy of the short allophone of that vowel. The three lexical vowels vary according to environment in a similar way as in Cocopa. Since some schwas are unpredictable, such as those in the left column in (6), Miller assumes them to be present in lexical representations. The forms on the right serve to illustrate the same phonotactic context without a schwa. The last form shows a context for optional vowel intrusion, i.e., a prokaryotic syllable.

(6)   Unpredictable schwas in Jamul Tiipay (Miller 2001: 21)

aləmi	'beard'	xalma	'gourd rattle'
wanəpu	'buttocks'	xənpaɬ	'tongue'
xəmuk	'to be three'	xəmuɬ / xmuɬ	'to be foamy'

Cocopa complex onsets can consist of almost any sequence of up to four obstruents, with the following restrictions. If a voiceless lateral is involved, it is cluster-initial. If a glottal stop is involved, it is final in the cluster. Sequences of stops are not attested, but sequences of fricatives are. If there is a nasal it is final too. The only examples for complex onsets with a sonorant other than a nasal are loanwords and have the sonorant as the internal member. Complex onsets of unstressed syllables are slightly more restricted. For example, they do not contain a glottal stop.

(7)   Cocopa stressed complex onsets

   a.   Sequences of obstruents

xps̬íw	'be blue, green'
ps̬kʷá	'I gossip about him'
ɬʲksís	unidentified plant species
pscʔá:w	'I have them as daughters'
scxʔú:ɲ	'yellowshafted flicker'
xs̬á:m	'be almost'
s̬xʈú	'I spit'

   b.   Rising sonority

ʃmá	'I sleep'
ɬʲmár	'I light a fire'
ɬʲs̬míx	'I intend to lay something big in'
ɬʲjú:m	'I think'
tré:n	'train'
krú:s̬	'cross'

Jamul uninterrupted initial clusters, as already indicated in the introduction, are much more restricted. They all start in a sibilant and the internal consonant is always a stop.

(8)   Jamul Tiipay uninterrupted initial consonant clusters

/ʃ-puk/	ʃpuk	'to lay head on pillow'
/s-pir/	spir	'to be strong'
/s-ti/	stu	'to pick up, gather, get'
/s-kan/	skan	'to flee'
/ʃ-ʈu/	ʃʈu	'to shove (with hands or instrument)'

All other sequences are broken up at least optionally by a schwa vowel, as will be discussed in the next subsection.

On stress, Crawford (1966: 28) states that there are three levels, strongly stressed, stressed and unstressed. Within what he calls a "macrosegment", which I interpret to roughly coincide with a word, there is usually only one stressed syllable. However, he also states that within a macrosegment with more than one syllable preceding the stressed syllable, "the first unstressed syllable has a slightly stronger stress than the following unstressed syllables" (Crawford 1966: 29). Crawford is very clear about the unstressability of prokaryotic syllables: "A stressed or strongly stressed syllable can only be one which contains a vowel." And on syllables he states that "[a] syllable can be entirely consonantal and consist of an onset only or of an onset and a coda with a predictable 'murmur' vowel following the onset as phonetic peak." (Crawford 1966: 34) According to Miller (2001)'s description of stress in Jamul, and in Yuman in general (Langdon 1975), stress on schwa syllables is not an option because of the morphological nature of stress placement. Stress is always placed on the morphological root of a word, which predominantly has the shape (C)V(C). Since the morphology is mostly prefixing, this results in word-final stress in most cases. In the few cases of bigger roots, as illustrated in (8), stress is still on the last vowel and schwas are not stressed.

Cocopa verb root reduplication is a semi-productive process. I consider it semi-productive because many reduplicated verbs do not have a non-reduplicated base form. Many do, however, and we can observe some regularities that indicate that it is impossible to reduplicate consonantal syllables. The preferred verb root for reduplication is of the form CVC(C). Roots with complex codas can be reduplicated, while verbs with complex onsets are not reduplicated. Initial consonant clusters arise only when an instrumental prefix is added to the reduplicated form. In this case inflection for person is possible, while the other reduplicated forms are impersonal uninflected forms. Inflection is realized on an adjacent auxiliary. One instrumental prefix exemplified is of the form CV- and the other is a sibilant. This sibilant causes either deletion of the reduplicant-initial (root) consonant or its alternation from a fricative into a stop, creating either a simple onset or a cluster, adhering to the restrictions for such clusters found in Jamul (8).

(9) Cocopa prefix-reduplicant interaction
     ʃírmír   'I take aim' (probably from *mírmír i* 'to be straight')
     skárxár/sxárxár   'I break into small pieces'

Thus, none of the many consonantal prefixes that would create complex onsets

or prokaryotic syllables are reduplicated or even used to further derive or inflect reduplicated forms.

Jamul reduplication is similarly restricted and unproductive. The base is maximally CVCC, as in (10a) and (10b). Of the 23 reduplicated verb stems Miller collected, only two forms have a prefix, and even there it is prefixed to the reduplicated form, as shown in (10c).

(10)   Reduplication in Jamul Tiipay
     a. milmil   'to be narrow'
     b. aʃkaʃk-i   'to go up and down, back and forth'
     c. t͡ʃəxəlxul   'to gargle' cf. təkəlkul 'to pile (things) up'

Verbs such as [txiːl] 'to get dressed, wear clothes' do not seem to undergo reduplication, not even with a reduced reduplicant (e.g., *[xiːl-txiːl])

The alternations observed in Cocopa (9) suggest that the restriction of reduplication on verb roots with simple onsets is a phonological one, and that the many stems that are formed with derivational consonantal prefixes, such as causatives, do not undergo reduplication because complex onsets and minor syllables are banned in the reduplicant.

Compare these reduplication patterns with those found in the sister language Diegueño/Kumeyaay (Langdon 1966), which displays almost identical patterns of schwa insertion. Langdon reports to have found many reduplicated forms. Almost all reduplicate only the stem syllable, as in the other two languages. There is, however, a very small set of bisyllabic reduplicants. Interestingly, in three of the four forms Langdon found, the initial vowel is a schwa.

(11)   Bisyllabic reduplicants in Kumeyaay (Langdon 1966: 202)
     kuɫaːɫ kuɫaːɫ 'to go up and down (like when riding a horse)'
     ɫəxup ɫəxuːp 'holes all over' (cf. ɫəxup 'hole, cave')
     səkap səkaːp 'half and half, to be more than half full' (cf. səkap 'to be half')
     xəkaɫ xəkaːɫ 'to be scalloped, uneven at the edges, to have teeth missing'

The fact that there are bisyllabic reduplicants in Kumeyaay and that they contain schwas can be counted as weak evidence that the schwas in Kumeyaay are phonological, unlike those in Cocopa and Jamul Tiipay. Presumably, reduplication targets prosodic structure, such as moras.

As illustrated in (7) and (8), the restrictions on initial clusters differ in Cocopa and Jamul. In the following we will more closely examine the insertion sites for intrusive vowels in both varieties and conclude that also the phonotactic constraints on prokaryotic syllables differ slightly.

3.2 Cocopa intrusive vowel landing sites

The intrusive vowel prevents a sonority rise and consecutive fall, as illustrated in (12). Minor syllables in Cocopa can have complex onsets, just like major syllables, i.e., containing two obstruents (12a). A vowel is inserted if either a sonorant is followed by an obstruent or vice versa (12b). The forms in (12b) could theoretically be syllabified with fewer inserted vowels, i.e., fewer prokaryotic syllables, as indicated by the conceivable but unattested forms marked with a question mark in (12b). This would, however, result in obstruent codas followed by sonorant onsets, as the question marked forms show. Such rising sonority profiles across syllables violate the Syllable Contact Law (Murray & Venneman 1983), according to which sonority should fall from one syllable to the next. Clusters with variable intrusion sites involve sonorants and either syllable contact created is wellformed (12c).

(12) Prokaryotic syllable phonotactics

    a.   sxᵃm.pá   'yellowjacket'

        ɬⁱpᵃm.wák   'you are to ride him'

        pʃkᵘ.wá:kˣ   'we intend to return him'

    b.   mᵃ.kⁱ.ɲá:p   'you relate'   ʔmᵃk.ɲá:p

        pᵃ.mⁱn.ʈⁱ.má:k   'we abandon them'   ʔpᵃm.nⁱʈ.má:

        mⁱ.cⁱm.pᵃ.ká:wc   'you meet each other'   ʔmⁱc.mⁱp.ká:wc

    c.   ɲⁱm.ɲⁱ.kʷájs / ɲⁱ.mⁱɲ.kʷájs   'we are your mother's brothers'

        ɲⁱɬ.mwa.já:c / ɲⁱ.ɬ ʲⁱm.wa.já:c   'you are around in it'

As in major syllables, sequences of stops are avoided (unless the last stop is a glottal stop). Obstruent-sonorant sequences are avoided too, suggesting that rising sonority in complex onsets is marked and restricted to loanwords.

(13) Stop-stop and obstruent-sonorant onsets are avoided

     ʈⁱ.ʈʔá:p   'I turn something upside down'

     pᵃ.qⁱ.la.ʃáw   'he cleaned him'

     ʈⁱ.má:j   'waves of the ocean'

     pⁱ.lík   'I taste'

Cocopa allows both complex onsets as well as, presumably, appendix plus onset initial clusters, with the appendix filled with a sibilant. Clusters that exceed these structures with maximally three consonants, and clusters that do not conform to the sonority restrictions and the manner ocp banning consecutive stops, are divided up into prokaryotic syllables, which can have complex onsets and

codas. The minor syllables are more restricted in Jamul Tiipay as are regular syllables.

3.3 Jamul Tiipay prokaryotic syllable phonotactics

The schwa vowel emerges between stops and between sonorants, between stops and sonorants but not glides, between sonorants and obstruents, and sonorants and sonorants (14a). It does not occur between sibilants and stops (8), but between sibilants and glides, as illustrated in the second example in (14). (14b) shows that also string-internally sibilant-stop sequences are tolerated, as word-initially (8).

(14) Jamul Tiipay cluster resolution

a.	/t-ɲur/	təɲur	'to curl (hair), to decorate'
	/m-ʃ-ja:j/	məʃəja:j	'to be afraid'
	/kʷ-n-ma:w/	kʷənəma:w	'his/her father's mother'
	/t-t-k-ju:t/	tətəkju:t	'to greet (pl)'
	/ɲ-ʃ-k-ʔ-mak/	ɲəʃkəʔmak	's/he took it away from me'
b.	/k-s-kan/	kəskan	'run away!'
	/m-ʃ-t-u:-jaj/	məʃtu:jaj	'to be afraid (pl)'
	/ɲ-ʃ-p-a:-ʔ-ʔá:w-a/	ɲəʃpaʔá:wa	'they made us stand up'

The glottal stop behaves differently in that it can precede any consonant but not follow a consonant.

(15) No insertion between glottal stop and other Cs

/ɲkʔ-wi:w/	ɲəkəʔwi:w	'look at me!'
/ɲ-ʃ-k-ʔ-mak/	ɲəʃkəʔmak	's/he took it away from me'

Unlike Crawford, Miller distinguishes between obligatory schwa insertion (14 and 15) and optional intrusion (16). Miller does not always give two forms in these examples. From the fact that she lists them in this context, I conclude that they display optional schwa.

(16) Variable epenthesis between two voiceless obstruents

/x-tat/	xtat /xətat	'(someone's) back'
/p-ʔaw/	pʔaw	'to stand, step; (for rain) to fall'
/t-k-a:-xa:p/	tka:xa:p	'bracelet'
/k-ʃ-u:-pit/	kʃu:pit/ kəʃu:pit	'close it!'
/t͡ʃxlkaj/	t͡ʃxəlkaj	'kidneys'
/t͡ʃ-k-u:jaw-a/	t͡ʃku:jawa	'to teach'
/s-na:j/	sna:j	'to dip up (water)'
/t͡ʃ-mi/	t͡ʃmi	'to lay (long or large object) down'

In longer sequences we find fewer intrusive vowels than expected, suggesting that there are limits to the number of prokaryotic syllables in a row. The occasional transcription of an optional schwa in string-internal sequences of sonorants followed by obstruents shows that internal clusters are preferably syllabified tautosyllabically as onsets and not heterosyllabically as coda-onset sequences. However, it is also noteworthy that none of the given forms has a word-initial complex onset to a prokaryotic syllable. Word-initial clusters are all followed by a full vowel. This differs from Cocopa, where we find up to three consonants followed by an intrusive vowel (12a).

(17) Bigger clusters

/t-t-xʷak/	tətxʷak	'to break (brittle object) (pl)'
/m-ɲ-kurʔak/	məɲkurʔak	'your husband'
/m-ʎ-piʃ/	məʎpiʃ/məʎəpiʃ	'you are small'
/t͡ʃ-k-pi:k/	t͡ʃəkpi:k	'to squash many'
/t-k-xap/	təkxap	'to put on, wear (bracelet, ring, shirt, eyeglasses)'
/k-t-k-xap/	kətkəxap/kətəkxap	'put (bracelet, ring, shirt, eyeglasses) on!'
/m-m-ʃ-ja:j/	məmʃəja:j məməʃəja:j	'you are afraid'
/ɲk-m-ʃ-ʔ-ja:j/	ɲəkəmʃəʔja:j	'be afraid of me!'
/m-m-ʃ-kʷaɬʲ/	məmʃəkʷaɬʲ/məməʃkʷaɬʲ	'you bother him/her; s/he bothers you'
/ɲm-m-ʃ-kʷaɬʲ/	ɲəməməʃkʷaɬʲ	'you bother me'

Miller (2001) analyzes the cluster patterns with an across-the-board schwa epenthesis rule and several schwa deletion rules that apply optionally, resulting in optionality for most of the inserted schwas. In addition, these rules also apply either rightwards or leftwards in a cluster. Thus, the two forms of 'you bother him/her; s/he bothers you' in (17) are the result of rightward or leftward application of a late schwa deletion rule scanning the result of the general schwa insertion rule |mə-mə-ʃə-kʷaɬʲ|. We can thus add another property of intrusive invisible vowels, optionality (4d).

3.4 Summary

The stress and reduplication patterns of Cocopa and Jamul Tiipay do not show any sign that the syllables with intrusive vowels are accessible by higher level prosody. Closer inspection of the distribution of intrusive vowels and where they

are optional and where not reveals restrictions on onsets and codas, which differ between regular and prokaryotic syllables as well as across the two languages. Cocopa regular onsets display complexity, allowing for proper complex onsets with rising or plateauing sonority and an OCP constraint that bans sequences of stops as well as sequences of fricatives. Prokaryotic syllables in Cocopa can have complex onsets consisting of obstruents alternating in continuancy and they can have simple codas. Regular onset phonotactics are stricter in Jamul Tiipay, permitting basically only sibilant-stop clusters and prokaryotic syllables seem to allow complex onsets only under duress, i.e., to avoid codas or too many consecutive prokaryotic syllables.

4 Theoretical implications

The Yuman patterns discussed here contribute to the understanding of minor syllables on the one hand and of excrescent vowels on the other.

4.1 Non-canonical syllables

I will not try to integrate all proposals of consonants dominated only by a syllable node or a mora or no syllable structure or an appendix into one model of a typology of prokaryotic syllables. These are in many cases competing proposals. However, a few remarks are in order.

The appendix (e.g., Vaux & Wolfe 2009 and references cited there) is an additional position that can be attached to the syllable, preceding the onset or a higher-level prosodic category, such as the foot or the word. In the analysis of Indo-European languages, this is usually invoked to account for sibilant-initial clusters that violate sonority sequencing. Clusters of rising sonority are treated as complex onsets. The only segment allowed in this position is accordingly a sibilant, and usually only one, as in English. The first segment in complex onsets is usually an obstruent and the second segment is a sonorant or in more restrictive languages a non-nasal sonorant. We have seen the former, i.e., sibilant-initial clusters, in Jamul Tiipay. They are not only highly restrictive in the first position, allowing only sibilants, but also in the second position, in which we find only stops. The cross-linguistically widespread rising sonority clusters are not attested or only in recent loanwords. In Cocopa, we find more combinations of obstruents in initial clusters. Only consecutive stops are avoided. Such obstruent clusters can have more than two members.

An analysis of the sibilant-initial clusters in Jamul Tiipay as appendix plus simple onset is an obvious choice. Whether the Cocopa obstruent sequences are

appendixes plus onset or complex onsets with a strict requirement for flat and low sonority is a more intricate issue. We will not solve this here, since these elaborations only serve to rule out an appendix analysis for the clusters broken up by excrescent vowels. If an intrusive vowel can or must be inserted between an appendix and the following onset consonant, it should also be attested in the sibilant + stop sequences in Jamul Tiipay. This is not the case. The vowel intrusion patterns can thus not be analyzed by the stipulation of an appendix position for each consonant preceding an intrusive vowel. Assuming that several appendixes can precede the first syllable of a word, one would also not expect any clusters of two consonants inside a sequence of appendixes, as in the second form in (12b) or those in (12c). This suggests that there is more elaborate syllable structure than just a sequence of appendixes.

The Yuman prokaryotic syllable is also different from the minor syllables that have been proposed as the weak part of the sesquisyllable in Southeast Asian languages (Matisoff 1973, Shaw 1994, for a recent discussion see Butler 2014). The minor (or half) syllable in a sesquisyllabic word precedes a full or major syllable. These arguably form iambic feet together and the minor syllable might even bear a tone (Svantesson & Karlsson 2004, Butler 2014). The minor syllable in sesquisyllables thus has to have prosodic structure that makes it visible for footing and that makes it a licit tone-bearing unit. The mora is usually assumed to be the relevant unit in iambic feet and tone association.

Yuman prokaryotic syllables contribute neither to foot construction nor can they be said to be prosodically active in any other way. Their only purpose is to avoid illicit consonant sequences within canonical syllables.

4.2 Excrescence and epenthesis

As has been argued at length here, the schwa vowels of Cocopa and Jamul Tiipay emerge between the constituents of syllables without nuclei. They are not inserted to repair an illicit structure, but they do emerge as a side effect of such an adjustment in avoidance of marked or ungrammatical phonotactics. They thus do not comply with one of the central criteria invoked by Hall for the diagnosis of excrescent/intrusive vowels. They do, however, fulfil other important criteria. They are short, reduced, unstable, and variable, and their quality is dependent on that of neighboring consonants, i.e., their immediate phonetic neighborhood.

Considering how the schwas of Cocopa and Jamul Tiipay have properties of both phonetic and phonological inserted vowels and lack properties of each type, it is tempting to propose the existence of a third category. Using the existing terminology, we could distinguish between three types of inserted vowels – epenthetic vowels that are integrated in the phonological structure, excrescent vow-

els that signal additional phonological structure, and intrusive vowels, which are phonologically irrelevant. The latter two categories are both phonologically invisible in that they are not available for the phonology, e.g., to house tones, contribute to foot construction or participate reliably in vowel harmony. However, this would be premature. The most important distinction is whether a vowel is affiliated with phonological structure, i.e., parsed in a syllable nucleus, or not. In addition, I think one can reasonably argue that the emergence of the excrescent vowels is a side effect of gestural timing, similar to that of Hall's intrusive vowels.

The presence of the additional onset to house the first consonant(s) of a sequence that would not constitute a well-formed onset with this initial consonant, has phonetic consequences. The final consonant in an onset is expected to have a substantial release phase, especially if it is a stop, which is expected to turn into a vowel, which always occupies the nucleus of a major or canonical syllable. The consonant in a prokaryotic syllable is also in an onset, it is just not followed by a nucleus. One can, however, assume that the articulatory targets are determined by its position in the syllable structure and that it behaves in the same way as a consonant in a major syllable does. The only difference is that the onset consonant in a prokaryotic syllable is not followed by a nucleus and thus no phonological vowel. It is thus the automatic articulatory mechanics at the end of the consonant in an onset that makes observers perceive a vocalic offglide or schwa-like vowel. A coda consonant on the other hand is not expected to have much of a release. In many languages, word-final stops do not have an audible release at all. The articulatory "habits" for onsets thus facilitate the emergence of a following transitional or excrescent vocoid, while the articulation patterns for coda consonants do not easily provide space for such a non-phonological vocoid.

An excrescent vowel in a prokaryotic syllable is thus not the result of an overlap of the transition between two consonants and the opening gesture of a phonological vowel. Its perception is, however, the result of gesture coordination determined by the prosodic structure associated with the surrounding segments and thus a phonetic by-effect of abstract phonological representations.

Accordingly, it is more appropriate to divide inserted vowels into epenthetic and excrescent vowels, and the latter into those caused by mere gestural coordination and those caused by the mapping of abstract phonological representations to articulatory actions.

5 Conclusions

Excrescent vowels in Cocopa emerge in response to sonority fluctuation inside consonant clusters and thus signal the presence of a prokaryotic syllable. Jamul Tiipay schwa insertion and variability is similarly conditioned by the sonority

of surrounding consonants. Hall's main argument for assuming the consonants flanking excrescent vowels to not project a separate syllable was their inactivity in stress placement and other prosodic patterns. This inactivity of prokaryotic syllables is explained here by their prosodic deficiency causing their inability to contribute to higher level prosodic structure: Prokaryotic syllables, i.e., those with an optional excrescent vowel, do not have a nucleus and do not project a mora, as proposed by Cho & King. In contrast to what Cho & King stipulated, however, Cocopa prokaryotic syllables can have a coda. If the distinction between obligatory and optional schwa observed by Miller in Jamul Tiipay signals a phonological difference, we are most probably dealing with defective syllables which contain a nucleus but do not project a mora in the case of obligatory schwas. Thus, they too are ignored in the computation of stress, feet, or other syllable counting operations.

There are two main results of this study. First, with the help of excrescent or intrusive vowels, we can recognize prokaryotic syllables. These syllables are inaccessible for prosodic computation because they lack a nucleus and a mora, but they are syllables because they are subject to syllable phonotactic constraints on onsets and codas. Cho & King's definition of what they call semisyllables thus must be broadened to include prokaryotic syllables with a coda.

Second, there are two types of intrusive (non-phonological) vowels. The first type are those described by Hall as stemming from gestural overlap of the vowel within a syllable with the transitions between consonants within that syllable. The second type, described here, emerges as a phonetic effect of standard articulatory patterns in the realization of consonants in specific syllable positions, in this case the rightmost consonantal position in an onset.

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