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Dossier Temas de fonología otomangue

Clusters vs. units in Otomanguean: the cases of Tlapanec (Mè'phàà) and Zapotec (Dixsa:)

Secuencias vs. unidades en las lenguas otomangues: los casos del tlapaneco (mè'phàà) y el zapoteco (dixsa:)

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Abstract

Since the pioneering work of Trubetzkoy (1939), there have been various proposals as to how to distinguish consonant clusters and units in individual languages. In this paper, I will look at the cases of Malinaltepec Tlapanec (*Mè'phàà*) and Teotitlán del Valle Zapotec (*Dixsa:*), two Otomanguean languages. I will look at general and language-particular criteria to distinguish clusters and units in these languages. I will show that in both cases the criteria do not always converge: some sequences are judged to be clusters by certain criteria but as units by others. Based on these observations, and drawing insights from Canonical Typology (Brown et al. 2012), I argue that the distinction between clusters and units is not dichotomous, but multidimensional: individual cases may simultaneously resemble clusters in some aspects but units in others, thus the typology of behaviors is richer than a simple binary opposition.

Keywords: complex segments; Canonical Typology; Tlapanec; Zapotec

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Resumen

Desde el trabajo pionero de Trubetzkoy (1939), se han presentado varias propuestas para distinguir las secuencias y las unidades consonánticas en las lenguas individuales. En este artículo, exploraré los casos del tlapaneco (*mè'phàà*) de Malinaltepec y el zapoteco (*dixsa:*) de Teotitlán del Valle, dos lenguas otomangues. Examinaré los criterios generales y particulares de cada lengua para distinguir secuencias y unidades en estas lenguas. Mostraré que en ambos casos los criterios no siempre coinciden: ciertas secuencias resultan ser secuencias según algunos criterios pero como unidades según otros. Basándome en estas observaciones e inspirado en la Tipología Canónica (Brown et al. 2012), argumentaré que la distinción entre las secuencias y unidades no es dicotómica, sino multidimensional: los casos individuales pueden considerarse simultáneamente secuencias en algunos aspectos, pero unidades en otros, entonces la tipología de los comportamientos es más rica que la oposición binaria simple.

Palabras clave: segmentos complejos; Tipología Canónica; tlapaneco; zapoteco

1. Introduction

When we study the sound systems of individual languages, we often find patterns which can be interpreted either as a cluster of two segments or a unit of a complex segment, which count phonologically as single segments but have internal structure comparable to that of sequences of segments, and are faced with the difficulty of distinguishing between them. Various authors have proposed criteria to distinguish them. One of the first authors to provide such criteria is

Trubetzkoy (1969 [1939]: 55ff), who lists the following criteria to distinguish the two, which range from structural (a, d, e, f, g), acoustic (c) to articulatory (b):

(1) Trubetskoy's criteria to distinguish units and clusters.
   a. Only those combinations of sound whose constituent parts in a given language are not distributed over two syllables are to be regarded as the realization of single phonemes.
   b. Combination of sounds can be interpreted as the realization of a single phoneme only if it is produced by a homogeneous articulatory movement or by the progressive dissolution of an articulatory complex.
   c. Combination of sounds can be considered the realization of a single phoneme only if its duration does not exceed the duration of realization of the other phonemes that occur in a given language.
   d. Potentially monophonematic combination of sounds, that is, a combination of sounds corresponding to the conditions of Rules (a) to (c), must be evaluated as the realization of a single phoneme, if it is treated as a single phoneme; that is, if it occurs in those positions in which phoneme clusters are not permitted in the corresponding language.
   e. Combination of sounds fulfilling the conditions of Rules (a) to (c) must be considered the realization of a single phoneme, if this produces symmetry in the phonemic inventory.
   f. If a constituent part of a potentially monophonematic sound combination cannot be interpreted as a combinatory variant of any oth-

er phoneme of the same language, the entire sound combination must be considered the realization of a single phoneme.

g. If a single sound and a combination of sounds corresponding to the above phonetic prerequisites stand in a relation of optional or combinatory variance, in which the sound combination must be considered the realization of a phoneme sequence, the single sound must also be considered the realization of the same phoneme sequence.

On the other hand, Pike (1947: Ch. 12) focuses on the structural criteria, preferring simple phonotactics than simple inventory. His criteria have been influential especially in the works of SIL-trained researchers, as Round & Macklin-Cordes (2015) point out:

(2) Pike's (1947) criteria to distinguish units and clusters

a. Certain kinds of sequences are likely to be forced by the pressure of the nonsuspicious predominant structural pattern into single phonetically complex phonemes. Whenever a suspicious sequence is paralleled by analogous nonsuspicious sequences, the suspicious phonetic sequence must be interpreted as a sequence of phonemes and not as a single phonetically complex phoneme.

b. If a suspicious sequence is paralleled by a reverse sequence of the same segments in the same relative environments in the language, the structural pattern is likely to separate them into sequences of separate phonemes.

c. Single phonemes tend to occur in single syllables.

Lastly, Steriade (1992) mentions three characteristics of units which are not shared with clusters: first, only plosives can be contour segments (units); second, the plosives can display intrasegmental contours only if it is released; third, distinctive intrasegmental contours never exceed two articulatory phases. The descriptive or analytic tradition has a detectable impact on the analysis of units vs. clusters: Round & Macklin-Cordes (2015) found that the choice between units vs. clusters is largely predictable if the following information is factored in: (i) whether the language is spoken in Australia or not, and (ii) whether the linguist is SIL-trained or not.

Other authors have discussed representational issues surrounding the complex segments, including Devine (1971), Anderson (1974), Campbell (1974), Clements & Keyser (1983: 85ff.), Buckley (1992), Weijer (1996; 2011), Tak (2011), and Gouskova & Stanton (2021), among others. In particular, Otomanguean languages spoken in Mexico have played an important role in the theoretical discussions on this topic. For instance, Stark (1947) on San Miguel el Grande Mixtec is one of the earliest studies on the topic, and the complex consonants in Huautla Mazatec, an Otomanguean language spoken in the northern part of Oaxaca, have sparked controversy as to their status. Pike & Pike (1947) argued that segments may be distinctively ordered within an onset or nucleus, while Steriade (1994) argues against complex syllable structure and instead claims that it is plosives that are complex and onset in Huautla Mazatec is mostly monosegmental. Lastly, Golston & Kehrein (1998) argue against Steriade's (1994) analysis and claim that Huautla data require neither complex syllables nor

complex plosives, but that phonetically and phonologically motivated repartitionings of distinctive features allow for a simple solution, showing that Mazatec has simple syllables and simple plosives, while the complexity arises due to the types of features that can be associated to nuclei and to onsets.

This paper will examine the cases of Malinaltepec Tlapanec (§2) and Teotitlán Zapotec (§3), both Otomanguean languages spoken in Mexico. Both of these languages have patterns which can be interpreted either as a cluster of two segments or as a unit of a complex segment (which I will refer to as *complex consonants*). I will look at both general and language-internal criteria in each language. For the general criteria, I will focus on the following in this paper: tautosyllabicity of the complex consonants (Trubetzkoy's criterion (a), Pike's criterion (c)); distribution (Trubetzkoy's criterion (d) and Pike's criterion (a)); symmetry in the phoneme system in the language (Trubetzkoy's criterion (e)); as well as whether or not the part of the complex sounds exists as an independent phoneme in the language (Trubetzkoy's criterion (f)). In addition, I will employ the evidence from morphology, as is employed in Stark (1947) on Mixtec and Avelino (1997) and Berthiaume (2003: Ch.4) on Northern Pame, another Otomanguean language (see also Pike 1947: 133). The phonetic criteria, articulatory and acoustic (Trubetzkoy's criteria (b), (c)), are beyond the scope of this paper; future studies can corroborate or not the findings of this paper which are based on phonological and morphological evidence (see Martinet 1939, Devine 1971 and Gouskova & Stanton 2021, among others, for criticisms on the validity of the phonetic criteria).

In this paper, I will show that these criteria mentioned above do not converge. Thus, the distinction between clusters and units is not dichotomous, but rather multidimensional: individual cases may simultaneously resemble clusters in some aspects but units in others, thus the typology of behaviors is richer than a simple binary opposition. Such a situation can be satisfactorily captured by Canonical Typology (Corbett 2006; Hyman 2006; 2012; Brown et al. 2012; Corbett 2015: 149; Kwon & Round 2015), especially following Round (2019), which is suited to analyze and define phenomena that are subject to variation (§4).

2. Malinaltepec tlapanec (mè'phàà) complex consonants

Tlapanec (Mè'phàà) is spoken in the eastern part of the state of Guerrero, and belongs to the Tlapanec-Subtiaba family, along with the now extinct Subtiaba once spoken in Nicaragua. Tlapanec-Subtiaba is one of the western Otomanguean languages, along with Otopamean, Chinantecan and Chiapanecan languages, according to the classification of Campbell (2017). This paper will focus on the Malinaltepec Tlapanec (ISO 639-3: [tcf]), which includes the Malinaltepec and Huehuetepec varieties (Marlett & Weathers 2015: 3). The data mainly comes from Carrasco Zúñiga's (especially Carrasco Zúñiga & Weathers (1988) and Carrasco Zúñiga (2006)) and Tiburcio Cano's works (especially his thesis Tiburcio Cano (2017)), as well as consultations with the latter.

Malinaltepec Tlapanec has five vowels, *a, e, i, o,* and *u*. Nasalization (represented with a tilde), glottalization and length (represented by doubling the vowel) are contrastive on vowels. Malinaltepec Tlapanec has three tones, low (*à*), mid (*a*) and high (*á*) which can occur on a mora; see §2.6 on which segments contribute to the mora. Malinaltepec Tlapanec has the consonants shown in Table 1 (cf. Carrasco Zúñiga 2006: 46ff.; Marlett & Weathers 2012; Oropeza Bruno 2014; Tiburcio Cano 2017: 41). Table 1 also includes ambiguous cases to be discussed in this section: aspiration, prenasalization, palatalization and labialiazation that are attested in my database, which are in italics. Aspiration and prenasalization appear in independent lines, while labialization and palatalization appear in the same cells as the plain series.

Among the consonants in Table 1, Marlett & Weathers (2012; 2018) argue that *ts* is an allophone of /s/; even though it is true that in some varieties certain words show free variation between [s] ~ [ts], as Oropeza Bruno (2014: 74) points out, there are some minimal pairs and thus I consider that /ts/ is an independent phoneme, albeit marginal. According to Marlett & Weathers (2012; 2018), *r* is an allophone of /d/, which appears in atonic syllables. It is true that its distribution is limited to atonic syllables, but I would rather consider *r* as a marginally contrastive phoneme, since in rare cases a [d] can appear in atonic syllables (such as [dúdĩĩ^{n}] ‘avocado’, [dúdíʔ] ‘*sal de cal*’), especially in loans and compounds. The phoneme /l/ is not common and is found only in loans and in some clitics. In this paper, I follow the analysis that the glottal stop [ʔ] is a vowel feature, rather than a

Table 1. Consonant inventory of Malinaltepec Tlapanec

		BILABIAL	DENTAL	POST-ALVEOLAR	VELAR	LABIO-VELAR	GLOTTAL
stops	voiced	b, b^w, b^j	d, d^w, d^j		g, g^w, g^j		
	prenasalized	^{m}b, $^m b^j$	^{n}d, $^n d^w$, $^n d^j$		^{n}g, $^n g^w$, $^n g^j$		
	voiceless	p, p^w, p^j	t, t^w, t^j		k, k^w, k^j		
	aspirated	p^h, p^{hj}	t^h, t^{hw}, t^{hj}		k^h, k^{hw}, k^{hj}		
fricatives	voiceless		s, s^w, s^j	ʃ, $ʃ^w$, $ʃ^j$			h, h^w, h^j
affricates	voiced			ʤ, $ʤ^w$			
	voiceless		ts, ts^w, ts^j	ʧ			
nasals	voiced	m, m^j	n, n^j				
	voiceless	m̥, $m̥^j$	n̥, $n̥^j$				
laterals			l				
tap			ɾ, $ɾ^w$, $ɾ^j$				
glides				j		w, w^j	

consonant (see discussions in Carrasco Zúñiga 2006; Navarro Solano 2012; Marlett ms; Marlett & Weathers 2012; Weathers et al. 2012; Tiburcio Cano 2017: 47ff.).

The ambiguous cases are prenasalization, aspiration,[1] labialization and palatalization. Labialization is generally assumed to be a sequence of a consonant (mostly velars) + a glide portion of a diph-

[1] Some varieties such as Malinaltepec (and Huehuetepec) have post-aspirated stops while others such as Acatepec or Ayutla have pre-aspirated stops but not post-aspirated stops (Marlett & Weathers 2012: 7–8). The focus of this paper is on the Malinaltepec and Huehuetepec varieties and thus only post-aspiration is discussed. Prenasalized consonants

thong (*w*),[2] while Marlett & Weathers (2012; 2018) analyze labialization as a unit, based on its distribution and alternation. Marlett & Weathers (2012; 2018) also consider prenasalized stops as singletons, based on their distribution and acoustic duration. On the other hand, Marlett & Weathers (2012; 2018) analyze palatalized consonants as sequences, due to its free distribution. I do not consider that palatalization and labialization are features of the nucleus; for instance, [b^{w}anuu] 'elders' should be /b^{w}a.nuu/ (unit) or /bwa.nuu/ (cluster), rather than /bu͡a.nuu/. This is because vowel sequences are generally not allowed in Tlapanec, except for a few heterosyllabic hiatus (Marlett & Weathers 2018).

The status of (post-)aspiration is more controversial. On the one hand, Carrasco Zúñiga & Weathers (1988: 22) and Carrasco Zúñiga (2006: 44) analyze (post-)aspirated stops as being contrastive with unaspirated series (thus units), while Weathers (1976: 368) and Suárez (1983: 31, 45-47) consider aspirated (post-)consonants as cluster of a consonant and *h*. On the other hand, Marlett & Weathers (2012; 2018) state that (post-)aspiration is not contrastive. In this paper, I tentatively assume that aspiration is contrastive, following the traditional view, since there can be minimal pairs between plain stops and post-aspirated stops, such as [t^{h}u^{n}ga] 'half' vs. [tu^{n}ga] 'cut in half'.

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and resonants can also occur with aspiration, but here the aspiration is realized as devoicing of the resonants.

[2] This is reflected in the orthography employed by speakers; for instance, [ʃk^{w}à] 'flat' is written as *škuà* in Carrasco Zúñiga (2006: 40). However, caution should be made against reading too much in orthography due to the influence from the Spanish orthography.

In the remainder of this section, I will look at seven criteria to distinguish clusters and units in Tlapanec: tautosyllabicity (§2.1), existence as independent phonemes (§2.2), systematicity (§2.3), maximum number of consonants (§2.4), morphology (§2.5), minimality requirement (§2.6) and allomorphy motivated by a constraint against a glottal stop followed by a cluster (§2.7).

2.1. *Tautosyllabicity*

All of the complex consonants in question are tautosyllabic, since all of them can occur at the absolute initial position: prenasalization [^{m}ba:] ‘land’, aspiration [t^{h}ana] ‘medicine’, labialization [s^{w}ã] ‘swelling’ and palatalization [d^{j}ulu] ‘palm’. Thus, all of such complex consonants satisfy Trubetzkoy’s criteria (a) and Pike’s criteria (c) for units. However, this fact is not incompatible with the cluster analysis either (cf. Devine 1971: 70–71). This is because this criterion is decisive only when a complex consonant *cannot* occur in the same syllable (such as the *sC* sequences in Spanish, which always have to occur at the syllable boundary), in which case such a complex consonant *cannot* be considered a unit. On the other hand, English *sC* sequences usually occur tautosyllabically,[3] but few would argue that *sC* is a unit (cf. Gąsiorowski 2000).

[3] In some morphological combinations this is not always the case; for instance, after productive *mis-*, as in *I mis-counted* [mɪs.k^{h}auntəd], the C portion has the aspiration, showing that it is not *[mɪ.skaunt] (Erich Round, p.c.).

2.2. *Existence as independent phonemes*

All the components of the complex consonants in question, that is nasals, /h/, /w/ and /j/, exist as independent phonemes in the language, as can be observed in Table 1. Thus, all of the complex sounds satisfy Trubetzkoy's criterion (f) for clusters, but again this fact is also compatible with the unit analysis. This is because this criterion is only decisive when a member of a complex consonant does *not* exist in the phoneme inventory of the language in question, in which case the complex consonant in question *cannot* be considered a unit (cf. Gouskova & Stanton 2021). For instance, Spanish has a post-alveolar voiceless affricate /ʧ/, but this consonant *cannot* be considered a cluster, since a post-alveolar voiceless fricative /ʃ/ does not exist as an independent phoneme in standard Spanish, but rather is not contrastive with the corresponding affricate. On the other hand, English has a glottal fricative /h/ as a phoneme, but no one would argue that aspirated stops are sequences.

2.3. *Systematicity*

All ambiguous secondary articulations in question can occur with the majority of the consonants, as can be seen in Table 1, and illustrated with examples in Table 2. This corresponds to Trubetzkoy's criterion (e) of systematicity. Here, the forms are organized according to the secondary articulations in the columns, and according to the places of articulation and manners of articulations in the lines; ʜ in paren-

thesis represents data from the Huehuetepec variety, while M represents Malinaltepec variety of Malinaltepec Tlapanec. As can be seen, there are no significant gaps that cannot be accounted for by general motivated phonotactic constraints, even though some combinations are more common than others, and some combinations are only found in morphologically complex forms.[4] Prenasalization only occurs with voiced plosives and cannot occur with voiceless obstruents or resonants, which is common cross-linguistically (Maddieson 1984: 67). Nor can aspiration occur with voiced obstruents, which is also typologically expected (Maddieson 1984: 27). Affricates and fricatives cannot cooccur with aspiration, which is not unexpected (Maddieson 1984: 38). On the other hand, labialization is not attested with /^{m}b/, /p^{h}/, /ʔ/, /ʧ/, /m/, /n/, /^{h}m/, /^{h}n/, and /l/,[5] while palatalization is not attested with /ʤ/, /ʧ/, /l/ and /j/, and thus appear unsystematic. These gaps could be accidental in some cases, while in others some explanations for the gaps are available. Thus, /l/ is marginal to begin with, and the other three consonants that cannot occur with palatalization, namely /ʤ/, /ʧ/ and /j/, are all post-alveolar; these gaps may be due to the general constraint motivated by Obligatory Contour Principle (Leben 1977), prohibiting the adjacent sequences of the same place of articulation. In this sense, all the problematic complex consonants are

[4] For instance, labialization is frequent with the velars but rare with other places of articulations (Marlett & Weathers 2018: 12), and palatalized velars and labiovelars are only found in polymorphemic forms.

[5] In Table 1, /jw/ is not found either but this is because /jw/ is indistinguishable from /wj/.

systematic, supporting the unit analysis of these consonants. However, again this fact is not incompatible with the cluster analysis either. For instance, a liquid can occur after any stops in Spanish, as in *plato, clase, broma, drama*, thus manifesting systematicity, but no one would argue that such sequences are units.

Table 2. Co-occurrence possibilities of secondary articulations

		PRENASALIZATION	ASPIRATION	LABIALIZATION	PALATALIZATION
bilabials	voiced	[^{m}baa] ‘land’ (H) [^{m}biʔi] ‘name’ (H) [à$^{m̰}$ba] ‘adult male’ (H)	-	[b^{w}anuu] ‘elders’ (M)	[hùb^{j}aaʔ] ‘your frog’ (M) [nirub^{j}ű́ű́] ‘he pulled me’ (H)
	voiceless	-	[p^{h}ii] ‘opening’ (H) [mèʔp^{h}àà] ‘Tlapanec’ (H) [jap^{h}a] ‘sea’ (H)	[naʃp^{w}á̋ʔá̋] ‘he puts them inside’ (M)	[sp^{j}áha] ‘mole’ (M)
	resonants	-	-	-	[gam^{j}ého] ‘misfortune’ (M) [nàgàm^{j}àʔ] ‘he gets cramp’ (M)

Table 2. Co-occurrence possibilities of secondary articulations *(continuation)*

		PRENASALIZATION	ASPIRATION	LABIALIZATION	PALATALIZATION
alveolars	voiced	[ⁿdíí] ‘cigarette’ (H) [bùⁿdìʔ] ‘*quintonil*’ (H) [ⁿdótʰáá] ‘saliva’ (H)	-	[ⁿdʷǎʔã] ‘vagabond’ (H) [nàdʷáʔáˊ] ‘he falls down’ (M)	[dʲulu] ‘wild dove’ (H) [ʃìdʲàaʔ] ‘your cows’ (M)
	voiceless	-	[tʰana] ‘medicine’ (M) [tʰàà] ‘diarrhea’ (M) [itʰa] ‘corncob’ (H)	[ʃtʷáhẽ] ‘rabbit’ (M) [tsʷíʔìí] ‘Xalatzala’ (H) [sʷã] ‘swelling’ (M)	[tʲakʰè] ‘will’ (M) [tsʲakʰè] ‘power’ (M) [sjǎ̃] ‘anger’ (M)
	resonants	-	[àn̥à] ‘two’ (M) [gàn̥ú] ‘comet’ (M)	[ɾʷahàà] ‘important person’ (M)	[nʲúú] ‘carbon’ (H) [an̥ʲúu] ‘green fly’ (H)
palato-alveolars	voiced	[ⁿʤàà] ‘party’ (H) [íⁿʤóo] ‘gourd sprout’ (M)	-	[ʤʷáʔa] ‘orphan’ (H) [ʤʷéʔgúʔ] ‘my sister’ (M)	-
	voiceless	-	-	[ʃʷenʲááʔ] ‘colander’ (H) [ʃʷáá] ‘market’ (M)	[ʃʲãʔũ] ‘joke’ (M)

Table 2. Co-occurrence possibilities of secondary articulations *(conclusion)*

		PRENASALIZATION	ASPIRATION	LABIALIZATION	PALATALIZATION
velars	voiced	[^{n}gaʔtsaʔ] ‘stain’ (H) [sma^{n}gà] ‘groin’ (M)	-	[ʤág^{w}à] ‘*chipilón*’ (H)	[g^{j}aʃè] ‘color’ (M) [àg^{j}aaʔ] ‘your pig’ (M)
	voiceless	-	[k^{h}ù̃ú̃] ‘hamelia patens’ (H) [ʦ^{j}ak^{h}è] ‘power’ (M)	[ʃk^{w}à] ‘flat’ (H) [àk^{w}ã́ã] ‘ant’ (H) [k^{w}eʔe] ‘pet companion’ (M)	[àk^{j}ã̀ãʔ] ‘your heart’ (M) [ʃùk^{j}áaʔ] ‘your animal’ (M)
labiovelar	resonant	-	-	-	[n^{j}aw^{j}ããʔ] ‘your rope’ (M)
glottals		-	-	[h^{w}ájúu] ‘bunch’ (M) [h^{w}ã] ‘seven’ (H)	[h^{j}áma] ‘boys’ (M) [wáh^{j}aʔ] ‘copal’ (H)

Some of these four secondary articulations can be combined, although many of such forms are polymorphemic: [^{n}d^{w}ã̀ʔã] ‘vagabond’ (H) (prenasalization + labialization); [ɾu^{n}d^{j}áaʔ] ‘your turkey’ (M) (prenasalization + palatalization); [mik^{hw}íí] ‘in the sky’ (M) (aspiration + labialization); and [ʃtìt^{hj}ù̃ʔ] ‘my lung’ (M) (aspiration + palatalization).

2.4. *Maximum number of consonants*

In this section, I will look at the maximum number of consonants in the cluster, to see if the complex consonants in question should be analyzed as units or clusters. This corresponds to Trubketzkoy's (1939[1963]) criterion (d) and Pike's (1947) criterion (c), and is also employed by Marlett & Weathers (2018) to determine the status of complex sounds.

In Tlapanec, onsets may contain two consonants, first of which has to be a fricative, and the second of which either nasal, pre-nasalized stops or voiceless stops (Carrasco Zúñiga 2006: 64–66; Weathers et al. 2012; Marlett & Weathers 2012: 7; Marlett & Weathers 2018: 24): [ska] 'infection'; [ʃnaʔ] 'feather'; [$^{m̥}$bu] 'correct'. Such clusters can be extended with an /ɾ/ (Weathers et al. 2012): [ni.ʃpɾí.gúu] 'he appeased him', [na.stɾi.gà] 'it shrinks', [ʃkɾa.ʦí] 'slingshot', [ʃtɾí.tìʔ] 'woodpecker'. We can use this generalization to judge whether ambiguous cases are clusters or units.

First, labialization should be considered as a unit, since there are forms such as [ʃk^{w}à] 'flat', [ʃk^{w}en] 'a type of weed', where labialization occurs with a sequence of a sibilant + a stop. There are also forms such as [ʃk^{w}ɾeʔ.un] [6] 'deaf', where *kw* needs to be analyzed as a cluster so that the cluster contains only three consonants, thus /ʃk^{w}reʔun/. Similarly, prenasalization can occur with a sibilant, as in [s^{m}ba] 'dirt' or [s^{n}ga] 'penis', thus suggesting that the prenasalization also forms

[6] Articulatorily, the labialization starts from [k] and continues until the [ɾ] portion.

a unit. There are also forms such as [ni.ⁿ̥grí.gú] (with a voiceless prenasalization) ‘they were hung up’ (Weathers et al. 2012: 19), which needs to be analyzed as /nihⁿgrígú/ with the prenasalization as a unit, so that the maximum number of the consonants in the cluster is three. Palatalization can also occur with a sibilant + C cluster, as in [ʃtʲá.hú] ‘lizard’, [ʃtʲú?.wa] ‘maguey’, suggesting that palatalized consonants are also units.[7]

On the other hand, aspirated consonants cannot cooccur with a preceding fricative (*sCh, *ʃCh or *hCh). This may suggest that aspirated consonants are clusters. Another possible explanation is that this gap is phonetically motivated: in general, because *s* is voiceless, the peak of glottal width is internal to *s*, not the following stop (Kim 1970), and thus aspiration is neutralized after *s*. Such a lack of contrast of aspiration after *s* is also common cross-linguistically; for instance, aspiration is not contrastive after a tautosyllabic *s* in English.

2.5. *Morphology*

The next criterion to distinguish clusters vs. units in Tlapanec is morphological: it is expected that a morpheme boundary can intervene consonant clusters, while it should not separate singletons (cf. Stark

[7] Alternatively, Erich Round suggested that the generalization here could be that the licit cluster is *CC*-glide-*r* (this is parallel to the case of English where the licit cluster is *s*-*C*-approximant), rather than that the maximum number of the consonants is three. If this generalization is correct, the data presented in this section only provides justification for the unitary status of prenasalization.

1947; Avelino 1997; Berthiaume 2003: Ch.4). In Tlapanec, morpheme boundary can intervene some of the ambiguous complex sounds. Thus, a morpheme boundary can intervene the aspirated consonant [t^{h}] as in (3a), [t^{j}] as in (4a), and the [t^{w}] sequence as in (5).[8] The forms in (b), where available, justify the underlying stem forms. Throughout this paper, in the segmented examples the first lines show the surface forms, while the second line shows the underlying representations with morphological segmentation, followed by gloss and free translation.

(3) a. [nit^{h}ɾígú] (H)
/ni-t-hrígu/
CMP-2SG-shell.corn
'you shelled (corn)'

b. [ni̥ɾígú] (H)
/ni-hrígu/
CMP.3SG-shell.corn
'he shelled (corn)'

(4) a. [nat^{j}a^{m}báá?] (H)
/na-t(a)-jambáá?/
INCMP-2SG-collaborate
'you collaborate'

b. [naja^{m}báá?] (H)
/na-jambáá?/
INCMP.3SG-collaborate
'he collaborates'

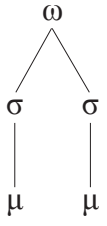
(5) [nà^{m}bàt^{w}ǎ?ǎ] (M)
/na-mbàt(V)+wá?ǎ/
INCMP.3SG-face.down+be.placed.in
'he puts him face down'

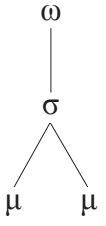
[8] List of abbreviations: CMP: completive; H: Huehuetepec; HAB: habitual; IN: inclusive; INCMP: incompletive; INF: informal; LOC: locative; M: Malinaltepec; PL: plural; SG: singular

No example was found where a morpheme boundary separates a prenasalized stop; it is indecisive if this is an accidental gap or this is because prenasalization cannot occur at the morpheme boundary.[9] We can conclude that according to this criterion, aspiration, palatalization and labialization behave as clusters.

2.6. *Minimality requirement*

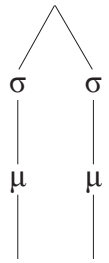
The next criterion, which serves to distinguish between clusters and units in Tlapanec is the minimality requirement (Weathers et al. 2012; Marlett & Weathers 2018), which dictates that the prosodic word has to be at least bimoraic: onset cluster contributes a mora, while units do not. The minimality requirement in Tlapanec can be satisfied by a disyllabic word, as in (6a), or a monosyllabic word with a long vowel, as in (6b), but not by a monomoraic syllable (6c). The forms in (7) exemplify each of the structures in (6):

(6) a. 

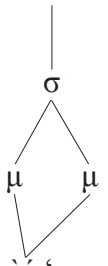
b. 

*c. 

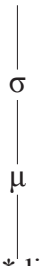
[9] A morpheme-final nasal could potentially occur as a result of vowel syncope from morphemes ending in NV, such as incompletive *na-/nu-*, completive *ni-*, etc., but I have no attested forms where this results in prenasalization.

(7) a. 

gu ma ‘tortilla’

b. 

gàá ‘armadillo’

c. 

*di

Glottal stop counts as a mora, and thus a monosyllabic word with a short vowel followed by a glottal stop also satisfies the minimality requirement (Weathers et al. 2012: 8): [gũʔ] ‘xato, tortilla made of soft corn’, [gũ̱ʔ] ‘moon’, [ʃ̀ìʔ] ‘smell’.[10]

One systematic exception to the generalization above is that a structure in (6c) is allowed when the onset has a consonant cluster (Weathers et al. 2012: 17): [ʃtá] ‘skin’, [s^{n}gà] ‘penis’, [ʃk^{w}à] ‘flat’, or [ska] ‘infection’. Weathers et al. (2012) argue that the onset fricatives in these cases are moraic; see Topintzi (2006) and Ryan (2014) for proposals that onset can contribute weight. [11] Thus, we can use this

[10] Based on this observation, Weathers et al. (2012) propose that glottal stop is the phonetic realization of an empty mora. I do not adopt such an analysis in this paper.

[11] A fricative alone in the onset position is not moraic, thus *sV* or *ʃV* sequences cannot constitute licit prosodic words. No forms with a short vowel with the onset cluster *Cr* are attested, thus we would not know if the criterion on moraicity is positional, i.e., whether it is associated with a position within the onset. Here I tentatively assume that *any* clusters, regardless of their substance or position, contribute a mora.

minimality requirement to judge whether the onset complex sounds are clusters or units.

Table 3 shows monomoraic phonological words (which does not end in a glottal stop), which contain one of the ambiguous complex sounds in question. As we see, each type of complex sounds in the onset position contributes to the mora, and thus the vowel can be monomoraic to constitute phonological words, although examples with prenasalization, aspiration and palatalization are scarce. This may suggest that all of these complex sounds are clusters according to this criterion.

Table 3. Monomoraic forms

PRENASALIZATION	ASPIRATION	LABIALIZATION	PALATALIZATION
[^{m}bá] ‘one’ (H)	[m̥á] ‘mute’ (H)	[(a)h^{w}ã] ‘seven’ (H) [h^{w}a] ‘bunch’ (H) [s^{w}ã] ‘swelling’ (M)	[sʲà̰] ‘anger’ (M)[12]

A prenasalized stop appears to contribute to the mora, as illustrated by [^{m}bá] ‘one’ above, but there is a contradictory piece of evidence: there is at least one monosyllabic form with a prenasalized stop in the onset position, which undergoes vowel lengthening to fulfill the bimoraic requirement (8a). The underlying short vowel is justified by the form in (8b), which has a locative suffix and thus satisfies the bimo-

[12] On p.60, Carrasco Zúñiga (2006) registers this form without a glottal stop, while on p. 352 with a final glottal stop, [sjà^{n}ʔ].

raic requirement without lengthening the vowel (cf. Carrasco Zúñiga 2006: 139).

(8) a. [^{m}baa] (M)
/mba/
land
'land'

b. [^{m}baíí] (M)
/mba-(j)íí/
land-LOC
'in the land'

A possible explanation for this inconsistency is that [^{m}bá] 'one' could be a proclitic, thus it does not need to satisfy the minimality requirement.[13]

Marlett & Weathers (2018: 24) also employ this criterion to determine the status of complex sounds, but with different conclusions: they argue that prenasalized and aspirated consonants should be considered units, since no monosyllabic major class words with a short vowel is found which only have a prenasalized or aspirated consonants in the onset. However, in my database there are monosyllabic major class forms with a short vowel which only has a prenasalized or aspirated consonants in the onset, as was shown above.

2.7. **ʔCC*

The final criterion for distinguishing clusters and units in (Huehuetepec) Tlapanec is the presence and absence of a final glottal stop

[13] Although this form can be uttered in isolation in an elicitation setting.

for two verbal prefixes, the passive and 3SG/1PL.IN agentive prefixes (Uchihara & Tiburcio Cano in press).[14] For these prefixes, the allomorph without the glottal stop is found when the stem begins with a consonant cluster, in addition to when the stem already contains a glottal stop or when the stem is disyllabic. I hypothesize that this alternation is motivated by the avoidance of a glottal stop followed by a consonant cluster, *ʔCC. This subsection only shows examples from the 3SG/1PL.IN agentive prefix; the passive allomorphy has exactly the same conditioning.

The 3SG/1PL.IN agentive prefix has two allomorphs, one with and the other without the final glottal stop. The segmental shape of the prefix varies according to the aspect-mode; here, we focus on the forms in the completive aspect, *ni-* and *niʔ-*. The distribution of these allomorphs is as follows. First, the following examples show stems which do not begin with initial consonant clusters (or which already contain a glottal stop); in such cases, the glottal stop of the prefix is realized. The 1SG forms in (b) justify that the glottal stop does not belong to the stem. Note also that the prefixes show complex allomorphy depending on the stem form (see Suárez 1983: 194 for instance for the alternation between *n-* and *nd-*), which will not be discussed here.

[14] The sensitivity to the number of stem initial consonants appears to be restricted to the Huehuetepec variety. Malinaltepec variety maintains the glottal stop in the prefix even when the stem begins with a consonant cluster. Thus, all the examples in this subsection are from the Huehuetepec variety.

		3SG	1SG
(9)	‘move’	a. [niʔ-bãã̀] ‘he moved him/it’	b. [nì-bã̀ã̀] ‘I moved him/it’
(10)	‘do’	a. [niʔ-ni] ‘he did’	b. [nì-nì] ‘I did’
(11)	‘buy’	a. [niʔ-ʦi] ‘he bought it’	b. [nì-ʦì] ‘I bought it’
(12)	‘see’	a. [^{n}deʔ-joo] ‘he saw him/it’	b. [^{n}dè-jòò] ‘I saw him/it’

On the other hand, when a monosyllabic stem begins with a consonant cluster, the glottal stop in the prefix is not found:

		3SG	1SG
(13)	‘caress’	a. [ni-ʃtaa] ‘he caressed him’	b. [nì-ʃtaa] ‘I caressed him’
(14)	‘sew’	a. [ni-ʃmí] ‘he sewed it’	b. [nì-ʃmì] ‘I sewed it’
(15)	‘lick’	a. [ni-ʃtuʔ] ‘he licked it’	b. [nì-ʃtùʔ] ‘I licked it’
(16)	‘teach’	a. [ne-s^{n}góo] ‘he taught him’	b. [nè-s^{n}góo] ‘I taught him’

Thus, we can employ this criterion to judge whether the complex sound in question is a cluster or a unit. First, palatalized consonants count as a unit according to this criterion, since the glottal stop in the prefix is found:

(17)	‘dance’	a. [niʔ-sʲa] ‘he danced’	b. [nì-sʲà] ‘I danced’

Prenasalized stops also count as units, since a glottal stop in the prefix is allowed before a stem with prenasalization.[15]

[15] Note in the morpheme *+rìgà* ‘surface’ does not count for the counting the number of stem syllables, since the prefix allomorphy is only sensitive to the number of the syllables of the first component of the compounds.

(18) ‘whip’ a. [niʔ-ⁿdi+ɾìgà] ‘he whipped it’ b. [nì-ⁿdi+ɾìgà] ‘I whipped it’

On the other hand, aspirated consonants count as a cluster, since the glottal stop in the prefix is deleted when a stem begins with aspiration. Recall that with resonants ‘aspiration’ is realized as devoicing of the resonants.

(19) ‘disturb’ a. [ni-m̥aa] ‘he disturbs him’ b. [nì-m̥aa] ‘I disturb him’
(20) ‘wash’ a. [ni-n̥ʲá] ‘he washed it’ b. [nì-n̥ʲà] ‘I washed it’

No data is available for the labialized consonants. In summary, according to this criterion, palatalization and prenasalization count as units while aspiration count as clusters; we are agnostic about the status of the labialized consonants.

2.8. *Summary*

In this section, we have seen seven criteria to distinguish between clusters and units in Malinaltepec Tlapanec: tautosyllabicity (§2.1), existence as independent phonemes (§2.2), systematicity (§2.3), maximum number of consonants (§2.4), morphology (§2.5), minimality requirement (§2.6) and allomorphy motivated by a constraint against a glottal stop followed by a cluster (§2.7). Table 4 summarizes the results of each of the criteria discussed in this section; dubious cases are in parentheses. As can be observed, not all the criteria converge. First, prenasalization is a unit according to distribution and *ʔCC,

while it behaves as a cluster with respect to minimality. On the other hand, labialization is a unit according to distribution, but behaves as a cluster with respect to morphology and minimality. Lastly, palatalization is a cluster according to morphology and minimality but behaves as a unit according to distribution and *ʔCC. Thus, the traditional dichotomy analysis of units vs. clusters does not hold for Malinaltepec Tlapanec.

Table 4. Non-convergence of the criteria in Malinaltepec Tlapanec

	PRENASALIZATION	ASPIRATION	LABIALIZATION	PALATALIZATION
Tautosyllabicity	indecisive	indecisive	indecisive	indecisive
Existence as independent phonemes	indecisive	indecisive	indecisive	indecisive
Systematicity	indecisive	indecisive	indecisive	indecisive
Maximum number of consonants	unit	(cluster)	unit	unit
Morphology	(unit)	cluster	cluster	cluster
Minimality	cluster	cluster	cluster	cluster
*ʔCC	unit	cluster	?	unit

3. Teotitlán Zapotec (dixsa:) complex sounds

Zapotec is mostly spoken in the state of Oaxaca and constitutes Zapotecan language family along with Chatino languages. Zapotecan is one of the eastern Otomanguean languages along with Mixtecan and

Popolocan languages (Campbell 2017). All the Zapotec data come from Teotitlán del Valle Zapotec (*Dixsa:*), spoken in the community of Teotitlán del Valle in the Central Valley of Oaxaca. The data comes exclusively from my consultation of the speakers.[16]

Teotitlán Zapotec has *a, ɛ, i, o* and *u*, in addition to *e*, which is an allophone of *ɛ,* whose distribution is conditioned by a complex set of phonological factors (Uchihara & Gutiérrez 2020), and *ɨ* which is marginal. In addition, three phonation types, modal (*a*), creaky (*a̰*) and glottalized (*aˀ*) vowels, and five tones, low (*a*), mid (*ā*), high (*á*), rising (*ǎ*), and falling (*â*), are contrastive. Teotitlán Zapotec has the following consonantal inventory, shown in Table 5. Here again, the ambiguous cases, that is palatalized and labialized consonants, are in italics. The sounds that only occur marginally or in loans are in parentheses.

The problematic complex sounds which we are concerned here are palatalization and labialization, which have been treated variously in previous studies on other Zapotec varieties. For instance, Smith-Stark (2003: 221) treats *kw* as a singleton, since it is the fortis counterpart of *b*. The same diachronic argument could hold for *ʈj*, which is the fortis counterpart of *ɾ* (Operstein 2012). Palatalization or labialization cannot be considered as vowels. Thus, forms with palatalization or labialization in the coda position, as in [ʒetʲ] ‘onion’ or [bɛkʷ] ‘dog’, are monosyllabic (CVC), rather than disyllabic (CVCV). First, all other

[16] The data comes mostly from Ambrocio Gutiérrez, María Dolores Santiago, and Zeferino Mendoza Bautista.

Table 5. Consonant phonemes in Teotitlán Zapotec

	BILABIAL		ALVEOLAR		PALATO-ALVEOLAR		PALATAL	VELAR		LABIO-VELAR
stop	b, b^j	p, p^j, (p^w)	d, d^j, d^w	t, t^j, (t^w)				g, g^j, g^w	k, k^j, k^w	
affricate			ʣ	ʦ, $ʦ^j$	ʤ	ʧ, $ʧ^j$, $ʧ^w$				
fricative		(f)	z, z^j, z^w	s, s^j, s^w	ʒ, $ʒ^j$, $ʒ^w$	ʃ, $ʃ^j$, ($ʃ^w$)			x, x^j, x^w	
nasal	(m)	mː, $mː^j$, ($mː^w$)	n, n^j, n^w	nː, $nː^j$						
tap/flap			ɾ, $ɾ^j$, $ɾ^w$	(r, r^w)						
lateral			l, l^j, l^w	lː, $lː^j$, $lː^w$						
glides							j			w

monomorphemic roots are monosyllabic in Teotitlán Zapotec. Secondly, when speakers are asked to hum these forms, they only have one unit, rather than two. Thirdly, Teotitlán Zapotec has Tone Sandhi where a vowel with a mid tone assigns a high tone to the vowel of the next syllable (Uchihara & Gutiérrez 2019). Thus, forms such as [bēnː^j] ‘person’ would be *bēnːí, if this form was disyllabic; however, this is not the case. When palatalization or labialization occur at the onset position, as in [b^{j}a̱ː] ‘cactus’ or [l^{w}a̱ː] ‘crop’, they cannot be considered CV sequences either (that is, /bi͡a̱ː/ or /lu͡a̱ː/). First, vowel sequences (whether tautosyllabic or heterosyllabic) are generally prohibited in Teotitlán Zapotec otherwise, except for certain

morphologically complex forms. A second piece of evidence against a CV analysis of the palatalization and labialization comes from the allomorphy of the progressive prefix of verbs, *ká(j)*- (Uchihara & Pérez Báez 2016). This prefix has an allomorph *ká*- before consonant-initial stems, as in [ká-tʲu̱:g] 'is cutting', while it is *kaj*- before vowel-initial stems, as in [káj-a:w] 'is eating'. Before stems whose habitual forms (with the habitual prefix *r*-) begin with the *ɾj* sequence, the progressive allomorph is *ká*-, thus confirming that such stems are consonant-initial*:* [ɾ-jak] 'gets cured', [ká-jak] (*káj-jak) 'is getting cured'.[17]

In this section, I will look at the following criteria to see whether palatalization and labialization are units or clusters: tautosyllabicity (§3.1), existence as independent phonemes (§3.2), systematicity (§3.3), distribution (§3.4), morphology (§3.5), metathesis (§3.6) and the distribution of mid-front vowels (§3.7).

3.1. *Tautosyllabicity*

Both palatalization and labialization are tautosyllabic, since they can occur at the absolute initial and final positions: [dʲa:g] 'ear', [be:dʲ] 'chicken'; [kʷɛʔ] 'side', [bɛkʷ] 'dog'. Thus, both of these complex consonants satisfy Trubetskoy's criterion (a) and Pike's criterion (c)

[17] There is one verb stem in my database whose habitual form begins with *ɾw:* [*ɾ-wa̱:*] 'carries', which is in free variation with [*ɾ-u̱:*]. Its progressive form is [*káj-wa̱:*] ~ [*káj-u̱:*], suggesting that this stem may be vowel-initial.

for units. However, again, this fact is not incompatible with the cluster analysis, as we have seen in §2.1.

3.2. *Existence as independent phonemes*

Both *w* and *j* exist as independent phonemes in the language, as can be observed in Table 5. Thus, both palatalization and labialization satisfy Trubetzkoy's criterion (f) for clusters, but this fact is also compatible with the unit analysis.

3.3. *Systematicity*

In Teotitlán Zapotec, labialization is commoner with velar consonants, but it can occur with other places of articulation as well, especially in loans. On the other hand, palatalization is common with all places of articulations (except for labiovelars). In some cases, palatalization and labialization can be combined, as in [bilʲʷa̰:] 'a kind of snake'. The following table shows some examples of the combinations of palatalization and labialization with each place and manner of articulation. The forms in parentheses are loans.

Table 6. Co-occurrence possibilities of palatalization and labialization

PLACE	MANNER	PALATALIZATION	LABIALIZATION
bilabials	lenis obstruent	[bʲa̱:] ‘cactus’ [bi̱:bʲ] ‘jojoba’	
	fortis obstruent	[gɛpʲ] ‘navel’	([pʷé:bl] ‘village’)
	fortis resonant	[ʤūm:ʲ] ‘basket’	([mʷé:s] ‘teacher’)
alveolars	lenis obstruent	[dʲa:g] ‘ear’ [be:dʲ] ‘chicken’ [bizʲé:] ‘well’ [ɾasʲ] ‘sleeps’	[bidʷa̱:] ‘banana’ [ɾuzʷâ:] ‘I plant’
	fortis obstruent	[tʲōp] ‘two’ [ʒetʲ] ‘onion’ [bitsʲâˀ] ‘louse’	([tʷá:j] ‘towell’) ([sʷé:tr] ‘sweater’)
	lenis resonant	[ba:lʲ] ‘star’	([kanʷá:] ‘canoe’) [ɾʷăˀ] ‘my mouth’ [lʷa̱:] ‘crop’
	fortis resonant	[bēn:ʲ] ‘person’	[l:ʷâˀ] ‘Oaxaca’
palato-alveolars	lenis obstruent	[ʒʲa:n] ‘anger’ [guʒʲɛ̱:] ‘meeting’	[ʒbaʒʷa̱:n] ‘owner’
	fortis obstruent	[ɾuʧʲɛˀn] ‘he covers’ [ʃʲa:g] ‘sheriff’ [n:aʃ(ʲ)] ‘chocolate’	[ɾiʧʷâ:] ‘I tear it’ ([ʃʷé:b] ‘Thursday’)
velars	lenis obstruents	[gʲeʃ] ‘avocado’	[gʷî:] ‘guava’ [bɛ̄:gʷ] ‘comb’
	fortis obstruents	[kʲɛ:] ‘head’ [bikʲ] ‘turn’ ([mĕ:xʲkʷ] ‘Mexico’)	[kʷɛˀ] ‘side’ [bɛkʷ] ‘dog’ ([xʷá:jn] ‘John’)

The only gaps are that labialization is not attested with the alveolar affricates /ʣ, ʦ/, the lenis post-alveolar affricate /ʤ/, or the fortis alveolar nasal /n:/. On the other hand, palatalization is not attested with lenis affricates /ʣ, ʤ/. Some of such gaps may be due to the marginal status of some phonemes; for instance, /ʣ/ is in free variation with the fricative /z/ in many cases. Thus, we could say that the distribution of palatalization and labialization is systematic, in that both of them can occur with any place of articulation, thus satisfying Trubetzkoy's criterion (e), systematicity, for units. However, this fact is also not incompatible with the cluster analysis.

3.4. *Distribution*

The next criterion to distinguish clusters and units in Teotitlán Zapotec is the distribution. Here, I apply Trubetskoy's criterion (d) and Pike's criterion (a), that is when a cluster is not allowed in certain positions such as coda, complex sounds that occur in such positions should be analyzed as units.

Palatalization and labialization can be found in the coda position, as can be seen in the following examples.

(21) palatalized coda
[kʉ:dʲ] 'thigh', [ʒetʲ] 'onion'

(22) labialized coda
[bɛkʷ] 'dog', [gură:gʷ] 'lizard'

Otherwise, no consonant clusters are allowed in the coda position in native lexicon, although in loans complex codas are allowed, as in [pʷɛ́:bl] ‘village (< Sp. *pueblo*)’ or [sá:bd] ‘Saturday (< Sp. *sábado*)’. In general, unambiguous consonant clusters are not common in Teotitlán Zapotec, restricted to a nasal + a lenis consonant ([ngaˀ] ‘purple’, [ndo̰:w] ‘mole amarillo’) or a sibilant + a consonant ([ʃtʲé:ʒ] ‘garlic’, [stú:j] ‘another/ once more’) at the onset position.[18] Thus, according to this criterion, we could conclude that both palatalization and labialization are units.

3.5. *Morphology*

The next criterion to distinguish units and clusters in Teotitlán Zapotec is morphological, as we saw in §2.5: it is expected that a morpheme boundary can intervene consonant clusters, while should not be able to intervene singletons. In Teotitlán Zapotec, a morpheme boundary frequently intervenes a consonant and the following *j*. This is the case with some verbs which begin with *j*. Most tense-aspect-mode prefixes in Teotitlán Zapotec are single consonants before *j*, and thus form palatalized consonants along with the stem initial *j*. The following examples show the habitual, completive and future forms of three verbs beginning with *j*. Here, we can see that *j* belongs to the stem rather than the prefixes.

[18] There are very few coda clusters of a nasal + a lenis obstruent, some of which may be loans: *badûnd* ‘hummingbird’, *nalănd* ‘stinky’, *ʤîngw* ‘vulture’, *rúng* ‘incomplete’, *ruxung* ‘wangle’.

		habitual	completive	future
(23)	‘get down’	a. [ɾʲet]	b. [bʲet]	c. [zʲet]
(24)	‘fall down’	b. [ɾʲa:b]	b. [bʲa:b]	c. [zʲa:b]
(25)	‘enter’	c. [ɾʲuˀ]	b. [bʲuˀ]	

Polymorphemic C^j can also be found in compounds, where the first member of the compound ends with a consonant and the second root starts with *j*, such as in (26) and (27). In the following examples, the forms in (b) and (c) show the isolation forms of each member of the compounds.

(26) a. [ɾasʲą̂:] ‘jump’ b. [ɾas] ‘be picked up’ c. [ją̂:] ‘above’
(27) a. [bɛl:ʲu:] ‘worm’ b. [bɛl:] ‘fish, snake’ c. [ju:] ‘earth’

On the other hand, a consonant and *w* are generally not separated by morpheme boundaries; (28) shows some monomorphemic forms containing labiovelars, both in onset and coda positions.

(28) monomorphemic labiovelars
[kʷą:n] ‘alfalfa’
[bɛkʷ] ‘dog’
[gʷɪ̄:ʒ] ‘Macuilxochitl’
[bɛ̄:gʷ] ‘comb’
[xʷá:jn] ‘John (< Sp. *Juan*)’

In my database, only one case is found where a morpheme boundary separates labialization. These facts may suggest that labiovelars are singletons, while palatalized consonants are sequences.

(29) [jag^{w}ă:n]
/ja:g+wă:n/
wood+?[19]
'mirror'

3.6. *Metathesis*

In the previous subsections, we have seen two pieces of evidence suggesting that palatalized consonants are clusters, namely existence of /j/ as an independent phoneme (§3.2) and morphology (§3.5). Another piece of evidence for the cluster status of the palatalized consonants comes from metathesis. In Teotitlán Zapotec, the underlying sequence of *n* and the *j* is metathesized in coda position when the preceding vowel is not a front vowel. The underlying *nj* sequence is justified by the fact that this sequence occurs unchanged in onset position when it is followed by a vowel-initial morpheme, as in (31b):[20]

[19] An anonymous reviewer pointed out possibly the second element of this compound comes from Proto-Zapotecan *wana 'mirror'; Cf. Atepec Zapotec '*huana'* (Nellis & Nellis 1983: 282), Tataltepec Chatino '*cuana'* (Pride & Pride 1970: 18).

[20] When the preceding vowel is *i* or *e*, *j* is deleted in this position: [rigī:n] /ri-gī:n-j/'HAB-kill'.

(30) *nj* Metathesis
/nj/ → [jn]/ $V_{[-back]}\_]\sigma$

(31) a. [ruːjn] b. [ruːnʲan]
/r-uːnj/ /r-uːnj=an/
HAB-do HAB-do=3SG.INF
'do' 'he does'

On the other hand, labialized consonants never undergo metathesis. This again may point to the possibility that C^{j} is a sequence, rather than a unit; in typological surveys of metathesis in Ultan (1978) or Buckley (2011), no case is reported where complex singleton segments undergo 'metathesis'.

3.7. *The distribution of [e] and [ɛ]*

The last criterion in Teotitlán Zapotec is the interaction of palatalized consonants with the preceding vowel. In general, local phonological processes are applied only when the sounds in question are adjacent. In Teotitlán Zapotec, the mid front vowels [e] and [ɛ] are in complementary distribution, and thus are allophones of the phoneme /ɛ/, although their conditioning phonological factors are complex, involving the height of the adjacent consonants, syllable structure and accent (Uchihara & Gutiérrez 2020). One such factor is the height of the following consonant: if the following consonant is [+high, -labial], that is *j*, palato-alveolars and C^{j} consonants where C ≠ *b* or *p*, [e] is found, as in (32). Otherwise the allophone [ɛ] is found, as in (33).

(32) [e]

[gę̰:j] (~ [gę̰:gʲ]) ‘ice’
[mě:ʒ] ‘table (> Sp. mesa)’
[bé:ʒ] ‘peso’ (> Sp. peso),
[teʃ] ‘chest of’
[ɾuɾeʃ] ‘turn (it) around’
[ge:ʤ] ‘village’
[ɾibe:ʤ] ‘yell’
[ɾilę̰:ʤ] ‘get separated’
[ɾukʷe:ʤ] ‘make something sound’
[ɾule:ʤ] ‘scold’
[gē:ʧ] ‘thorn’
[ɾutēʧ] ‘scatter’
[be:dʲ] ‘chicken’
[mě:dʲ] ‘money’
[ɾę̰:dʲ] ‘get washed’
[ɾinę̰:dʲ] ‘get ahead’
[sé:tʲ] ‘oil (> Sp. aceite)’
[kětʲ] ‘there is not’
[ɾe:nʲ] ‘blood’
[ʃtę̰:n(ʲ)] ‘of’
[ɾugʷe:nʲ] ‘get anxious’
[xé:nːʲ] ‘Genaro’
[bēnːʲ] ‘person’
[né:lʲ] ‘Manuel’
[ɾigēlːʲ] ‘hurry up’
[ʃindékʲ] ‘thing’
[ɾibēkʲ] ‘put’
[ɾekʲ] ‘get burned’
[ɾizekʲ] ‘burn’
[zēkʲ] ‘this way, thus’
[ɾēkj] ‘there’

(33) [ɛ]

[bɛ:] ‘cochineal’
[bę̰:] ‘colored ant’
[dɛ:] ‘ash’
[kʷɛˀ] ‘side of’
[lɛˀ] ‘patio’
[ʦɛˀ] ‘voice of’
[zɛˀ] ‘corn’
[ɾibɛ:] ‘sit down’
[ɾidɛˀ] ‘be gathered’
[gɛt] ‘tortilla’
[bɛt] ‘skunk’
[lɛt] ‘place’
[zɛ:d] ‘salt’
[bɛ́:d] ‘Pedro’

[ɾɛ̰:d] ‘come’
[ɾudɛ̰:d] ‘give’
[bɛʦ] ‘brother of (a male)’
[dɛʦ] ‘back of’
[bɛ̰:z] ‘jaguar’
[bitɛ̰:z] ‘nest’
[galgɛ:z] ‘support for a party, guelaguetza’
[gɛ:z] ‘cigarette’
[nɛ:z] ‘road’
[ɾibɛ̰:z] ‘wait’
[ɾin:ɛ̄:z] ‘trap’
[ɾug^{w}ɛ:z] ‘wash someone’s body’
[gɛs] ‘pot’
[k^{w}ɛs] ‘temple (part of the forehead)’
[m^{w}ɛ́:s] ‘teacher (< Sp. maestro)’
[lɛ̌s] ‘thin’
[n:ɛs] ‘the day before yesterday’
[gɛ:l] ‘corn tree’
[bɛl:] ‘fish’
[gɛ̄l:] ‘fruit’
[g^{w}ɛ̌l:] ‘youngest child’
[ɾiɾɛ̄l:] ‘stumble into’
[ɾutɛ̄l:] ‘roll (it)’
[pɛ́:ɾ] ‘pear’ (< Sp. pera)
[ɾɛ̌:n] ‘there (medial)’
[bɛ̄:g^{w}] ‘comb’
[ʃibɛ:g^{w}] ‘bowl’
[bɛk^{w}] ‘dog’
[ɾɛ:b^{j}] ‘told’
[ɾizɛ̰:b^{j}] ‘fall down’
[gɛp^{j}] ‘navel’
[ɾɛp^{j}] ‘go up’

Here, in order to maintain the generalization that [e] is found before a [+high, -labial] consonants, palatalized consonants need to be considered as units. If palatalized consonants were clusters, we can no longer generalize the raising context as [+high, -labial]: with palato-alveolar consonants and *j*, the mid front vowel raises to [e] when followed by a [+high] consonant, while with palatalized consonants

the mid front vowel is raised to [e] when this vowel is followed by a [-labial] consonant but also followed by *j*. In other words, with palato-alveolar consonants this is a case of local vowel-consonant assimilation, while with palatalized consonants this is a case of non-local harmony.

On the other hand, the labiovelar glide *w* also raises the preceding mid front vowel, as in (34), but labiovelar [g^{w}] or [k^{w}] do not raise the preceding mid front vowel, as can be seen in (35):

(34) _w
- a. [bĕ:w] ‘coyote’
- b. [bę̄:w] ‘moon’
- c. [beˀw] ‘flea’
- d. [gę̲:w] ‘river’

(35) _g^{w}, k^{w}
- a. [bɛ̄:g^{w}] ‘comb’
- b. [ʃĭbɛ:g^{w}] ‘bowl’
- c. [bɛk^{w}] ‘dog’

This is in a sharp contrast with palatalization; unlike labialization, palatalized velars do trigger vowel raising, as can be observed above in (32), such as [ribēk^{j}] ‘put’ or [rēk^{j}] ‘there’. Thus, it could be the case that palatalized velars are units while labiovelars are clusters, and that palatalized velars trigger raising of the preceding vowel because

they are units, while labio-velars fail to trigger raising of the preceding vowel because they are clusters.

3.8. *Summary*

In this section, I have examined seven criteria to determine whether palatalized and labialized consonants in Teotitlán Zapotec are clusters or units. Table 7 summarizes the reaction of palatalization and labialization to each criterion. Here again, we observe that not all the criteria converge. Palatalization behaves as a unit with respect to distribution and raising, but as a cluster in terms of morphology and metathesis. On the other hand, labialization behaves as a unit with respect to distribution, morphology and metathesis, but as a cluster in terms of raising.

Table 7. Non-convergence of criteria in Teotitlán Zapotec

	PALATALIZATION	LABIALIZATION
Tautosyllabicity	indecisive	indecisive
Existence as independent phonemes	indecisive	indecisive
Systematicity	indecisive	indecisive
Distribution	unit	unit
Morphology	cluster	unit
Metathesis	cluster	unit
ɛ-raising	unit	cluster

4. Conclusion: an approach from canonical typology

In this paper, the status of various ambiguous complex sounds has been examined according to several criteria, and we have seen that both in Malinaltepec Tlapanec and Teotitlán Zapotec, the criteria do not always converge. Here I propose that the situations in Tlapanec and Zapotec can be captured by Canonical Typology (Corbett 2006; Hyman 2006; 2012; Brown et al. 2012; Corbett 2015: 149; Kwon & Round 2015), especially following Round (2019). Canonical Typology is suited to analyze and define phenomena that are subject to variation, extracting various dimensions along which we characterize variation and establish the logical extrema of these dimensions, if they exist. By viewing these dimensions as independent axes of variation, we construct the theoretical spaces of possibilities. Typically, for each dimension, one end is identified as 'canonical'. The purpose of this is not to be prescriptive, but to connote how the dimension relates to an existing concept that is already familiar to linguists, such as 'cluster' or 'unit'. The canonical instance satisfies all the criteria, and such instances tend to be rare or non-existent. Specific instances of the phenomenon under investigation can then be measured against any given criterion *Ci* and assessed as being either more or less canonical with respect to it, and this can be done for each criterion *C1, C2, C3*. Those which satisfy such criteria best are the canonical core.

In general, Canonical Typology has been applied to give a nuanced description of the differences between languages (for instance, Hyman 2006 and Dingemanse 2019 on application of Canonical Typology to

phonology). However, I adopt Kwon's (2017) "Localized Canonical Typology" to evaluate variations within a language-specific category (see also Round & Corbett 2020), in this case, clusters and units. In Localized Canonical Typology, a canonical core is set for units and clusters, in this case, to characterize the most straightforward units and clusters. This defines a theoretical endpoint from which various real instances of units and clusters can be measured. The relationship between units and clusters is clarified when a wide range of complex consonants are measured against the same criteria.

Here, I propose the following characterization of canonical core for *clusters*. Systematicity (Trubetzkoy's criterion (e)) is excluded from characterization here, since as was mentioned above, the systematicity can be an argument for unit or for cluster analysis.

(36) Characterization of the canonical core for canonical clusters:
   a. They may or may not occur within the same syllable (Trubetskoy's criterion (a), Pike's criterion (c)).
   b. Each component of the cluster has to be an independent phoneme in the language (Trubetskoy's criterion (f)).
   c. Their distribution is different from unambiguous singletons (Trubetskoy's criterion (d), Pike's criterion (a)).
   d. Can occur across morpheme boundaries.
   e. One member of a cluster can be separated from the other; for instance, they can metathesize.
   f. The second member of a cluster cannot interact with the preceding vowel (or the first member of a cluster with the following vowel),

skipping the intervening consonant. That is, the C_2 cannot interact with the V in VC_1C_2, and the C_1 cannot interact with the V in C_1C_2V.

g. A cluster may have an extra weight compared to a singleton.

For instance, the sequence *sk* in English is a canonical cluster; the sequence *sk* usually occurs tautosyllabically, thus the criterion (36a) does not apply here; both *s* and *k* are independent phonemes in English, thus according to (36b) this sequence can be a cluster, but not necessarily; this sequence is sometimes found at a morpheme boundary, as in *misconduct*, thus satisfying (36d); in some varieties of English, *sk* sequence at the final position can undergo metathesis, such as *ask* ~ *aks*,[21] thus satisfying (36e); finally, the sequence *sk* is not found in the coda position after a long (or tense) vowel or a diphthong, while singletons (and clusters that end in a coronal consonant, such as *seemed*) can occur after long vowels or diphthongs, as in *seem* (Hall 2001), thus satisfying (36f).

On the other hand, the following is the proposed characterization of canonical core for units, which is the opposite of the characterization of clusters:

[21] This metathesis is possibly diachronic and lexical; thus, metathesis is not possible with other forms with the *sk* sequence, such as *bask, cask* or *mask* (Erich Round, p.c.).

(37) Characterization of the canonical core for canonical units
   a. They always occur within the same syllable (Trubetskoy's criterion (a), Pike's criterion (c)).
   b. Each component of the unit may or may not be an independent phoneme in the language (Trubetskoy's criterion (f)).
   c. Their distribution is the same as unambiguous singletons (Trubetskoy's criterion (d), Pike's criterion (a)).
   d. Cannot occur across morpheme boundaries.
   e. One member of a unit cannot be separated from the other; for instance, they cannot metathesize.
   f. The second member of a unit can interact with the preceding vowel (or the first member of a cluster with the following vowel). That is, the C_2 can interact with the V in $VC_1{}^{C2}$, and the C_1 can interact with the V in ${}^{C1}C_2V$.[22]
   g. A unit may not have an extra mora.

A canonical singleton satisfies all of the (applicable) criteria in (37). For instance, the alveopalatal lenis affricate *ʤ* in Teotitlán Zapotec always occurs tautosyllabically, thus satisfying (37a); both /d/ and /ʒ/ are independent phonemes in Teotitlán Zapotec, thus its status is indecisive according to (37b); it can occur in the coda position, as other singletons can, thus satisfying (37c); a morpheme boundary never separates *ʤ*, thus satisfying (37d); the plosive and fricative portion

[22] However, some authors have suggested that complex segments only interact so that elements to the left interact with their left half and elements to the right with their right half (Weijer 1996; Lin 2011).

of this affricate cannot undergo metathesis, thus satisfying (37e); *ʤ* raises the preceding mid front vowel, thus satisfying (37f); finally, *ʤ* does not have an extra mora, since when it occurs at the coda position in a tonic syllable the preceding vowel has to be long to satisfy the requirement that the tonic syllable be bimoraic (such as [ge:ʤ] 'village'), since *ʤ* does not have a mora.

Table 8 shows the results of application of these characterizations to the Malinaltepec Tlapanec data. Here, the criterion (g) is understood to be responsible for the minimality requirement and *ʔCC. Criteria (a) and (b) are indecisive as we saw in §2 and criteria (e) and (f) are not applicable, since Tlapanec does not have processes that involve metathesis or consonant-vowel interaction. Dubious cases are in parentheses. We can observe that aspiration is a canonical cluster since it satisfies all the three criteria applicable to Tlapanec. Palatalization and prenasalization are less canonically clusters since they are units according to the criterion (c) and are ambiguous with respect to the criterion (g). Finally, labialization is the closest to a canonical unit, since it qualifies as a unit for two of the three criteria.

This can be schematized in a 3D diagram as in Figure 1 (suggested by Erich Round), which shows the relationship of the consonant types to the three significant dimensions: (c), (d), and (g). Thus, aspiration (C^h) is close to the Canonical Cluster in all three dimensions; on the other hand, labialization (C^w), prenasalization (^nC) and palatalization (C^j) are further away from the Canonical Cluster.

The same criteria can be applied to palatalization and labialization in Teotitlán Zapotec. Criteria (a) and (b) are indecisive with respect

Table 8. Canonicity of Malinaltepec Tlapanec complex consonants

	PRENASALIZATION	ASPIRATION	LABIALIZATION	PALATALIZATION
a	-	-	-	-
b	-	-	-	-
c	unit	_(cluster)	unit	unit
d	cluster	cluster	(unit)	cluster
e	-	-	-	-
f	-	-	-	-
g	cluster/unit	cluster	(cluster)	cluster/unit

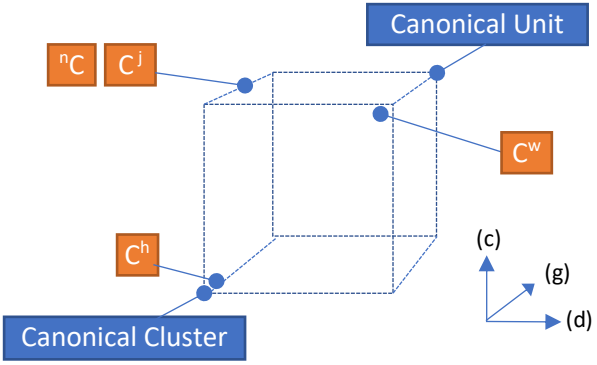


Figure 1. Canonicity of Malinaltepec Tlapanec complex consonants

to the status of palatalization and labialization as we saw above. Here, both the criteria (c) and (f) are responsible for the fact that palatalization and labialization can occur in the coda position, while canonical clusters cannot. According to these criteria, labialization is closer to a canonical unit, satisfying four criteria, while palatalization is intermediate between a canonical unit and cluster, satisfying three of the criteria for a unit and the other two criteria for a cluster.

Table 9. Canonicity of Teotitlán Zapotec complex sounds

	PALATALIZATION	LABIALIZATION
a	-	-
b	-	-
c	unit	unit
d	cluster	unit
e	cluster	unit
f	unit	cluster
g	unit	unit

I conclude this paper by mentioning several lessons we might learn from the Tlapanec and Zapotec data in this paper. First, we saw that it is rarely the case that various general and language-internal criteria for distinguishing clusters and units converge within a language, at least in Malinaltepec Tlapanec and Teotitlán Zapotec. It is possible that other languages in the world behave in the same way. Secondly, we saw complex consonants which are intermediate between

the two canons: prenasalization and palatalization in Malinaltepec Tlapanec, and palatalization in Zapotec. It is difficult to determine if they are phonologically units or clusters; in fact, one of the principle insights behind Canonical Typology is that it makes distinctions along multiple dimensions rather than making simple, binary distinctions (e.g. unit vs. cluster).[23] Thirdly, since many of the criteria can be language-specific, involving peculiar morphophonemic alternations, possibly there are only a few cross-linguistically applicable general criteria to distinguish clusters from units, as Trubetzkoy (1939) or Pike (1947) attempted. These may include syllabification (Trubetzkoy's criterion (a), Pike's criterion (c)), articulatory overlap (Trubetzkoy's criterion (b)), acoustic duration (Trubetzkoy's criterion (c)), distribution (Trubetzkoy's criterion (d), Pike's criterion (a)), the existence of an independent phoneme in the language (f) and morphology. Otherwise, linguists may need to look deep into the structure of the language to find criteria which may distinguish clusters and units. Moreover, some of the proposed criteria, such as systematicity (Trubetzkoy's criterion (e)), may in many cases be indecisive as to the unit vs. cluster status.

This paper is an addition to the recent attempts at examining the status of complex consonants from the perspective of Canonical Typology (Round & Macklin-Cordes 2015; Round 2019). Canon-

[23] Anonymous reviewers suggested the possibility that a cluster and a unit can contrast within the same system, as have been reported in other languages, such as Yaitepec Chatino (Rasch 2002: 37). This is also a possibility for Malinaltepec Tlapanec and Teotitlán Zapotec but concluding whether this is the case or not is beyond the scope of this paper.

ical Typology is usually employed to account for the crosslinguistic variation, but I have adopted Kwon's (2017) Localized Canonical Typology in this paper to account for the variation within one system, thereby demonstrating the validity of the canonical approach for language-internal variation as well.

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