

RESEARCH

Fortis/lenis, glides and vowels in Quiaviní Zapotec

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Glides in San Lucas Quiaviní Zapotec (Otomanguean) are underlyingly moraic and behave as other fortis consonants. Further, this Zapotec variety presents a clear case of [–consonantal] high vowels and [+consonantal] glides, exhibiting different patterns of behavior. This requires us to consider vowels and glides as separate entities in the underlying representation, rather than establishing a distinction between them based on differences in moraicity.

Keywords: Zapotec; phonology; fortis and lenis; vowels; glides; phonological weight

1 Introduction

Glides in general are considered to lack phonological weight (Hyman 1985; Hayes 1989), and according to some analyses, the difference between a vowel and a glide is represented with a difference in moraicity, as in (1) (Jakobson et al. 1952; Clements and Keyser 1983; Deligiorgis 1988; Hayes 1989: 256; Rosenthal 1994; see also Levi 2004; 2011 for summaries of the studies on glides in general); that is, *i* with a mora surfaces as a vowel [i] (1a), whereas *i* without a mora surfaces as a glide [y] (1b):

- (1) a. $\begin{array}{c} \mu \\ | \\ i \end{array} = [i]$ b. $i = [y]$

In this paper, we argue that, in San Lucas Quiaviní Zapotec (henceforth, QZ), a Central Zapotec variety spoken in the Valley of Tlacolula, Oaxaca Mexico, the glides /w/ and /y/ are moraic and behave exactly like other fortis (moraic) consonants, as in (2). This poses a problem for the analysis in (1) which derives both a high vowel and a glide from the same underlying entity, attributing their difference to moraicity. This requires us to consider vowels and glides as separate entities in the underlying representation, supporting analyses proposed by Hyman (1985: Ch.6), Waksler (1990), and Rosenthal (1994: §4.3), among others.

In QZ, as in many other Zapotec varieties in the region, there is a requirement that the root syllable be bimoraic (Arellanes 2009: Ch.5; Chávez Peón 2010: Ch.2). Fortis consonants are long in duration (Nellis and Hollenbach 1980; Jaeger 1983, etc.) and are argued here to have the same underlying representation as an underlying geminate (Davis 2011a; b), that is, a mora linked to a single root node. In this study we argue for the moraic representation of fortis consonants (§3.3). An underlying moraic consonant in coda position, as in (2a), is doubly-linked on the surface; the corresponding nucleus vowel is not

lengthened, since the combination of the nucleus vowel and the moraic coda consonant satisfies the Bimoraic Requirement (§3.2). The same can be observed in roots ending in a glide (2b): the glide is underlyingly moraic and the nucleus vowel is not lengthened; often, the glide portion is realized as a long vowel (justification of the status of the coda as a glide will be explained in detail in §5 below). Compare these cases with the case of a root syllable with a lenis coda, which is underlyingly weightless (2c). Consequently, the nucleus vowel is lengthened to satisfy the bimoraic requirement.

- (2) a. Fortis coda
- | | | |
|---|---|---|
| $\begin{array}{c} \mu\mu \\ \quad \\ /beL/ \\ \text{'sister (of a woman)'} \end{array}$ | → | $\begin{array}{c} \sigma \\ \diagup \quad \diagdown \\ \mu \quad \mu \\ \quad \\ b \quad e \quad L \\ [βēl:]^1 \end{array}$ |
|---|---|---|
- b. Glide coda
- | | | |
|--|---|---|
| $\begin{array}{c} \mu\mu \\ \quad \\ /bew/ \\ \text{'moon, comb'} \end{array}$ | → | $\begin{array}{c} \sigma \\ \diagup \quad \diagdown \\ \mu \quad \mu \\ \quad \\ b \quad e \quad w \\ [βēu:] \end{array}$ |
|--|---|---|
- c. Lenis coda
- | | | |
|--|---|---|
| $\begin{array}{c} \mu \\ \\ /nan/ \\ \text{'thick'} \end{array}$ | → | $\begin{array}{c} \sigma \\ \diagup \quad \diagdown \\ \mu \quad \mu \\ \quad \\ n \quad a \quad n \\ [nā:n] \end{array}$ |
|--|---|---|

In this study, we argue that glides in QZ are V₂ moraic and fortis by showing that the V₂ portions of [Vi(:)] or [Vu(:)] in examples such as (2b) exhibit all the properties of consonants and thus should be analyzed phonologically as glides. In order to provide the relevant evidence in support of this analysis, we sort out the complex sequences of vocoids in QZ, which is the second goal of this paper. Some Central Valley Zapotec varieties are reported to have large inventories of diphthongs (Munro and Lopez 1999: 3; Munro et al. 2007: 21-22; Arellanes 2009: 311; Chávez Peón 2010: 17), and the analysis of diphthongs has been problematic in Central Valley Zapotec varieties (Smith-Stark 2002: 8). For QZ, specifically, Munro and López (1999: 3) propose nine “vowel complexes” which they represent orthographically as *ai*, *au*, *ei*, *eu*, *ia*, *ie*, *iu*, *ua*, *ue*, with a tenth one, *ëi* involving a high back to central unrounded vowel which remains in use only among a decreasing number of speakers. In this paper we show that the only “true” diphthongs (a sequence of [-consonantal] + [-consonantal] segments) are /ia/, /ie/, /ua/ and marginally /ia/, and argue that in all other cases, different sources should be considered, such as the /Vy/ and /Vw/ sequences, that is, [-cons] + [+cons]. The case in QZ is peculiar among Central Valley Zapotec varieties in that it contrasts the vocoid sequences resulting from the /Vy/ and /Vw/ sequences on the one hand and true diphthongs on the other; other varieties in the region, such as Mitla Zapotec (Briggs 1961), San Pablo Güilá Zapotec (López Cruz 1997;

¹ All the data come from the authors’ own original fieldwork, unless otherwise noted. The data were collected by both of the authors in 2011, 2012, and 2015 from three speakers of QZ. One speaker, female, is born and raised and had resided permanently in the municipality of San Lucas Quiaviní, Oaxaca, Mexico. The other two speakers, a female and a male speaker, were born and raised in San Lucas Quiaviní and have resided in Los Angeles, California during adulthood and at the time of elicitation.

Arellanes 2008) or Teotitlán del Valle Zapotec only have the /Vy/ and /Vw/ sequences and thus do not exhibit this contrast. In this respect, QZ allows us to compare the representations and behaviors of these two types of sequences.

Basic background information on QZ is provided in §2, followed by an overview of the fortis-lenis distinction in Zapotec languages in §3. This provides the basis for the analysis in §4, of the two major types of sequences of vocoids that have been documented for QZ for this study. §5 demonstrates that the V_2 portions of the [Vi:] and [Vu:] sequences are in fact glides, by providing data that show that these V_2 portions manifest all the consonantal properties, despite their clear vowel-like realizations. §6 proposes that glides in QZ are moraic and behave exactly like other moraic (fortis) consonants. §7 examines prevocalic glides, where it has been reported to exhibit unexpected behaviors, and show that the analysis of glides as moraic (fortis) consonants allows us to account for such behaviors. §8 concludes with a summary.

2 Language background

QZ is a Tlacolula Valley Zapotec variety within the Central Zapotec branch of Zapotec languages (Smith-Stark 2003; Kaufman 1987–1989). QZ is spoken in the municipality of San Lucas Quiavini, Oaxaca, Mexico, and in immigrant communities in the Los Angeles, California region (Munro and Lopez 1999; Pérez Báez 2013a; b; 2014, *inter alia*).

QZ roots are mainly monosyllabic as a result of loss of pre- and post-tonic vowels. For instance, *ri-gu'unyě* 'HAB-scratch' in Juchitán Zapotec, a Central Zapotec variety which preserves both pre- and post-tonic vowels, is cognate with *r-gū'uny* in QZ. The syllable structure in the QZ native lexicon is $C(C(y))V(C(y))$ (cf. Munro and Lopez 1999: 3; Chávez Peón 2010: 12ff.). Onset consonant clusters are common but coda consonant clusters are limited to Cy clusters in the native lexicon.² Prominence is assigned to the root syllable (Munro and Lopez 1999: 3; Chávez Peón 2010: Ch.3). Vowel length is not contrastive in QZ, but vowels are lengthened before a lenis coda or in the absence of a coda consonant on the prominent syllable, to satisfy the requirement that the prominent syllable be bimoraic (cf. §3.2; Munro and Lopez 1999: 3; Chávez Peón 2010: Ch.2).

QZ has six monophthongs, *a*, *e*, *i*, *o*, *u*, and *ĩ*, the last of which occurs only in a few words and in some bound morphemes (cf. Munro and Lopez 1999: 2). As in other varieties of Zapotec, QZ has vowel types based on phonation: modal (*a*), breathy (*ᵛ*), creaky (*ᶤ*), and interrupted (*a'a*) (Munro and López 1999; Chávez Peón 2010). Our analysis coincides with Chávez Peón (2010) in showing that monosyllabic vowels have one (and only one) phonation type that is contrastive, as in other Zapotec varieties. This differs from Munro and Lopez (1999) who propose that different phonation types can occur in a sequence within a syllable.

QZ has four contrastive tones: low, high, rising and (high-low) falling. In QZ, low and high tones can occur with vowels of any type, while the falling tone is not contrastive with the high tone on a breathy vowel, and the rising tone can only occur with modal vowels.³ Both tone and phonation are realized over the rime (the nucleus vowel + the coda consonant) when the coda is a resonant or a glide.

² C^w is found in QZ but they are analyzed as singletons (cf. §3.1).

³ Our data is in line with Chávez Peón's (2010) analysis that tone is contrastive in QZ, independent of phonation type, rather than with the proposal in Munro and Lopez (1999) that tone is predictable from the combinations of phonation types. The former position is supported by the fact that minimal pairs contrasting only in tones are found in QZ. For instance, [ndā:] /nda/ 'sensitive' (*ndāa* in Munro and Lopez 1999) and [ndāā] /ndá/ 'bitter' (*ndaā*) both have modal vowels with different tones; [ndāᵛ] /ndā/ 'loose' (*ndāa*) and [ndáᶤ] /ndá/ 'hot' (*ndaāa*) both have creaky vowels with different tones. The former analysis is also supported by comparative data (Uchihara 2016).

3 Fortis/lenis contrast in QZ and their representations

Understanding the fortis/lenis contrast in QZ is crucial in following the discussions of this paper. We first introduce the descriptive facts on the fortis/lenis contrast in §3.1. QZ has a requirement that the prominent root syllable be bimoraic, which can either be satisfied by lengthening the vowel if the coda is absent or lenis, or by a short vowel and a fortis coda consonant (§3.2). In §3.3 we argue that fortis consonants are underlyingly moraic, rather than proposing that the fortis consonants acquire moraicity due to Weight-by-Position.

3.1 The fortis/lenis contrast

As in other Zapotec varieties and even other Otomanguean languages, QZ exhibits a contrast between the lenis series of consonants (the left phoneme in each cell in Table 1) and the fortis series (right phoneme in each cell).⁴ This does not apply to affricates and glides, nor to *f* or *x* (which only occur in loanwords), all of which do not come in pairs and behave as fortis consonants (Arellanes 2008: Ch.4; Chávez Peón 2010: Ch.2). Fortis obstruents are voiceless, never fricated if they are stops, and relatively long. Lenis obstruents are often voiced (but devoiced in word-final position), variably fricated, and relatively short. For sonorants, the main difference between fortis and lenis is duration. Table 1 provides the consonantal phonemes in QZ (cf. Munro and Lopez 1999; Chávez Peón 2010: 6). The phonemes in Table 1 are given in our orthographic representation. The phonemes in parentheses (*f* and *x*) only occur in loans.

3.2 Bimoraic Requirement and Vowel Lengthening

Many Zapotec varieties, including QZ, have a requirement that the root syllable be bimoraic (Arellanes 2009: Ch.5; Chávez Peón 2010: Ch.2; 2015). This requirement can be expressed as in (3). In this paper, we assume that the root constitutes the Prosodic Word (PWORD), and that the affixes and clitics (with vowels) attached to it are extrametrical and thus outside of this domain. The PWORD consists minimally of one syllable (the

	labial	dental/ alveolar	palato- alveolar	palatal	velar	labio- velar
plosive	b/p	d/t			g/k	g ^w /k ^{w5}
nasal	m/M ⁶	n/N			ŋ/ŋ̃	
tap/flap		r/R				
fricative	(f)	z/s	ʃ/ʃ̃		(x)	
lateral		l/L				
affricate		ʈ	tʃ			
glides				y		w

Table 1: QZ consonant phonemes.

⁴ On the fortis/lenis distinctions in Otomanguean languages, see also Nellis and Hollenbach (1980), Jaeger (1983) and Avelino (2004) for Northern Zapotec, Leander (1998) for Southern Zapotec, and Dicanio (2012) for Trique.

⁵ We analyze labio-velar *g^w* and *k^w* as singletons, rather than clusters (cf. López Cruz 1997: 52; Kaufman 2016 for the relevant comparative analysis), since *w* can only follow a *k* or *g*, except in loanwords (§7.1). Phonetically, QZ has palatalized consonants which we analyze as sequences of a consonant + *y* given that often a morpheme boundary comes between them (*r-ya* ‘HAB-clean’; *b-yab* ‘CMP-fall’) and because *y* can occur after any consonants, except after *g^w*, *k^w*, *y*, or *w*.

⁶ In other Central Zapotec varieties, such as in San Pablo Güilá Zapotec (Arellanes 2009: 100) or Teotitlán del Valle Zapotec (Ambrocio Gutiérrez, p.c.), only fortis *M* is attested and its lenis counterpart (*m*) is not found in the inventory. Its status in QZ is not clear either but we follow Chávez Peón (2010) in listing the lenis counterpart in the inventory.

PWORD can contain more than one syllable, when roots are compounded), which consists minimally of two moras (McCarthy and Prince 1986):

(3) Bimoraic Requirement



Vowel length is not contrastive in QZ (i.e. all the vowels are underlyingly monomoraic). However, a root vowel is lengthened when the following consonant is lenis or when there is no coda, in order to satisfy the Bimoraic Requirement:

(4) Vowel Lengthening

$$V [+ \text{prominence}] \rightarrow [+ \text{long}] / _ (C_{[-\text{moraic}]})$$

The examples in (2) above illustrate Vowel Lengthening.

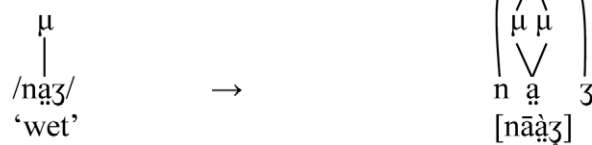
3.3 Representation of the fortis/lenis distinction

We argue that fortis consonants are *underlyingly* moraic and when in coda position, they are doubly-linked on the surface as in (5a).⁷ The nucleus vowel is not lengthened since the combination of the nucleus vowel and the coda consonant satisfies the Bimoraic Requirement. In contrast, lenis consonants are weightless (5b), and thus the nucleus vowel lengthens to satisfy the Bimoraic Requirement as in (5b).

(5) a. Fortis coda



b. Lenis coda

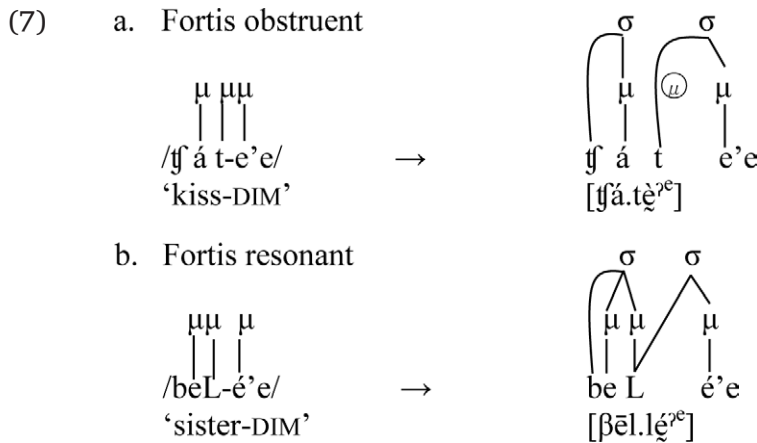


The loss of weight of fortis consonants in onset position can be accounted for by the ‘onset-creation rule’ as per Hyman (1985: 15). In general, moraic phonemes lose weight in the onset position (Hyman 1985). In (6), following Hyman’s notational conventions, the deleted weight unit is represented by the circle around the μ :



⁷ There have been various proposals as to how to represent the fortis/lenis distinctions in the feature system in these languages. Hollenbach (1984) proposes the feature [\pm tense], while others have proposed the feature [\pm fortis] (Chávez Peón 2010). Arellanes (2009) proposes that fortis is specified for the feature [-continuous], while lenis is underspecified for this feature. In our approach such a feature is unnecessary, since the underlying moraicity accounts for the distinction.

When a fortis consonant in coda position is followed by a vowel due to affixation or cliticization, the fortis consonant becomes intervocalic. An intervocalic fortis consonant manifests different behaviors depending on whether they are obstruents or not (Chávez Peón 2015: 219). Thus, an intervocalic fortis obstruent (7a) becomes the onset of a new second syllable with its nucleus being the suffixed or encliticized vowel; the fortis obstruent loses weight in this environment. In this case, we expect the vowel of the root *á* to be lengthened, due to the Bimoraic Requirement (3), since now this syllable is open. However, Vowel Lengthening (4) does not apply here due to morphological reasons (Chávez Peón 2015: 227). An intervocalic fortis nasal or liquid, on the other hand, becomes ambisyllabic, as in (7b):



Chávez Peón (2010: §3.2) rejects an analysis where the fortis consonants are underlyingly moraic, as proposed here, assuming that such an analysis is equal to an analysis where fortis consonants are geminates. He further argues that fortis consonants are not underlyingly moraic, but that they acquire moraicity through Weight-by-Position (Hayes 1989). The arguments against a geminate analysis, as per Chávez Peón (2010), are the following: (i) the fact that fortis consonants occur initially and finally in QZ, two cross-linguistically unusual positions for geminates; (ii) there are unpaired obstruents, *tʃ* and *ts*, and fricatives, *f* and *x*, which are fortis but lack in their lenis counterparts; (iii) that the contrast termed as singleton/geminate is not neutralized word-initially, and (iv) that fortis obstruents are not long intervocalically (cf. (7a) above).

Initial geminates are indeed uncommon cross-linguistically, but they are attested (Davis 1999; Kraehenmann 2011). This weakens the arguments (i) (fortis consonants appear word-initially and finally) and (iii) (no neutralization of fortis/lenis at the word-initial position) above. With regard to (ii) (no lenis counterparts for *tʃ*, *ts*, *f*, and *x*), *f* and *x* are loan phonemes (§3.1), and the lack of lenis counterparts of *tʃ* and *ts* appears to be due to the recent merger of lenis affricates and fricatives, *tʃ* with *ʒ*, and *ts* with *z*.⁸ With respect to (iv), Chávez Peón (2015: 219) reports that fortis resonant consonants are long intervocalically (while fortis obstruents are not; cf. (7)), and thus the lack of the ambisyllabicity of the fortis consonants is not a feature that is generalizable to all QZ consonants.

Moreover, a moraic coda only adds syllable weight (and prevents vowel lengthening), and does not add duration to the coda, and therefore a Weight-by-Position analysis, proposed in Chávez Peón (2010), requires an additional mechanism (such as [\pm fortis]) to provide the length to the fortis consonants in the coda and intervocalic positions. Such a

⁸ For instance, Teotitlán del Valle Zapotec, a very closely related variety to Quiavini Zapotec, preserves the contrast between an affricate *tʃ* (*lūtʃ* ‘tongue’) and a fricative *ʒ* (*luʒ* ‘kite tail’) (Ambrocio Gutiérrez, p.c.).

feature ([±fortis]) is also required to ensure that only the fortis consonants, and not the lenis consonants, acquire the mora by Weight-by-Position. Thus, a Weight-by-Position analysis requires two representations, one with the feature [±fortis] and the other with a mora. Under our moraic analysis, on the other hand, the feature [±fortis] is redundant and unnecessary since the duration of the fortis consonant comes from the multiple-linking of the coda. Having established the representation of the fortis/lenis contrast in QZ, we now move on to the analysis of vocoids.

4 Two major types of vocoid sequences

QZ has a significant number of sequences of vocoids, as is the case with other Central Valley Zapotec varieties (Munro and Lopez 1999: 3; Munro et al. 2007: 21-22; Arellanes 2009: 311; Chávez Peón 2010: 17). To be clear, by “sequences of vocoids” we refer to purely phonetic sequences of vowels (or vocoids, in phonetic terms) within a syllable, irrespective of the phonological nature of the sequence – whether the segments are phonologically [+cons] consonants or [–cons] vowels. The term “diphthong”, on the other hand, refers to the sequence of vocoids that constitutes the nucleus of a syllable in which both the V_1 and the V_2 portions are phonologically [–cons] vowels (Pike 1947: 236). Sequences of vocoids in QZ can be classified into the following two major types (cf. Munro et al. 2007: 36-37)⁹: a sequence where the V_1 portion tends to be longer than the V_2 portion as shown in (8) and, a sequence where the V_2 portion is either of equal duration as the V_1 portion or longer as shown in (9). We label the former case ‘Type A’ as in (8), and the latter ‘Type B’ as in (9). We argue below that Type A sequences are true diphthongs while Type B sequences are phonologically /Vw/ and /Vy/. Examples are given in IPA transcriptions first, followed by our proposed phonological representations, justification of which follows in all cases.

(8) Type A: [–cons] + [–cons]

a. [lí:ā]¹⁰
/lía/
‘girl’

b. [βðū:àʔ]
/bduǎ/
‘banana’

(9) Type B: [–cons] + [+cons]

a. [kāi:]¹¹
/kay/
‘early in the morning’

b. [βēū:]
/bew/
‘coyote’

⁹ In Munro and Lopez (1999), the Type A sequence is typically represented by doubling the V_1 portion (*bdūiia*’ [βðū:àʔ] ‘banana’; *iiahahz* [i:àz] ‘year’; data from Munro and Lopez 1999 in italic), while the Type B sequence is typically represented by single vowels both for the V_1 and the V_2 portions (e.g. *lāi*’ [lāi:ʔ] ‘center’; *gēu*’ [γēū:ʔ] ‘river’). However, their representations are not always consistent and do not always match our data and observations. For instance, Munro and Lopez (1999) transcribe [βēū:] ‘coyote’ as having a longer V_1 portion, *be’ēu* and [lí:ā] ‘girl’ as having the same duration for the V_1 and V_2 portions, *lia*. As such, the data presented in this paper are based on data we have collected and transcribed. See also the Appendix at the end of this paper for the correspondences between our analysis and that in Munro and Lopez (1999).

¹⁰ In one of the recordings, the V_1 portion is 280ms and the V_2 portion is 174ms.

¹¹ In one of the recordings, the V_1 portion is 135ms while the V_2 portion is 351ms.

4.1 Type A sequences: [-cons] + [-cons]

In a Type A sequence, the V_1 portion tends to be longer than the V_2 portion, and the possible vowel combinations are limited to [i:a] (10), [i:e] (11), [u:a] (12) and marginally [i:a] (13):

- (10) a. [lí:ā̃]
/lía/
'girl'
- b. [ī:àz̃]
/iãz/
'year'
- (11) a. [rʒī:ēz̃]
/r-ʒiez/
'HAB-laugh'
- b. [rɣī:ēβ̃]
/r-gieb/
'HAB-sew'
- (12) a. [βðū:àʔ̃]
/bduã/
'banana'
- b. [rɣū:āð̃]
/r-guad/
'HAB-sting'
- (13) a. [pʰtsī:à̃]
/btsiã/
'organ pipe cactus fruit'
- b. [tsī:àʔ̃]
/tsiã/
'ten'

As Table 2 shows, these sequences can occur with any of the four tones (low, high/falling¹², rising) and exhibit any of the four phonation types (modal, breathy, creaky, interrupted); non-modal vowels with a rising tone are not attested.

4.2 Type B sequences: [-cons] + [+cons]

In Type B sequences, the V_2 portion is at least as long as the V_1 portion and more typically, it is longer than the V_1 portion. The V_2 can only be either [i] or [u], but the vocoids can be of any phonation type and bear any tone phonetically provided both have the same tone and phonation type phonologically Table 3.

¹² In QZ, high and (high to low) falling tones are contrastive (Chávez Peón 2010), but rarely appear in the same phonological environment. For this reason, Table 2 refers to high and falling tones within one single column.

	Low	High/Falling	Rising
Modal	[ryū:ãǝ] /r-guad/ 'HAB-sting'	[pkí:ã] /bkía/ 'nit (louse egg)'	[ðū:ãǝ] /dúad/ 'chest'
Breathy	[yī:ã̃] /giã/ 'rock'	[βīðjúã̃n:] /bidyúã̃N/ 'hummingbird'	
Creaky	[yī:ã̃ʔ] /giã/ 'flower'	[ðí:ã̃β] /díãb/ 'scar'	
Interrupted	[yī:ʔã] ¹³ /gi'a/ 'market'	[ndú:ʔã] /ndú'ã/ 'Oaxaca'	

Table 2: Type A sequences with combinations of tone and phonation.

Having presented the phonetic properties of Type A and B sequences, we move to §5 where we show that at the phonological level, the V_2 portion of Type A sequences exhibits clear vowel properties while the V_2 portion of Type B sequences exhibits consonantal properties.

5 The consonantal properties of V_2 [i] and [u] in Type B sequences

In this section, we present evidence both in terms of distribution (§5.1) and patterns of behavior (§5.2) to show that, in Type B sequences, the V_2 portions, either [i:] or [u:], are phonologically [+cons] glides (contra previous studies which analyze them as part of diphthongs: Briggs 1961; Munro and Lopez 1999; Arellanes 2008; Chávez Peón 2010). The term 'glide' in this paper is defined phonologically in terms of distinctive features: a vowel is [-cons], and a glide is [+cons] (Hyman 1985: Ch.6; Waksler 1990; Rosenthal 1994: §4.3). Further, we show that both portions in Type A sequences manifest [-cons] vowel properties and thus the sequences should be analyzed as true diphthongs. We then consider in §5.3, alternative analyses and provide evidence that invalidate such analyses. §5.4 provides a summary for the section.

	Low		High/Falling		Rising	
Modal	[βēū:] /bew/ 'moon'	[nkāi:] /n-kay/ 'STAT-dark'	[tíū:] /tíw/ 'uncle' ¹⁴	[kãβãi:] /kabáy/ 'horse' ¹⁵	[βrãū:] /brãw/ 'lizzard'	[βãi:] /bãy/ 'rebozo'
Breathy	[rβãū:] /r-bãw/ 'HAB-glean'	[lãi:] /lãj/ 'teeth'				
Creaky	[yēū:ʔ] ¹⁶ /gēw/ 'river'	[nãi:ʔ] /nãj/ 'yesterday'	[djãū:ʔ] /dyãw/ 'Santiago'	[môū:ʔ] /môj/ 'Moise'		
Interrupted	[βī:ʔã] /bi'iw/ 'flea'					

Table 3: Type B sequences with combinations of tone and phonation.

¹³ The V_1 portion is semi-long or short with an interrupted vowel.

¹⁴ < Spanish *tío*.

¹⁵ < Spanish *caballo*.

¹⁶ The V_2 portion is semi-long when it is creaky or interrupted.

5.1 Distributional evidence in support of a /Vy/, /Vw/ analysis in Type B sequences

Three independent distributional facts converge to show that the V_2 portion of Type B sequences have [+cons] properties, while that of Type A sequences show [–cons] vocalic properties.

5.1.1 Distribution of the rising tone

In QZ, syllables with a rising tone only occur in closed syllables (14); (15) provides sample data.

(14) *CV]σ

(15) a. [mā́áj̃]
/mǎny/
'animal'

b. [ʒū́úβ̃]
/ʒǔb/
'dried corn kernel'

c. [rçḗéΛ̃]
/r-ʃěly/
'HAB-open'

This constraint is typologically unexpected, given the tendency for contour tones to require longer vowel duration and thus open syllables would be expected as an environment conducive to the occurrence of contour tones (Zhang 2004). In QZ, however, this constraint can be traced back to the historical source of the rising tone.¹⁷ Crucially, QZ syllables with the sequences [Vi:] or [Vu:] without a coda consonant can bear a rising tone as shown in (16). We account for this distribution by analyzing Type B sequences as being [–cons] vowel + [+cons] glide sequences where the glides *y* and *w* behave as consonants in coda position.

(16) a. [mḗú:]
/měw/
'dirty'

b. [βā́i:]
/bǎy/
'rebozo'

c. [βrā́ú:]
/brǎw/
'lizard'

In contrast, in Type A sequences, a rising tone can occur only if the syllable has a consonant in coda position. Examples are provided in (17). This suggests that the V_2 portion in Type A sequences is a phonological [–cons] vowel, in contrast to the Type B sequence.

(17) a. [ʒi:é́β̃]
/ʒǐeb/
'goat'

¹⁷ Comparative analysis with data from San Baltazar Chichicapan Zapotec, which preserves the original CVCV root template, suggests that the rising tone in QZ resulted from the loss of the second vowel from the original CVCV template, where the first syllable has a rising tone and the second syllable has a low level tone. For instance, the cognate of (22b) in Chichicapan Zapotec is *zhōba* (Smith-Stark 2002: 28). Original monosyllabic roots with the rising tone and the original CVCV roots all resulted in a low tone in QZ (Uchihara 2016).

- b. [ðū:áð̃]
/d̥uad/
'chest'

5.1.2 No coda after Type B sequences

Type B sequences cannot be followed by a coda consonant in QZ native words (ex. *ait#)¹⁸. This gap in distribution is easily accounted for if we analyze Type B sequences to be phonemically /Vy/ and /Vw/, and posit that QZ does not allow coda sequences the *VyC]_σ or *VwC]_σ, as stated in (18).

- (18) *VGC]_σ (G = glides w, y)

This constraint also conforms to the general phonotactic constraint proposed in Munro and Lopez (1999) and Chávez Peón (2010: 14-15; see §2) for QZ, that the only licit coda consonant clusters in native words are consonant + glide clusters.

There is no clear motivation for a restriction against Type B sequences that are followed by a coda consonant, if we analyze Type B sequence as a sequence of two phonological [-cons] vowels. A complex nuclei is not considered here as a motivation for the restriction, since Type A sequences can freely be followed by a coda consonant as shown in (19).

- (19) a. [li:àz̃]
/liaz̃/
'house'
- b. [yī:èβ̃]
/giɛβ̃/
'metal'
- c. [lū:àn]
/luañ/
'sleeping platform'

To summarize, the evidence presented in this section suggests that the V₂ portions in Type A sequences are phonological [-cons] vowels, while the Type B sequences end in a [+cons] segment (that is, a glide).

5.1.3 Fewer co-occurrence restrictions

There are fewer restrictions on the vowels that can occur in the V₁ position in Type B sequences as compared to Type A sequences. In Type B sequences, *a*, *e*, *o* and *u* can occur before a V₂ [i:], and *a*, *e* or *i* can occur before a V₂ [u:] (cf. López Cruz 1997: 54; Arellanes 2009: 311 on closely related San Pablo Güilá Zapotec)¹⁹. For Type A sequences, in contrast, the only attested combinations are *ia*, *ie*, *ua* and marginally *ia*, as shown in §4. Table 4 shows the possible vocoid combinations in Type B sequences. It is typologically common for diphthongs to be limited in their combinatorial possibilities (Maddieson 1984: 134), which further supports the analysis of Type A sequences as true diphthongs.

¹⁸ Exceptions to this constraint are limited to a few recent loanwords from Spanish, such as [fáust] 'Faust'.

¹⁹ In other words, a high front vowel cannot precede a palatal glide and a high back rounded vowel cannot precede a labiovelar glide (*iy, *uw). This is possibly due to the Obligatory Contour Principle relevant across Otomanguean languages (Longacre 1957; DiCano 2008). *i* is not found in the V₁ position either, but this is possibly due to the marginal status of the phoneme *i*.

	V ₁	V ₂	i	u
a			[nkāi:] /n-kay/ 'STAT-be.dark'	[rāū:] /r-ahw/ 'HAB-eat'
e			[yēi:] /gēy/ 'ice'	[βēū:] /bew/ 'coyote'
i				[ngī ^e ū:] /ngiw/ 'man'
o			[jóī:] /yóy/ 'yoyo'	
u				
ɨ				

Table 4: Combinations of vocoids in the Type B sequence.

The reduced restrictions in the combinatorial possibilities of attested Type B sequences are easily explained if [i:] and [u:] are analyzed as consonants /y/, /w/, since other coda consonants do not have any co-occurrence restrictions on the preceding vowel.

5.2 Evidence from allomorphy

In this section, we will look at two pieces of evidence from allomorphy which reveal consonantal properties of the V₂ portions of Type B sequences.

5.2.1 Diminutive suffix allomorphy

QZ has a productive diminutive suffix, which can be attached to almost any noun. The diminutive suffix has different allomorphs depending on whether the noun root ends in a vowel or a consonant (Munro et al. 2008: III-171ff.). In vowel-final noun roots, the diminutive suffix is *-ny*, which also replaces the phonation of the root vowel with an interrupted vowel. This is shown in (20) to (22). The (a) forms show the bare roots, while the (b) forms show the forms with the diminutive suffix.

	Root	Diminutive
(20)	a. [(y)īā:] ²⁰ /gya/ 'sweatbath'	b. [(y)jæʔæ̃jɲ] ²¹ /gya'any/ 'sweatbath.DIM'
(21)	a. [βī̃] /bi/ 'air'	b. [βī̃ʔjɲ] /bi'iny/ 'air.DIM'
(22)	a. [yū̃] /gu/ 'sweet potato'	b. [yū̃ʔjɲ] /gu'uny/ 'sweet.potato.DIM'

For consonant-final noun roots, the diminutive suffix is either *-e'e* after a non-palatalized consonant as shown in (23) and (24), or *-i'i* after a palatalized consonant as shown in (25) and (26).

	Root	Diminutive
(23)	a. [βēʔk ^w] /bək ^w / 'dog'	b. [βēʔk ^w ēʔ ^e] /bək ^w -e'e/ 'dog-DIM'

²⁰ Onset *g* is optionally omitted, and *y* is realized as a vowel [i], as we will see in §7.

²¹ Vowels before a palatalized consonant are raised.

- (24) a. [nāán] /nǎn/ 'mother'
 b. [nāánèʔ^e] /nǎn-e'e/ 'mother-DIM'
- (25) a. [lū:ʒ] /luʒ/ 'tongue'
 b. [lū:ʒíʔⁱ] /luʒ-i'i/ 'tongue-DIM'
- (26) a. [zē:ɲ] /zɛny/ 'work'
 b. [zē:ɲìʔⁱ] /zɛn-i'i/ 'work-DIM'

Crucially, nouns ending in Type B sequences take the diminutive allomorph corresponding to consonant final nouns: *-e'e* after [Vu:] and *-i'i* after [Vi:] (cf. Munro et al. 2008: III-173). This is shown in (27) to (30). Note that monophthongal *i* and *u* take the diminutive allomorph for vowel-final roots, as shown above in (21) and (22) above.

- | | Root | Diminutive |
|------|---------------------------------------|--|
| (27) | a. [βrāú:] /brǎw/ 'lizard' | b. [βrāúwèʔ ^e] /brǎw-e'e/ 'lizard-DIM' |
| (28) | a. [γēùʔ ^r] /gɛw/ 'river' | b. [γēùwèʔ ^e] /gɛw-e'e/ 'river-DIM' |
| (29) | a. [βāí:] /bǎy/ 'rebozo' | b. [βāíjìʔ ⁱ] /bǎy-i'i/ 'rebozo-DIM' |
| (30) | a. [γēìʔ ^r] /gɛy/ 'ice' | b. [γēìjìʔ ⁱ] /gɛy-i'i/ 'ice-DIM' |

Contrast this with noun roots ending in Type A sequences, which take the diminutive allomorph for vowel-final roots, *-Vʔny* (cf. Munro et al. 2008: III-173):

- | | Root | Diminutive |
|------|-----------------------------|-------------------------------------|
| (31) | a. [βðū:àʔ] /bduǎ/ 'banana' | b. [βðūʔàjɲ] /bdu'any/ 'banana.DIM' |
| (32) | a. [psī:à] /bsiǎ/ 'eagle' | b. [psīʔàjɲ] /bsi'any/ 'eagle.DIM' |

5.2.2 Forms with suffixes or enclitics

When a suffix or an enclitic beginning with a vowel is attached to roots ending in Type B sequences, a *y* [j] or *w* [w] are realized between the root and the suffix or the enclitic.

- | | Stem | 1SG | 2SG |
|------|-------------------------|--|--|
| (33) | a. [tíú:] /tíw/ 'uncle' | b. [ʃtíúwáʔ] /ʃ-tíw = á'/ 'POSS-uncle = 1SG' | c. [ʃtíúwùʔ] /ʃ-tíw = u'/ 'POSS-uncle = 2SG' |

- (34) a. [yēiːʔ] /gey/ 'ice'
 b. [ʃkējájáʔ] /ʃ-key = áʔ/ 'POSS-ice = 1SG'
 c. [ʃkējjúʔ] /ʃ-key = uʔ/ 'POSS-ice = 2SG'

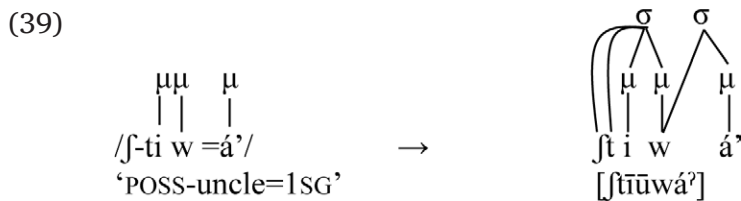
This is in contrast to Type A sequences, where the V_2 portion is deleted before a vowel-initial suffix or enclitic, and where the root vowel and the vowel of the suffix/ enclitic fuse to form a rime. (35) and (36) illustrate such cases:

- | | | | |
|------|----------------------------------|--|---|
| | Root | 1SG | 2SG |
| (35) | a. [yī:àʔ]
/gia/ 'flower' | b. [kí:àʔ]
/ʃ-gia = áʔ/ 'POSS-flower = 1SG' | c. [kíùʔ]
/ʃ-gia = uʔ/ 'POSS-flower = 2SG' |
| (36) | a. [rū:àʔ]
/r-uá/ 'HAB-carry' | b. [rú:àʔ]
/r-uá = áʔ/ 'HAB-carry = 1SG' | c. [rūùʔ]
/r-uá = uʔ/ 'HAB-carry = 2SG' |

It is not the case that homorganic glides (*y* and *w*) are inserted when the root ends in a high vowel. When a root ending in a monophthong *i* or *u* is combined with a vowel initial suffix or enclitic, a glide is not inserted, but the root vowel and the vowel of the suffix or the enclitic merge to form a rime, just as it occurs with words that have Type A sequences. This is illustrated in (37) and (38):

- | | | | |
|------|---------------------------------|---|---|
| | Stem | 1SG | 2SG |
| (37) | a. [rniːʔ]
/r-ni/ 'HAB-say' | b. [rni:àʔ]
/r-ni = áʔ/ 'HAB-say = 1SG' | c. [rniùʔ]
/r-ni = uʔ/ 'HAB-say = 2SG' |
| (38) | a. [yūh]
/gu/ 'sweet.potato' | b. [kú:àʔ]
/ʃ-gu = áʔ/ 'POSS-sweet.potato = 1SG' | c. [kūù]
/ʃ-gu = uʔ/ 'POSS-sweet.potato = 2SG' |

In §3.3, we saw that an intervocalic obstruent does not become ambisyllabic, while intervocalic nasals and liquids do. (33) and (34) above show that an intervocalic glide also become ambisyllabic with the following syllable (in (39), the representation of the loss of the weight of *ʃ* and *t* at the onset position is omitted):



In this sense, the glides behave in the same way as liquids and nasals but not as obstruents. This is expected, since glides constitute a natural class (resonants, [-syllabic, +sonorant]) with liquids and nasals. The generalization will be that resonants ([-syllabic, [+sonorant]) become ambisyllabic while obstruents ([-sonorant]) do not. That is, only the resonants, including the glides, can be multiply linked to different syllabic nodes, while obstruents cannot (and, as we saw above in (35) - (38), neither can vowels).

5.3 Alternative analyses

As we have seen, distribution and allomorphy provide solid evidence in support of the analysis that [Vi:] and [Vu:] in QZ are phonologically [-cons] vowel + [+cons] glide sequences. In this section, we consider alternative analyses. Specifically, we consider an

analysis of [–cons] vowel sequences or of heterosyllabic sequences, and provide evidence to show that these alternative analyses would not account for distributional facts and patterns of behavior.

The first alternative would be to analyze both Type A and Type B sequences as true diphthongs (sequences of [–cons] vowels), and stipulate that a high vowel (*i*, *u*) is always lengthened. However, such an analysis would fail to account for the consonant-like properties of the V_2 portion that we have argued for in this section, as well as the parallelism with fortis consonants. Further, such an analysis fails to make any prediction when both the V_1 and the V_2 portions are high vowels, as in the sequence *iu*, while the analysis proposed in this study correctly predicts that the V_2 portion is lengthened in such cases ([tí^hū:] /tíw/ ‘uncle’).

Briggs’ (1961: 2) analysis is close to this first alternative. She identifies sequences in Mitla Zapotec that are analogous to Type B sequences in QZ, that is, sequences where the V_2 is either *i* or *u*. Briggs argues that these sequences should be analyzed as true diphthongs (i.e. both V_1 and the V_2 portions as [–cons] vowels), based on the fact that the V_2 portions of these sequences can bear tones. A more appropriate characterization in QZ, given the evidence provided so far in this study, would be that both the tone and phonation type of the nucleus are realized over the Type B vocoid sequence, which is phonologically a rime (nucleus + coda). Thus, the rising tone of the nucleus vowel, for instance, is realized as a sequence of a mid portion on V_1 and a high portion on V_2 (40a); the breathiness (b) or the creakiness (c) of the nucleus vowel is also realized over the rime, and often only on the V_2 portion, which is phonologically the coda:

(40)	Rising	Breathy	Creaky
a.	[mēú:]	b. [βēù:]	c. [yēĩ ^h ’]
	/mēw/	/bēw/	/gey/
	‘dirty’	‘turtle’	‘ice’

However, an argument based on the fact that the V_2 portion can bear the tones is invalid since the same patterns occur in syllables with a (fortis) resonant coda (i.e. *R*, *L*, *N*, *ŋ*, *M*; Arellanes 2008: 180-181; Chávez Peón 2010: Ch.5), which are undoubtedly consonants. The examples in (41) show that tone (41a), breathiness (b) or creakiness (c) of the nucleus vowel is realized over the rime. Whether glides or resonants, the coda consonant cannot bear its own (phonological) tone; it can simply carry over (a portion of) the tone or phonation types of the nucleus vowel.

(41)	Rising	Breathy	Creaky
a.	[lāŋ:]	b. [βēŋ:]	c. [βēŋ:]
	/lāŋ/	/bēŋL/	/bēŋL/
	‘3SG.PROX’	‘fish’	‘snake’

The second possible alternative is to analyze the [Vi:] and [Vu:] sequences as being disyllabic, i.e. [V.yi] or [V.wu], or [V.i] or [V.u], as in the case of Spanish hiatus (Harris and Kaisse 1999, *inter alia*). For instance, [βrāú:] ‘lizard’ (/brāw/) could be analyzed either as /bra.wú/ or as /bra.ú/ under such an analysis. The evidence, however, does not support such an analysis. First, as mentioned in §1, all monomorphemic roots in QZ are of the shape ((C)C(y))V(C(y)) (Chávez Péon 2010: 49). Thus, it is reasonable to assume that all monomorphemic roots in QZ are monosyllabic. If we were to analyze Type B sequences as being disyllabic, then roots with Type B sequences would be the only disyllabic roots in the language.

Furthermore, if the vowels were to belong to different syllables, V_1 and V_2 should be able to carry different (phonological) tones (for instance, a rising tone followed by a low tone, /*^hV.yi/ etc.) or have different (phonological) phonation types (for instance, a creaky

vowel followed by a breathy vowel, /*V.yj/, etc.), but this is not the case as shown in Table 3. Phonologically, the Type B sequence vocoids, together as a unit can only carry one of the four tones and single one of the four phonation types which can be carried by a monophthong, as was shown in §4.2.

A third alternative is to analyze Type B sequences as being composed of two vowels followed by a homorganic glide, /Viy/ or /Vuw/. Under such an analysis, [βrāú:] ‘lizard’ (/brāw/) would be analyzed as /braúw/. Such an analysis would predict the existence of sequences where the second vowel is other than /i/ or /u/, such as /Vay/, /Vuy/.²² However, such sequences are not found in QZ.

5.4 Summary

Table 5 summarizes the discussion in this section. We have shown that the V₂ portion of the Type B sequences have consonantal properties and the sequences should be analyzed as /Vy/ and /Vw/, while the V₂ in Type A sequences have vocalic properties and should be analyzed as true diphthongs, /ia/, /ie/, /ua/, and marginally /ia/.²³

6 Glides as fortis consonants

In the preceding section, we have shown that the V₂ portion of Type B sequences exhibits [+cons] properties, and thus should be analyzed as /Vy/ and /Vw/ sequences. This in turn means that glides in QZ are realized as full and steady (and often long) vowels. It follows to ask why it might be that glides are realized as full and steady vowels in QZ. We suggest that V₂ is lengthened because glides behave as fortis consonants in QZ (§6.1). Analyzing glides as fortis entails that glides in QZ are moraic in underlying representation. This poses a problem for a proposal that glides and vowels differ only in their moraicity. In §6.2 we argue that the difference between vowels and glides in QZ should be represented with the feature [consonantal].

6.1 Glides are fortis

Glides behave like any fortis consonant in QZ when in coda position. First, both fortis consonants and glides are underlyingly moraic; the preceding nucleus vowel is not lengthened as the Bimoraic Requirement ((3) above) is satisfied when these consonants and glides are in coda position as in (42a, b). In contrast, lenis consonants in coda position are not moraic and thus the nucleus has to be lengthened as shown in (42c) in order to satisfy the Bimoraic Requirement, as in the case in open syllables as shown in (42d):

Type	Phonetic realizations	Phonological properties	Phonemic representation	Examples
A	V ₁ long: [i:a], [i:e], [u:a], ([i:a])	V ₁ , V ₂ are [-cons]	Diphthongs: /ia/, /ie/, /ua/, (/ia/)	[li:àz̥] /liáz/ ‘house’; [yí:èβ̥] /giɛb/ ‘metal’ [βðú:à̃] /bduǵ/ ‘banana’
B	V ₂ long: [Vi:], [Vu:]; V ₂ is [i] or [u]	V ₂ is [+cons]	/Vy/, /Vw/	[βrāú:] /brāw/ ‘lizard’; [kāi:] /kay/ ‘early morning’

Table 5: Types of Sequences of Vocoids.

²² This is because a heterorganic sequence of a vowel + a glide (such as ay) is expected to be less marked than a homorganic sequence of a vowel + a glide (such as iy), since the latter would violate the OCP-place (Obligatory Contour Principle on place of articulation; Frisch et al. 2004) which avoids similarity in the place of articulation. In general, a homorganic sequence of a vowel + a glide or a glide + a vowel is dispreferred in QZ (e.g. k^w → k / _u in ny-ák = u’ SUBJ-put.on.shirt = 2SG ‘you would put on a shirt’; cf. ny-ak^w = á’ SUBJ-put.on.shirt = 1SG), as in other Otomanguean languages (Longacre 1957; DiCanio 2008).

²³ The V₁ portion of the Type A sequences show vowel-like properties with respect to the distribution, which will be discussed in §7.1.

- (42) a. Fortis coda
- $\begin{array}{c} \mu\mu \\ | \quad | \\ /beL/ \\ \text{'sister'} \end{array} \quad \rightarrow \quad \begin{array}{c} \sigma \\ \diagup \quad \diagdown \\ \mu \quad \mu \\ | \quad | \\ b \quad e \quad L \\ [βēl:] \end{array}$
- b. Glide coda
- $\begin{array}{c} \mu\mu \\ | \quad | \\ /bew/ \\ \text{'moon, comb'} \end{array} \quad \rightarrow \quad \begin{array}{c} \sigma \\ \diagup \quad \diagdown \\ \mu \quad \mu \\ | \quad | \\ b \quad e \quad w \\ [βēū:] \end{array}$
- c. Lenis coda
- $\begin{array}{c} \mu \\ | \\ /nan/ \\ \text{'thick'} \end{array} \quad \rightarrow \quad \begin{array}{c} \sigma \\ \diagup \quad \diagdown \\ \mu \quad \mu \\ | \quad | \\ n \quad a \quad n \\ [nā:n] \end{array}$
- d. No coda
- $\begin{array}{c} \mu \\ | \\ /nda/ \\ \text{'sensitive'} \end{array} \quad \rightarrow \quad \begin{array}{c} \sigma \\ \diagup \quad \diagdown \\ \mu \quad \mu \\ | \quad | \\ n \quad d \quad a \\ [ndā:] \end{array}$

Furthermore, glides in coda position are long just like other fortis consonants due to its multiple-linking of the coda. Analyzing glides in QZ as fortis, and thus underlyingly moraic, allows us to make explicit the parallelism between glides and other fortis consonants.

In contrast, the Type A sequences, as units, share a mora. We assume here that the Type A sequence as a unit counts as one mora and the two vowels are linked to one mora; this is because if the Type A sequence counted as two moras, we would not expect Vowel Lengthening (4), which in fact is applied. When this sequence is in an open syllable or is followed by a lenis consonant, as in (43a), the V_1 portion acquires a mora due to Bimoraic Requirement (3) and this V_1 portion is lengthened. When a Type A sequence is followed by a fortis consonant, as in (43b), the lengthening is not applied and both the V_1 and the V_2 portions remain as short vowels:

- (43) a. Lenis coda
- $\begin{array}{c} \mu \\ /li\grave{a}z/ \\ \text{'house'} \end{array} \quad \rightarrow \quad \begin{array}{c} \sigma \\ \diagup \quad \diagdown \\ \mu \quad \mu \\ | \quad | \\ l \quad i \quad \grave{a} \quad z \\ [lī:\grave{a}z] \end{array}$
- b. Fortis coda
- $\begin{array}{c} \mu \quad \mu \\ /zu\grave{a}t/ \\ \text{'bone'} \end{array} \quad \rightarrow \quad \begin{array}{c} \sigma \\ \diagup \quad \diagdown \\ \mu \quad \mu \\ | \quad | \\ z \quad u \quad \grave{a} \quad t \\ [zū\grave{a}t] \end{array}$

A possible objection to the fortis analysis of the glides in QZ is that these fortis glides do not have lenis counterparts. However, not all consonantal phonemes participate in lenis/fortis pairs: in QZ, *f* and *x*, which only occur in Spanish loans, and affricates, do not have

lenis counterparts (Chávez Peón 2010: 36, 40). Crucially, if a consonant lacks a counterpart, it will be a fortis consonant. It is therefore not problematic that in the analysis proposed in this study, glides would lack lenis counterparts (cf. Arellanes 2009: 176-177).

6.2 Representations of high vocoids

As we have seen in §5, both a high vowel (*i*, *u*) and a glide (*y*, *w*) are moraic in QZ. Thus, we need distinct representations for the two, but one cannot represent the contrast between the two in terms of underlying moraicity (cf. Hayes 1989 proposes that vowels be moraic and glides not be moraic). Rather, we argue that in QZ, the contrast between a high vowel and a glide resides in the feature [\pm consonantal] (Hyman 1985: Ch.6; Wakslar 1990; Rosenthal 1994: 266), as in (44). As we have seen above, the crucial difference between a glide and a vowel in QZ is that the former manifests consonantal properties, while the latter does not.

- (44) a. Glide
 μ
 |
 [-consonantal]
 /y/
- b. High vowel
 μ
 |
 [+consonantal]
 /i/

7 Prevocalic glides

In the preceding sections, we have seen the behavior of the postvocalic glides. Analyzing glides as moraic (fortis) consonants further accounts for the unexpected behavior of prevocalic glides in QZ: prevocalic glides are realized as full steady vowels, further supporting our analysis that glides in QZ are fortis. In QZ, as in other Zapotec varieties in the region (cf. Arellanes 2009: §3.1, §3.3.2, §5.2.1 on San Pablo Güilá Zapotec), a sequence of the type /(C)yV/, /(C)wV/ is realized as [(C)iV:], [(C)uV:] sequences. We refer to the sequence of the vocoids [iV:] [uV:] as Type C sequences. In Type C sequences, the V_1 portion is clearly realized as a vowel, rather than as the secondary articulation of consonants.²⁴ The forms in (45) have such sequences.²⁵

- (45) a. [βli̯àːʔ]
 /bly̯a/
 ‘ditch’
- b. [(y)ĩàːn̄]
 /gy̯aːn̄/²⁶
 ‘corn cob’
- c. [kũàːn̄]
 /k̄w̄aːn̄/
 ‘alfalfa’

²⁴ In (45b), the V_1 portion is 167 ms, while the V_2 portion is 386 ms in one of the recordings. In (45c), the V_1 portion is 139 ms, while the V_2 portion is 393 ms.

²⁵ In Munro and Lopez (1999), the Type C sequences are represented variously. In some cases, they are represented as a sequence of a glide + a vowel (e.g. [βi̯aː:] /bya/ ‘prickly pear cactus pad’ as *byàa*). In other cases, they are represented as a sequence of vowels, either where the V_1 and the V_2 have the same length (e.g. [rsi̯ààβ̄] /r-sy̯ab/ ‘HAB-lower’ as *rsiàhb*), or where the V_1 is shorter than the V_2 (e.g. [βli̯àːʔ] /bly̯a/ ‘ditch’ as *bliàa*’s). See also the Appendix for a table of correspondences between the analysis presented in this study and that proposed in Munro and Lopez (1999).

²⁶ Words beginning with /gy/ or /g^w/ can optionally drop the initial *g*. This velar stop is obligatory when the possessive prefix *x-* is attached; in which case its fortis counterpart is realized, as in the case with other lenis consonants in the word-initial position: *x-kyan* = *á* POSS-corn cob = 1SG ‘my corn cob’. This fact suggests /gy/ and /y/ on the one hand and /g^w/ and /w/ on the other may not be contrastive in the word-initial position.

In the following subsection, we argue that these apparent phonetic sequences of vocoids are indeed [+cons] glide + [-cons] vowel sequences, based on the distributional evidence.

7.1 Distributional evidence in support of a /yV/, /wV/ analysis

A [uV:] sequence only occurs after velar consonants /g, k, x/²⁷. This would be unexpected if this [u] were phonemically a [-cons] vowel; a restriction on /u/ to occur only after velar consonants would be rather unusual. However, the distribution that we observe is explained if the vocoid were a consonant, /w/. As explained in Table 1, we analyze C^w as in g^w and k^w as singletons rather than sequences of $C + w$, with velar consonants being the only consonants to have labialized counterparts (see similar analysis on San Pablo Güilá Zapotec by López Cruz 1997: 52). In contrast, the monophthong u or the true diphthong ua do not have such a restriction and are found after any consonant:

- (46) a. [βū̀:ǰj]
/bū̀dy/
'chicken'
- b. [ðū̀:β]
/dub/
'maguēy'
- c. [βðū̀:àʔ]
/bdùa/
'banana'
- d. [lū̀:àn]
/lùan/
'sleeping platform'

The second piece of distributional evidence in support of the glide + vowel analysis of Type C sequences is that the sequences [iV:] and [uV:] exhibit no restrictions on the quality of V_2 , except that i (which is a rare vowel phoneme to begin with) cannot occur as V_2 , and that high front vowels cannot co-occur with a preceding palatal glide, nor can rounded vowels co-occur with a labiovelar glide (i after y , and u or o after w ; this is possibly due to the Obligatory Contour Principle-effect found across Otomanguan languages; Longacre 1957; DiCanio 2008). This is shown in Table 6.

This again is easily explained if we analyze the V_1 portion of Type C sequences as a consonant: as onset consonants, they do not have any co-occurrence restrictions on the following vowel. This is in contrast to the true diphthongs discussed in §4

$V_1 \backslash V_2$	a	e	i	o	u	$í$
i	[dī̀:̣ỵ] /dỳạg/ 'ear'	[yī̀:̣ḥṭ] /gỳẹt/ 'squash'		[dī̀:̣ẓ] /dỳọz/ 'god'	[rī̀:̣ʔ̣ṭẹ] /r-ỳụṭʃ/ 'HAB-mix'	
u	[kū̀:̣ạṇ] /k ^w ̣ạn/ 'alfalfa'	[k ^w ̣ẹ̄ʔ̣ẹ] ²⁸ /k ^w ̣ẹ'ẹ/ 'side'	[k ^w ̣ị́:̣ū̀: /k ^w ̣ị́w/ 'fox'			

Table 6: Combinations of the vocoids in the Type C sequences.

²⁷ Possible exceptions are certain Spanish loans ([pwḗn:] 'bridge' < Sp. puente, [twáí:] 'towel' < Sp. toalla).

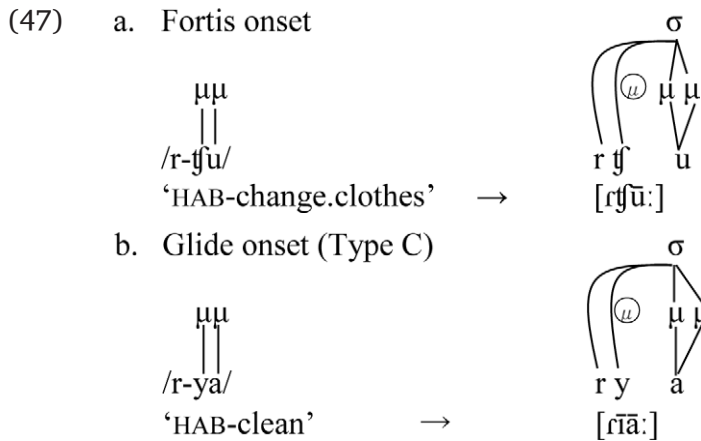
²⁸ In 'side' and 'fox', the realization of the V_1 portion is closer to that of secondary articulation of an onset, possibly due the following interrupted vowel in (b) and the moraic w in (c).

and §5, which have severe co-occurrence restrictions (the only possible diphthongs are /ia/, /ie/, /ua/, and marginally /ia/), a property that is common for diphthongs cross-linguistically.²⁹

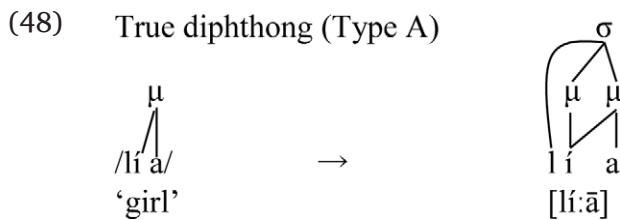
7.2 Representation of the prevocalic glides

In this section, we have seen that the V_1 portion of the [iV:], [uV:] exhibit [+cons] properties, and in turn have shown that the prevocalic glides are realized as full steady vowels. Analyzing glides as fortis consonants, as we proposed in the preceding sections, allows us to account for this apparent anomaly. Just like other fortis consonants in the onset position (Jaeger 1983; Leander 2008: §4.6), glides are of longer duration as compared to lenis consonants in the onset position (but shorter than intervocalic or coda fortis consonants), which motivates their realization as full vowels, rather than as secondary articulation of the preceding consonant.

A fortis consonant loses its moraicity in the onset position, and thus the nucleus vowel is lengthened, provided that it is not followed by a fortis coda (47a), as we saw in §3.3. The same applies to a glide in the onset position (b). In general, moraic phonemes lose weight in the onset position (Hyman 1985).



Compare this situation with the Type A sequences (true diphthongs *ia*, *ie* and *ua*), which share a mora; that is, when there is no coda or the coda is a lenis consonant, the V_1 acquires the mora to satisfy the Bimoraic Requirement:



Again, analyzing Type C sequences as true diphthongs (both V_1 and V_2 as phonological [-cons] vowels) not only fails to account for the consonantal properties of the V_1 portion as we saw in earlier in this section, but also fails to account for the distinction between Type C and the Type A sequences (true diphthongs): the V_1 portion is lengthened in the case of Type A sequences, while the V_2 portion is lengthened in the case of the Type C sequences. If we analyze Type C sequences as true diphthongs, there would be no way

²⁹ An additional support for analyzing the Type C sequence as a [+cons][-cons] sequence is the allomorphy of the progressive aspect prefix *ka-/kay-*. This morpheme takes the allomorph *ka-* before a consonant initial roots (*ká-gieb* ‘PROG-sew’), and *kay-* before a vowel initial roots (*káy-af* ‘PROG-break.LG’). Roots beginning with a Type C sequence takes the allomorph for a consonant initial roots, *ka-* (*ká-ya* ‘PROG-clean’ [káijã:] * [káijjã:]).

of predicting which portion of the diphthong is lengthened; this time the V_1 portion is a high vowel, i or u , for both types of the sequences (Type A: [i:a], [i:e], or [u:a]; Type C: [iV:] or [uV:]). As a consequence, each diphthong would have to be stipulated as to whether the V_1 portion or V_2 portion is lengthened. Such an analysis would unnecessarily complicate the representation of QZ vowels, since such an analysis would entail not only that the vowel length is contrastive in QZ, but also that vowel length is only contrastive in diphthongs.³⁰

8 Conclusion

In this study, we have argued that glides in QZ are moraic; that is, glides behave just like other fortis consonants, in that the nucleus vowel of a syllable with a glide in coda position is not lengthened. The unexpected behavior of glides in the onset position can also be accounted for by our analysis that glides are fortis (moraic) in QZ; that is, a glide in the onset position loses its moraicity, as expected, but its duration is still remarkably long and has a steady state, as is the case for other fortis (moraic) consonants (§7). The glides being moraic poses a problem for an analysis that proposes that a high vowel and a glide are underlyingly the same entity and where the difference between them is represented by a difference in moraicity (Hayes 1989). We have therefore proposed the representation of a high vowel with the feature [-cons] and a glide with the feature [+cons] (§6).

Critical to this conclusion is the analysis of the complex system of sequences of vocoids in QZ. We have shown that there are two major types of sequences in QZ (§4): Type A, where the V_1 portion tends to be longer than the V_2 portion, and either [i:a], [i:e], [u:a] (and marginally [i:a]); Type B, where the V_2 portion tends to be longer than the V_1 portion, and the V_2 portion is either i or u ([Vi:] or [Vu:]). We have proposed that Type A sequences are phonologically true diphthongs /ia/, /ie/, /ua/ (and /ia/) while Type B are phonologically vowel + glide (/Vy/ and /Vw/) sequences by showing that the V_2 portion of Type B sequences exhibit consonantal properties (§5; §6). A third type of sequences is also found, where the V_2 portion is longer but this time the V_1 portion is either i or u ([iV:] and [uV:]); its V_1 portion exhibits consonantal properties, and thus these are analyzed as glide + vowel (/yV/, /wV/) sequences (§7). Table 7 summarizes each type of sequences discussed in this paper.

Type	Phonetic realizations	Phonological properties	Phonemic representation	Examples
A	V_1 long: [i:a], [i:e], [u:a], ([i:a])	V_1, V_2 are [-cons]	Diphthongs; /ia/, /ie/, /ua/, (/ia/)	[li:àz̥] /liàz/ 'house'; [yĩ:èβ̥] /giəb/ 'metal' [β̥ðū:à̃] /bduà/ 'banana'
B	V_2 long: [Vi:], [Vu:]; V_2 [i] or [u]	V_1 is [-cons] V_2 is [+cons]	/Vy/, /Vw/	[βrāú:] /brāw/ 'lizard'; [kāi:] /kay/ 'early morning'
C	V_1 short: [iV:], [uV:]; V_1 [i] or [u]	V_1 is [+cons], V_2 is [-cons]	/yV/, /wV/	[βlià:ʔ] /blyà/ 'ditch'; [kūà:ŋ] /kʷan/ 'alfalfa'

Table 7: Types of sequences.

³⁰ Arellanes (2009) argues, for San Pablo Güilá Zapotec, that /y/ and /w/ (of the /yV/ and /wV/ sequences) are “lenis” vowels. However, such an analysis is untenable at least for QZ as it would result in a situation where only /i/ and /u/ would have lenis counterparts and no other vowels would. Moreover, such an analysis fails to explain the distributional fact that one of the members of the Type C sequences has to be a high vowel (Arellanes 2009: 171). Finally, a lenis-vowel analysis fails to account for the consonant-like phonological properties of the V_1 portion of the Type C sequence.

This paper contributes to an under-explored phonological aspect of the sound system of Tlacolula Valley Zapotec varieties. By providing an in-depth phonological analysis of QZ, we have shown that these varieties are extremely rich and complex not only with respect to their phonetic realizations, such as the complex interaction of tones and phonation types (Munro and Lopez 1999; Arellanes 2009; Chávez Peón 2010, *inter alia*), but also in terms of the phonological system.

Abbreviations

DIM = diminutive, HAB = habitual, POSS = possessive, PROG = progressive, PROX = proximate, SG = singular, STAT = stative

Supplementary Files

The supplementary files for this article can be found as follows:

- **Supplementary File 1:** Appendix. <http://dx.doi.org/10.5334/gjgl.13.s1>

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Competing Interests

The authors declare that they have no competing interests.

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