



Open and closed mid-front vowels in Teotitlán del Valle Zapotec

PUZZLES AND PROBLEMS

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Teotitlán del Valle Zapotec¹ is spoken in the community of Teotitlán del Valle, in the Central Valley of Oaxaca in the Mexican state of Oaxaca. Teotitlán Zapotec is one of the Central Zapotec languages, which belong to the Zapotecan language family within the Otomanguean language stock. Teotitlán Zapotec has two mid-front vowels, [ɛ] and [e]. The distribution of these two mid-front vowels is conditioned by the nature of the adjacent consonants and accent and presents challenges to formal analysis due to a number of properties predictive of the distribution: the disjunctive set of consonants conditioning the alternation, the ganging effect of consonant type and syllable structure as triggers, the featural characterization of the process as raising assimilation, and asymmetries between derived and non-derived environments in the observed patterns.

1 Background on Teotitlán del Valle Zapotec Phonology

The syllable structure of Teotitlán del Valle Zapotec is $(C)CV$. Onset clusters are limited in Teotitlán Zapotec. The canonical root shape of Teotitlán Zapotec is monosyllabic, either closed $(C)VC$ or open $(C)V$, while affixes or clitics are canonically monosyllabic and open $(C)V$, although there are a few which end in a consonant, too ($(C)VC$ or just C)

1.1 Teotitlán Zapotec vowels

Teotitlán Zapotec has seven vowel qualities ($a, \varepsilon, e, i, \dot{i}, o, u$), although the contrast between /o/ and /u/ is marginal as in many other varieties (Smith-Stark 2003: 226, 229; Kaufman 2016: 8; Beam de Azcona et al.

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¹ As of 2000, in Teotitlán del Valle, 78% of the total population are speakers of Zapotec, out of which the majority (92.5%) are bilingual in Spanish (INEGI 2000).

2019). The high central vowel /i/ is found in some words, but this vowel is disappearing in Teotitlán (Arellanes et al. 2014), being replaced by /u/. The mid-front vowels ϵ and e are the focus of this paper.

Table 1 summarizes the vowel system of Teotitlán Zapotec. The marginal, dubious phonemes are in parentheses. The table below focuses on the vowel qualities of modal (short) vowels. Long vowels and vowels with other phonation types occur with all the vowel qualities shown in the table.

Table 1: Teotitlán vowel system

	Front	Central	Back
High	i	(i)	u
Mid	(e)		o
	ϵ		
Low		a	

Vowel length is mostly predictable from accent and the consonant that follows. In tonic syllables, the vowel is long when followed by a lenis consonant or no consonant; otherwise, the vowel is short. However, this is not always the case, since all loanwords and some native words have a long vowel even when the tonic vowel is followed by a fortis consonant. For this reason, we consider vowel length in Teotitlán Zapotec to be marginally contrastive; vowel length is marked with a colon (:), even where length is predictable.

As in other varieties of Zapotec, Teotitlán Zapotec is “laryngeally-complex” (Silverman 1997), in that vowels contrast tonally and in terms of phonation (Munro and Lopez 1999; Smith-Stark 2003; Arellanes 2009: Ch. 3; Chávez Peón 2010). In Teotitlán Zapotec, the modal vowel /a/ contrasts with both the weakly laryngealized vowel /a̤/, which is realized as a creaky vowel, and the strongly laryngealized vowel /aʔ/, which is realized as [aʔ] ~ [aʔa]; we will refer to them as creaky and rearticulated vowels, respectively. Teotitlán Zapotec is tonal as other Zapotec languages and has five tones: low (a), mid (ā), high (â), rising (ã), and falling (â).

1.2 Teotitlán Zapotec consonants

Central Zapotec varieties exhibit a contrast between the lenis series of consonants (the first phoneme in each pair in Table 2 written using IPA symbols for voiced obstruents and singleton sonorants) and the fortis series (the second phoneme in each pair written as voiceless obstruents and geminate sonorants), like other Zapotec varieties (Nellis & Hollenbach 1980; Jaeger 1983; Avelino 2004). The primary feature distinguishing between fortis and lenis consonants is duration, with fortis consonants being longer. As shown in Table 2, nearly all consonants have palatalized counterparts, except for the labialized velar consonants. Phonemes in parentheses are only attested in loans.

Table 2: Consonant phonemes in Teotitlán Zapotec

	Labial		Palatalized Labial		Dental/Alveolar		Palato-alveolar		Palatalized Alveolar		Velar		Palatalized Velar		Labialized Velar	
Plosive	b	p	b ^j	p ^j	d	t			d ^j	t ^j	g	k	g ^j	k ^j	g ^w	k ^w
Nasal	m	m:			n	n:			n ^j	n: ^j						
Tap/Flap					r	r:										
Fricative		(f)			z	s	ʒ	ʃ		s ^j	x					(x ^w)
Lateral					l	l:			l ^j	l: ^j						
Affricate					dz	ts	dʒ	fʃ								
Glides									j							w

2 The phonemic status of [ɛ] vs [e]

The phonemic status of [e] and [ɛ] in Teotitlán Zapotec is controversial, but we can tentatively conclude that [e] and [ɛ] are allophones of one phoneme /ɛ/.

2.1 Distribution

One of the factors conditioning the allophony is the following consonant. The data in (1-8) show the consonants triggering [e] in tonic syllables regardless of phonation type of the vowel. Verbs are listed with the habitual prefix *r(i)-*, *ra-* or *ru-*, unless indicated otherwise.

- | | | | | |
|-----|---|------------------------------|-------------------------------------|------------------------------|
| (1) | <u> </u> _j | | | |
| | gɛ:j (~ gɛ:g ^j) | ‘ice’ | | |
| | [l:e [?] (j)] | ‘blessing’ | | |
| (2) | <u> </u> _w | | | |
| | bɛ:w | ‘coyote’ | | |
| | bɛ̃:w | ‘moon’ | | |
| | bɛ ^w :w | ‘flea’ | | |
| | gɛ:w | ‘river’ | | |
| (3) | palato-alveolar fricatives (<u> </u> _{ʃ, ʒ}) | | | |
| | <u> </u> _ʃ | | <u> </u> _ʃ | |
| | mɛ:ʃ | ‘table’ (< Sp. <i>mesa</i>) | tɛʃ | ‘chest of’ |
| | bɛ:ʃ | ‘peso’ (< Sp. <i>peso</i>) | ru-rɛʃ | ‘turn (it) around’ |
| (4) | palato-alveolar affricates (<u> </u> _{ʧ, ʤ}) | | | |
| | <u> </u> _ʧ | | <u> </u> _ʧ | |
| | gɛ:ʧ | ‘village’ | gɛ̃:ʧ | ‘thorn’ |
| | gɛ:ʧ | ‘pimple’ | ri-dɛ̃ʧ | ‘get scattered’ |
| | ri-bɛ:ʧ | ‘yell’ | ru-tɛ̃ʧ | ‘scatter’ |
| | ri-lɛ̃:ʧ | ‘get separated’ | | |
| | ri-l:ɛ̃:ʧ | ‘separate (it)’ | | |
| | ru-k ^w :ɛ:ʧ | ‘make something sound’ | | |
| | ru-lɛ:ʧ | ‘scold’ | | |
| (5) | palatalized alveolar plosives (<u> </u> _{d^j, t^j}) | | | |
| | <u> </u> _{d^j} | | <u> </u> _{t^j} | |
| | bɛ:d ^j | ‘chicken’ | sɛ:t ^j | ‘oil’ (< Sp. <i>aceite</i>) |
| | mɛ:d ^j | ‘money’ | kɛt ^j | ‘there is not’ |
| | r-ɛ:d ^j | ‘get washed’ | | |
| | ri-nɛ:d ^j | ‘get ahead’ | | |
| | ru-n:ɛ:d ^j | ‘bring forward’ | | |
| (6) | palatalized alveolar nasals (<u> </u> _{n^j, n:^j}) ² | | | |
| | <u> </u> _{n^j} | | <u> </u> _{n:^j} | |
| | rɛ:n ^j | ‘blood’ | xɛ:n: ^j | ‘Genaro’ |
| | ʃtɛ:n ^(j) | ‘of’ | bɛn: ^j | ‘person’ |
| | ru-g ^w :ɛ:n ^j | ‘get anxious’ | | |

² Word-final /n^j/ is realized without the palatalization in some cases, but the underlying palatalization is realized when it is followed by a vowel-initial morpheme: [ʃtɛ:n^ju] / ʃtɛ:n^j=u/ ‘yours’.

(7)	palatalized laterals ($_l^j, l^j$)		
	$_l^j$		$_l^j$
	né:l ^j	‘Manuel’	ru-kēl:l ^j
			ri-gēl:l ^j
			‘hurry him up’
			‘hurry up’

(8)	palatalized velar ($_k^j$)
	xindék ^j
	‘thing’
	ri-bēk ^j
	‘put’
	r-ek ^j
	‘get burned’
	ru-zek ^j
	‘burn’
	zēk ^j
	‘this way, thus’
	rēk ^j
	‘there’

On the other hand, open [ɛ] is found in tonic syllables in complementary environments. Thus, /ɛ/ is found in an open syllable, whether the vowel is modal, creaky or rearticulated (9); before non-palatalized alveolar consonants, namely alveolar plosives /t/ and /d/ (10), the alveolar affricate /ts/ (11)³, alveolar fricatives /z/ and /s/ (12), alveolar laterals /l/ and /l:/ (13), the rhotic /r/ (14), the alveolar nasal /n/ (15), and finally, before labialized velar plosives /g^w/ and /k^w/ (16). In our database, a mid-front vowel is not attested before /b/, /p/, /g/ or /k/.

(9)	open syllable		
	modal	creaky	rearticulated
	bɛ:	‘cochineal’	bɛ:
	‘colored ant’	ru-zɛ?	‘spin (thread)’
	dɛ:	‘ash’	bɛ?
	‘mushroom’	ra-dɛ̃:	‘get narrow’
	ra-bɛ:	‘be happy’	ri-bɛ̃:
	‘take out’	ri-dɛ?	‘get gathered’
	ra-dɛ:	‘get dusty’	ri-gɛ?
	‘get infected’	ri-gɛ̃:	‘side of’
	r-aknɛ̃:	‘help’	ru-stɛ̃:
	‘make (it) narrow’	ri-bɛ:	‘this’
	ndɛ:	‘sit down’	‘here’
	ri-dɛ:	‘get fetched’	ru-tɛ?
	‘corn’	ri-gɛ̃:	‘drink’
	‘curse’	r-ɛ:	‘make (him) drink’
	‘go’	r-estɛ̃:	‘gather’
	‘get up’	ri-gɛ:	
	‘fetch’	ru-lɛ:	
	‘step’	nɛ:	
	‘REPORTATIVE’		

(10)	alveolar plosives ($_t, d$)		
	$_t$		$_d$
	gɛt	‘tortilla’	zɛ:d
	‘salt’	ri-lɛt	bɛ:d
	‘get empty’	‘Pedro’	r-ɛ̃:d
	ri-l:ɛ̃t	‘lower (it)’	ru-dɛ:d
	‘skunk’	‘give’	r-ɛ̃:d (~ r-ǎ:d)
	bet	‘place’	‘get pierced’
	lɛt	‘deep’	ru-sɛ:d
	gét		‘study’
			ru-tɛ:d
			‘pass’

³ /dz/ is a marginal phoneme in Teotitlán Zapotec and is only found in onset position before /i/ (this [dzi] sequence is in free variation with [zi], [zu] or [dzu]); it cannot occur in coda position.

- (11) alveolar affricate (_ts)
 bɛts ‘brother of (a male)’
 bɛʃts ‘buzzard’
 dɛts ‘back of’

- (12) alveolar fricatives (_z, s)

<u>_z</u>		<u>_s</u>	
bɛːz	‘toad’	m ^w ɛːs	‘teacher (< Sp. <i>maestro</i>)’
bɛːz	‘jaguar’	ra-lɛs	‘become thin’
biteːz	‘nest’	ri-l:(j)ɛs	‘pick up’
galgɛːz	‘support for a party’	lɛs	‘thin’
gɛːz	‘cigarette’	ngɛs	‘black’
ggɛːz	‘white cocoa bar’	gɛs	‘pot’
nɛːz	‘road’	k ^w ɛs	‘temple (part of the forehead)’
ri-bɛːz	‘wait’		
ri-dɛːz	‘get hugged’		
r-ɛːz	‘wash one’s body’		
ri-gɛːz	‘hug’		
ri-n-ɛːz	‘trap’		
ri-rɛːz	‘get split’		
ri-t(j)ɛːz	‘split’		
ru-g ^w ɛːz	‘wash someone’s body’		
ru-k ^w ɛːz	‘crush’		
ru-kwɛːz	‘detain’		
gɛːz	‘seven’		

- (13) alveolar laterals (_l, l:)

<u>_l</u>		<u>_l</u>	
bɛːl	‘meat’	bɛl:	‘fish’
gɛːl	‘corn tree’	gɛl:	‘annona’
		bɛl:	‘sister of (a woman)’
		g ^w ɛl:	‘youngest child’
		ri-dɛl:	‘role up’
		ri-karɛl:	‘gear up’
		ri-rɛl:	‘stumble into’
		ru-tɛl:	‘roll (it)’
		bɛl:	‘how many’

- (14) _r
 x^wɛːrs ‘effort’ (< Sp. *esfuerzo*)
 pɛːr ‘pear’ (< Sp. *pera*)

- (15) _n
 rɛːn⁴ ‘there (medial)’

- (16) labialized velar plosives (_g^w, k^w)

<u>_g^w</u>		<u>_k^w</u>	
bɛːg ^w	‘comb’	bɛk ^w	‘dog’
ʃɪbɛːg ^w	‘bowl’		

⁴ Word-final /n/ is realized as a velar [ŋ].

In addition, open [ɛ] is found before palatalized labials, namely /b^j/ and /p^j/. Recall that closed [e] is found instead when followed by other palatalized consonants, as we saw above.⁵

(17) palatalized labials (_b^j, p^j)

_b ^j		_p ^j	
r-ɛ:b ^j	‘told’	gɛp ^j	‘navel’
ri-dɛ:b ^j	‘get spread, smeared’	r-ɛp ^j	‘go up’
r-ɛ̄:b ^j	‘swallow’	r-ul:ɛ̄p ^j	‘raise’
ri-lɛ:b ^j	‘get accustomed’		
ri-gɛ:b ^j	‘spread, smear’		
ri-l:ɛ:b ^j	‘get boiled’		
ru-zɛ:b ^j	‘hang’		
ri-zɛ̄:b ^j	‘fall down’		
ri-zɛ̄:b ^j	‘get hanged’		
ru-g ^w ɛ:b ^j	‘make swallow’		
ru-l:ɛ:b ^j	‘boil (it)’		
ru-sɛ̄:b ^j	‘throw into (a bag, etc.)’		
ru-l:ɛ:b ^j	‘accustom him’		

Table 3 summarizes the distribution of [e] and [ɛ] in the tonic syllables discussed so far. The environments where [e] is found are shaded in grey, while those where [ɛ] is found are unshaded. The phonemes in parentheses do not occur after a mid-front vowel in our database and thus we would not know if they trigger raising or not.

Table 3: Following consonants which predict [e]

	Labial	Palatalized labials	Alveolar	Palato-alveolar	Palatalized alveolars	Palatalized velar	Velar	Labialized velar
Plosive	(b), (p)	b ^j , p ^j	d, t		d ^j , t ^j	k ^j , g ^j	(g), (k)	g ^w , k ^w
Affricate			(dz), ts	ɟʒ, tʃ				
Fricative			z, s	ʒ, ʃ	(s ^j)			
Liquid			l, l:		l ^j , l: ^j			
Nasal	(m), (m:)		r, (r:)		n ^j , n: ^j			
Glide			n, (n:)		j			w

The issue that arises here is how to define the environments where [e] is found, in particular, which phonological feature(s) captures the class of palato-alveolars, palatalized alveolars and velars, and /w/, all of which predict [e].

One proposal is to generalize environments in terms of the features [+high, -labial], that is any non-labial [+high] consonants, and /w/.⁶ Under this approach (and others using standard articulatory-based features), /w/ cannot be unified with other consonants, and the rule has to be stated disjunctively. This account would rely on the assumption that velars and labialized velars are [-high] (cf. Elorrieta Puente 1996) and that the feature [high] is not relevant for labials and alveolars. It would also treat /k^j/, which conditions raising to [e], as a front velar that is [+high], in keeping with analyses that assume palatalized or front velars share the [+high] feature with palatals (Lahiri & Blumstein 1984; Odden 2005: 144). The

⁵ There is one instance of open /ɛ/ followed by /s^j/: /gutes^j/ ‘slept’. We consider this to be exceptional. First, there is only one such instance. Second, the /ɛ/ of this form may come from an original *a, rather than *e, since in other TAM categories, the root has /a/: /r-as^j/ ‘sleeps’.

⁶ /w/ is also exceptional in the sense that it does not trigger the occurrence of [e] when it precedes a mid-front vowel, as shown in §3.1.

feature [-labial] eliminates labials, palatalized labials and labialized velars which are [+labial]. Such a proposal has the advantage of capturing the process as raising: the mid-front vowel is raised due to the feature [+high] of the following consonant. Such an analysis can also unify the alternation between [e] and [ɛ] on the one hand, and the cooperative raising to [i] on the other, which is clearly a raising process (§4), both of which are triggered by the same set of consonants

Issues with such a proposal are the following. First, the assumption that velars are [-high] is problematic; velars are typically treated as [+high] since they are produced with the tongue body raised from a neutral mid-central position (Chomsky & Halle 1968). In addition, [+high] is what distinguishes velars from their [-high] dorsal counterparts, the uvulars, which are associated with a lower tongue body position. Secondly, [e] and [ɛ] are both considered to be [-high] in standard theories; generally, [e] and [ɛ] are distinguished by [tense] or [lax]. Thus, capturing the alternation as a raising assimilatory process is problematic.

An alternative is to characterize the triggering consonants as [+coronal, -anterior, -labial]. Such features, along with those for /w/ as [-cons, +labial], can capture correctly the environments where [e] is found, without treating velars as [-high]. Moreover, in this analysis, the alternation between the open and closed mid-front vowels no longer requires recourse to the non-standard assumption that the two vowels are distinguished by the feature [high]. However, with such features we cannot capture the insight that the allophony here is likely to be height assimilation triggered by the consonant (even if the feature encoding the assimilation is not [high]). In addition, such an analysis would fail to unify the allophony in question and the cooperative raising of the mid-front vowel to [i], to be discussed in §4, which is more clearly a raising process.

In historical terms, the environments where [e] is found are those where the second vowel of the disyllabic roots was a high vowel, except for cases where the intervening consonant was bilabial (/b/, /p/) or velar (/k^w, /g^w). This can be illustrated by comparing the Teotitlán Zapotec forms to their cognates in Juchitán Zapotec, which preserves the second vowel of disyllabic roots and has raised vowels relative to Teotitlán Zapotec (the Juchitán forms are from Picket et al. 2007). The first three forms in Table 4 have [e] in Teotitlán Zapotec and high vowels in the second syllable in Juchitán Zapotec. On the other hand, the last three forms have [ɛ] in Teotitlán Zapotec and [-high] vowels in the second syllable in Juchitán Zapotec.

Table 4. Cognates of forms in Juchitán Zapotec

gloss	Teotitlán	Juchitán
'riverbed'	gɛ:w	'gì:gu
'people'	bēn: ^j	'bin:ĩ
'thorn'	gēŋ	'gìŋĩ
'back of'	dɛts	'deŋʃe
'meat'	bē:l	'bɛ:lă
'tortilla'	gɛt	'geta

The glide /w/, which is the only consonant that is [-high, +labial] and still conditions the occurrence of [e], corresponds to a /wu/ sequence in Juchitán and/or San Baltazar Chichicapan Zapotec, another Central Zapotec variety that preserves the second syllable of disyllabic roots (the Chichicapan forms are from Thomas Smith-Stark's database):

Table 5. Cognates of forms with final /w/ in Juchitán and Chichicapan Zapotec

	Teotitlán	Juchitán	Chichicapan
'coyote'	bě:w	-	'bwě:wu
'moon'	bē:w	'bɛ:wũ, 'bɛ:jũ	'bwe'wũ
'river'	gɛ:w	'gì:gu	'gì:wu

Exceptions to the generalization above are very few and include the following. The first such case is where the mid-front vowel is followed by a consonant that should condition the occurrence of [e], but where open [ɛ] is found instead: [lɛʔn] /lɛʔnⁱ/ ‘stomach, inside’. The open /ɛ/ of this form possibly comes from former *a, with subsequent raising due to the following palatalized /nⁱ/. In other Central Zapotec varieties, this word has the vowel /a/: San Lucas Quiavini /laʔnⁱ/ and San Pablo Güilá /laʔnⁱ/ (López Cruz 1997: 60). The final /ⁱ/ in isolation is not realized, but its underlying presence is justified by its inflected forms: [lɛʔnⁱa] /lɛʔnⁱ=a/ ‘my stomach’. Another set of exceptions involve those cases where open [ɛ] is expected but closed [e] is found instead: [blé:] ‘If only!’. Some such cases may be accounted for by another source of closed [e], namely from the sequence /u:j/. Thus, the sequence /u:j/ shows free variation in (18) and (19), while in (20), the form with /u:j/ (with accent) is the numeral ‘one’. Its non-tonic counterpart with fused [e] is grammaticalized as an indefinite article:

- | | | | |
|---------|----------------------|----|-------------------|
| (18) a. | [dũ:j] ‘all (whole)’ | b. | [dě:] |
| (19) a. | [stú:j] ‘another’ | b. | [sté:] |
| (20) a. | [tu:j] ‘one’ | b. | [te] ‘INDEFINITE’ |

2.2 Alternations

The distribution of the mid-front vowels [e] and [ɛ] in Teotitlán Zapotec can further be confirmed by morphologically motivated alternations, where [ɛ] in word-final position alternates with [e] when the following morpheme begins with a consonant that conditions the occurrence of [e].

The first such morpheme is the second person singular enclitic =w, the allomorph of =u that appears after a vowel; thus, when this enclitic is attached, the stem final [ɛ], as can be observed in the isolated forms in (a), alternates with [e] in (b).

- | | without =w | | with =w |
|---------|---|----|---|
| (21) a. | g ^w ɛ:
/g ^w -ɛ:/
CMP-go
‘went’ | b. | g ^w ɛ:w ⁷
/g ^w -ɛ:=u/
CMP-go=2SG
‘you went’ |
| (22) a. | gulɛ̃:
/gu-lɛ̃:/
CMP-take.out
‘took out’ | b. | gulɛ̃:w ⁸
/gu-lɛ̃:=u/
CMP-take.out=2SG
‘you took out’ |
| (23) a. | k ^w ɛʔ
/k ^w ɛʔ/
side
‘side’ | b. | k ^w eʔw
/k ^w ɛʔ=u/
side=2SG
‘your side’ |

Another morpheme that conditions alternation of word-final [ɛ] to [e] is the first person plural enclitics =(w)un (inclusive) or =(w)ūn (exclusive). The /w/ of these enclitics conditions the occurrence of [e], but this /w/ is deleted due to the general and common in Otomanguean languages (Longacre 1957) OCP-driven phonotactic constraint in Teotitlán Zapotec against the sequence of /w/ and a back vowel (/u/ or /o/), *wV_[+back].⁹

⁷ When the 1SG and 2SG enclitics are attached, the stem modal vowel alternates with a creaky vowel, due to Laryngeal Displacement (Uchihara & Gutiérrez in press).

⁸ Here, the rising tone on the second syllable is due to the combination of the underlying mid tone on the stem, and the high tone which is assigned to the following syllable after a mid tone (tone sandhi). For more detail on tonal processes in Teotitlán Zapotec, see Uchihara & Gutiérrez (2019).

⁹ The 1PL forms undergo stem alternation, such as prefix alternation, tone alternation and suppletion, in addition to the [e] ~ [ɛ] alternation discussed here (Uchihara & Gutiérrez in press).

- | | | | |
|------|----------------|--|-----------------------|
| | without =(w)un | | with =(w)un |
| (24) | a. rigɛ: | | b. radé:ún |
| | /ri-gɛ:/ | | /ra-dé:=(w)un/ |
| | HAB-fetch | | HAB-fetch.1PL=1PL.IN |
| | ‘fetch’ | | ‘we fetch’ |
| (25) | a. kájɛʔ | | b. kádéʔun |
| | /káj-ɛʔ/ | | /ká-déʔ=(w)un/ |
| | PROG-drink | | PROG-drink.1PL=1PL.IN |
| | ‘drink’ | | ‘we drink’ |
| (26) | a. restē: | | b. réstē:ún |
| | /r-estē:/ | | /r-éstē:=(w)un/ |
| | HAB-get.up | | HAB-get.up.1PL=1PL.IN |
| | ‘get up’ | | ‘we get up’ |

The third morpheme that triggers the [e] ~ [ɛ] alternation is the diminutive suffix $-ʔn(i)$. In isolation, the palatalization is not realized,¹⁰ but their inflected forms (when followed by a vowel-initial morpheme) justify the presence of the underlying palatalization, as shown in (27c and 28c).

- | | | | | | |
|------|-------------|--|------------------------|--|-----------------------------|
| | without DIM | | with DIM ¹¹ | | with DIM + inflection |
| (27) | a. tseʔ | | b. tseʔn | | c. tseʔn ⁱ u |
| | /tseʔ/ | | /tseʔ-(ʔ)n(i)/ | | /tseʔ-(ʔ)n ⁱ =u/ |
| | voice | | voice-DIM | | voice-DIM=2SG |
| | ‘voice of’ | | ‘little voice’ | | ‘your little voice’ |
| (28) | a. dɛ: | | b. deʔn | | c. xteʔn ⁱ u |
| | /dɛ:/ | | /dɛ:-ʔn(i)/ | | /x-dɛ:-ʔn ⁱ =u/ |
| | ash | | ash-DIM | | POSS-ash-DIM=2SG |
| | ‘ash’ | | ‘little ash’ | | ‘your little ash’ |

Lastly, the enclitic = k^i ‘invisible’ also triggers the alternation of the preceding [ɛ] to [e]:

- | | | | |
|------|-----------------|--|-----------------------|
| | without = k^i | | with = k^i |
| (29) | a. rɛ: | | b. rɛk ⁱ |
| | /rɛ:/ | | /rɛ:=k ⁱ / |
| | DEM.DIST | | DEM.DIST=INV |
| | ‘there’ | | ‘there (invisible)’ |

3 The effect of the onset consonant in a closed syllable

In the previous section, we saw the effect of the postvocalic consonants and /w/ following the mid-front vowel. The allophony of the mid-front vowel is also conditioned by the same subset of consonants (namely, /tʃ/, /dʒ/, /z/, or /ʃ/, /j/, and palatalized consonants) in the prevocalic position, but only when the vowel is in a closed syllable at the same time (§3.1). This cooperative effect of the consonant height and the syllable structure is further confirmed by alternation evidence (§3.2).

¹⁰ If there was palatalization, it would be clearly audible since the palatalization would be realized as a [j] before [n] in this position, due to *j*-Metathesis (Uchihara & Gutiérrez in press).

¹¹ These forms can also be interpreted as containing the 3SG.DEI enclitic =*en*: ‘the voice of a deity’, ‘the ash of a deity’.

3.1 Distribution

First, when the mid-front vowel preceded by one of the conditioning consonants listed in §2 is in an open syllable, a mid-front vowel /ɛ/ is not realized as [e], unlike when they are followed by one of the same consonants, regardless of the phonation type of the vowel.

(30) Open syllable

Modal	Creaky	Rearticulated
k ^j ɛ: ‘head of’	ri-d ^j ɛ: ‘go out’	biz ^j ɛ? ‘cacao’
biz ^j ɛ̄: ‘water well’	g ^j ɛ: ‘flower’	lug ^j ɛ? ‘market’
l ^j ɛ: ‘Maria’	ri-g ^j ɛ: ‘dye’	n ^j ɛ? ‘foot of’
g ^j ɛ: ‘stone’	ru-g ^j ɛ̄: ‘observe’	ʒg ^j ɛ? ‘Teotitlán del Valle’
bis ^j ɛ: ‘eagle’	bik ^j ɛ̄: ‘nit’	
r-jɛ: ‘go to origin’		
ri-g ^j ɛ: ‘squeeze’		
ru-d ^j ɛ: ‘squeeze’		

However, when a mid-front vowel preceded by one of these conditioning consonants (but not /w/) is *also* in a closed syllable, closed [e] is found. The following are examples with coronal consonants *t*, *d*, *s*, *z*, *n*, or *l* in the postvocalic position:

(31) alveolar plosives (_t, _d)

r-jet	‘get down’
r-jet	‘get ground’
r-jɛ:d	‘get combed’

(32) alveolar fricatives (_s, _z)

ri-t ^h es	‘jumps over’
ri-t ^h ɛ̄:z	‘split’

(33) alveolar nasal (_n)

z ^(j) ɛ̄:n	‘many (countable)’
d ^h ɛ̄:nd	‘store’ (< Sp. <i>tienda</i>)
oʃɛ̄:nt	‘eighty’ (< Sp. <i>ochenta</i>)

(34) alveolar lateral (_l)

ʃɛ̄:l	‘spouse of’
ra-dʒɛ̄:l	‘find’
ri-ʃɛ̄:l	‘send’

The mid-front vowel is also realized as [e] after the conditioning consonants when this vowel is *also* followed by tautosyllabic bilabials /p/ and /b/ (35), palatalized labials /p^j/ and /b^j/ (36), a velar /k/ (37) or a labialized velar /k^w/ (38) in the coda position. The form in (38) shows that a palatalized labial can condition the occurrence of [e] in a closed syllable, even though it does not in the postvocalic position as we have seen in §2.

(35) labial plosive (_p, b)

ʃ ^(j) ɛ̄:p	‘Josefa’
n ^j ɛ̄:b	‘ice cream’ (< Sp. <i>nieve</i>)

(36) palatalized labials (_p^j, _b^j)

r-(j)ep ^j	‘raise’
káj-ep ^j	‘is going up’
ʃɛ̄p ^j	‘will go up’

- (37) velar plosive ($_k$)
 ʧʰ(j)é:k ‘cheque’ (< Sp. *cheque*)
- (38) labialized velar ($_k^w$)
 bʰěk^w ‘hawk’

When the mid-front vowel is both preceded and also followed by one of the conditioning consonants in coda position, [e] is found as expected:

- (39)
- | | |
|------------------------|------------------|
| jē:n ^(j) | ‘saliva of’ |
| naʒé:n ^(j) | ‘wide’ |
| ri-ʃěk ^j | ‘untie’ |
| ri-ʒěk ^j | ‘get untied’ |
| biljē ^{ʔ(j)} | ‘black zapote’ |
| giblʰé:(j) | ‘key’ |
| r-unjʧē:(j) | ‘weave’ |
| ru-ʃē:ʒ | ‘sneeze’ |
| ʒet ^ʰ | ‘onion’ |
| r-jet ^ʰ | ‘get bent’ |
| ʃʰé:ʒ | ‘garlic’ |
| r-jetʃ | ‘shudder’ |
| gʰen: ^j | ‘neck of’ |
| r-jē:d ^j | ‘get frustrated’ |
| ri-ʃē:l ^(ʰ) | ‘open (it)’ |
| r-jē:l ^ʰ | ‘flourish’ |
| ru-ʃetʃ | ‘shout’ |
| gʰeʃ | ‘avocado’ |
| lʰé:(j) | ‘lock’ |
| ʧē:(j) | ‘correctly’ |

Recall that /w/ triggers the realization of the preceding mid-front vowel as [e] (§2). However, /w/ or labialized velars do not condition the occurrence of the following mid-front vowel as [e], even when this vowel is followed by a coda consonant:

- (40)
- | | |
|---------------------|-----------------------------------|
| g ^w ɛ:l | ‘youngest child’ |
| x ^w ɛ:rs | ‘effort’ |
| mwé:s | ‘teacher’ (< Sp. <i>maestro</i>) |

Thus, the generalization here is that the mid-front vowel is realized as [e] when it is preceded by the conditioning consonants in a closed syllable. This process can be stated informally as follows, where the consonantal feature trigger (F) is unclear (see §2 for discussion):

- (41) /ɛ/ → [e] / C_F_C]_σ

This is a case of a “cooperative” or “ganging” effect (Flemming 1995; Lionnet 2016, 2017; McPherson 2016) that targets the mid-front vowel: a prevocalic conditioning consonant alone is not ‘strong’ enough to condition the allophony of the following mid-front vowel, but it does when it ‘cooperates’ with the syllable structure (closed syllable). One possible phonetic explanation for this effect of the syllable structure is due to *undershoot* (Lindblom 1990; Moon & Lindblom 1994) or an imperative to minimize articulatory effort, captured as the constraint LAZY (Kirchner 2004): vowels in a closed syllables tend to be shorter (closed syllable vowel shortening is common cross-linguistically; Maddieson 1985), and shorter vowels fail to reach their lower target positions because speakers do not open their jaws as widely when there are shorter temporal intervals, whether due to speech rate (DiCanio et al. 2015) or lack of prominence (Erickson & Kawahara 2016). This account assumes that the articulatory position required for [e] is farther than that of

[e] from the baseline or rest position. Recall that in Teotitlán Zapotec both short and long vowels can occur in a closed syllable, as we have seen in §2.1: there exist near-minimal pairs as in (39) above, *ritjes* ‘jumps over’ vs. *ritjē:z* ‘split’; however, vowels may be phonetically shorter, whether they are phonemically short or long, in a closed syllable than in an open syllable.¹² Such an account is all the more plausible since in atonic syllables the realization of the mid-front vowel is [e], as we will see in §5.

We have seen above that the mid-front vowel preceded by a conditioning consonant has to be in a closed syllable. If the syllable structure really is crucial in predicting the allophony, we would expect [ɛ] when the mid-front vowel is followed by a consonant but in a different syllable (that is, C_Fɛ.CV). This is in fact true in some cases, as in (42). In (42), both forms are morphologically complex: *r^hɛ: .dán* consists of habitual *r-*, verb root *-jɛ:* ‘go to the origin’, and the 3PL informal enclitic =*dán*; *nis.g^hɛ: .pi:* is made up of *nis* ‘water’, *g^hɛ:* ‘stone’ and *bi:* ‘air’.

- (42) *r^hɛ: .dán* (**rjɛ: .dán*) ‘they go to the origin’
nis.g^hɛ: .pi: (**nis.g^hɛ: .pi:*) ‘storm’

However, in other cases, this is not borne out; namely when a closed syllable becomes open due to morpheme concatenation. When a C_FɛC syllable is followed by a vowel-initial morpheme, thereby rendering the coda consonant heterosyllabic, then the mid-front vowel remains close [e], as can be seen in the following examples. The forms in (b) are without the following morphemes, justifying that the mid-front vowel is [e] when there is no following morpheme.

- (43) a. *r^hɛ .tan* (**r^hɛ .tan*) b. *r^hɛt*
 /r-jɛt=an/ /r-jɛt/
 HAB-get.down=3SG.INF HAB-get.down
 ‘he gets down’
- (44) a. *fɛ̃ .lɛ^h .nan* (**fɛ̃ .lɛ^h .nan*) b. *fɛ̃ l*
 /fɛ̃-l-ɛ^hn=an/ /fɛ̃ l/
 spouse.of-DIM=3SG.INF spouse.of
 ‘his little spouse’

This lack of allophonic alternation may be due, within a constraint-based paradigm, to Paradigm Uniformity (Steriade 1999; Raffelsiefen 2005, among others): the allophone [e] is maintained even when the syllable structure changes due to morpheme concatenation, in order to maintain the stem form (in this case, the nucleus vowel) invariable.

So far, we have not found any exceptions to the generalization above. There are some apparent exceptions where a closed [e] is found after one of the conditioning consonants in an open syllable, but in all of such cases the mid-front vowel can optionally be followed by a palatal glide *j*, which conditions the raising of the preceding mid-front vowel, as we saw in §2.

- (45) Apparent exceptions
 l^hɛ: (j) ‘lock’
 fɛ̃: (j) ‘correctly’

3.2 Alternations

Alternations between closed [e] and open [ɛ] in the same morpheme, according to the preceding consonant and the syllable structure, are also found. Thus, the following forms, both in a closed syllable, are in free

¹² The interaction of syllable structure and vowel quality is found in English, where lax vowels are found only in tonic closed syllables. It has been argued that this is because lax vowels are monomoraic and thus need a consonant in the coda position to satisfy Weight-to-Stress principle (Prince 1990), while tense vowels are bimoraic (Hammond 1997). However, the situation in Teotitlán Zapotec is the opposite: [ɛ] is found both in open and closed syllables while [e] is only found in closed syllables.

variation, with the [e] ~ [ɛ] alternation conditioned by the presence or absence of preceding palatalization. This alternation confirms the importance of the feature of the prevocalic consonant.

- | | | | |
|------|-------------------------|----|-------------------------|
| | not preceded by j | | preceded by j |
| (46) | a. [rit̪ē:z] ‘split’ | b. | [rit̪ ^h ē:z] |
| (47) | a. [rit̪es] ‘jump over’ | b. | [rit̪ ^h es] |

In the following cases, when a stem with open [ɛ] is followed by a palatalized labial (which itself does not condition raising in the postvocalic position; §2) and is preceded by a morpheme ending in one of the conditioning consonants, this mid-front vowel is realized as a closed [e]. This again confirms the role of the prevocalic consonant in the allophony. Note here that the Paradigm Uniformity is not maintained and rather the stem vowel alternates between [ɛ] and [e].

- | | | | |
|------|--------------------------------|----|----------------------------|
| | not preceded by C _F | | preceded by C _F |
| (48) | a. rep ^j | b. | kájep ^j |
| | /r-ɛp ^j / | | /káj-ɛp ^j / |
| | HAB-go.up | | PROG-go.up |
| | ‘go up’ | | ‘is going up’ |
| (49) | a. rep ^j | b. | ʃǽp ^j |
| | /r-ɛp ^j / | | /ʃ-ɛp ^j / |
| | HAB-go.up | | POT-go.up |
| | ‘go up’ | | ‘will go up’ |

When a stem with an open-mid [ɛ] is in an open syllable, this vowel does not alternate with the closed-mid [e] as in the cases above. This confirms the importance of the syllable structure (closed syllable) in the allophony. In (50), the (b) form has the progressive prefix, which ends in /j/; however, this /j/ does not condition the allophony of the root-final vowel.

- | | | | |
|------|---------------------|----|---|
| | not preceded by j | | preceded by j |
| (50) | a. rɛ [?] | b. | kájɛ [?] (*kájɛ [?]) |
| | /r-ɛ [?] / | | /káj-ɛ [?] / |
| | HAB-drink | | PROG-drink |
| | ‘drink’ | | ‘is drinking’ |

4 Cooperative raising to [i]

In the previous subsection, we saw that a subset of prevocalic consonants (/j/, /ʃ/, /ʒ/, /tʃ/, /dʒ/, or palatalized consonants) and the syllable structure (a closed syllable) team up to raise a mid-front vowel. When the postvocalic coda consonant is also one of the conditioning consonants (including /w/), the mid-front vowel can raise to [i], neutralizing with the underlying /i/ (with a subsequent deletion of the preceding /j/ or palatalization, due to the general OCP-driven constraint that prohibits the sequence *ji).

Such an alternation can be observed with the 2SG enclitic =w. The (a) forms are isolation forms with open /ɛ/, while (b) forms are followed by =w and have /i/ instead of /ɛ/.

- | | | | |
|------|----------------------------------|----|--|
| | without =w | | with =w |
| (51) | a. n ⁱ ɛ [?] | b. | ni [?] w (*n ⁱ ɛ [?] w) |
| | /n ⁱ ɛ [?] / | | /n ⁱ ɛ [?] =u/ |
| | foot | | foot=2SG |
| | ‘foot’ | | ‘your foot’ |
| (52) | a. k ^j ɛ: | b. | k ⁱ :w |
| | /k ^j ɛ:/ | | /k ⁱ ɛ:=u/ |
| | head | | head=2SG |
| | ‘head’ | | ‘your head’ |

- | | | | |
|---------|---|----|---|
| (53) a. | ʃĕ:
/ʃ-ε:/
POT-go
‘will go’ | b. | ʃĩ:w (*ʃĕ:w)
/ʃ-ε:=u/
POT-go=2SG
‘you will go’ |
| (54) a. | ridĭε:
/ri-dĭε:/
HAB-leave
‘leave’ | b. | ridi:w
/ri-dĭε:=u/
HAB-leave=2SG
‘you leave’ |

This cooperative effect appears to be at work only in derived contexts. Thus, lexical sequences of C_FeC_F are attested, as we saw in §3.1, which should not be attested if this cooperative effective were operative at the lexical level. Below are repeated examples from (39):

- | | | |
|------|------------------------|------------------|
| (55) | ʃē:n ^(j) | ‘saliva of’ |
| | naʒé:n ^(j) | ‘wide’ |
| | ri-ʃĕk ^j | ‘untie’ |
| | ri-ʒĕk ^j | ‘get untied’ |
| | biljĕ ^(j) | ‘black zapote’ |
| | giblĕ ^(j) | ‘key’ |
| | r-unjĕ ^(j) | ‘weave’ |
| | ru-ʃē:ʒ | ‘sneeze’ |
| | ʒet ^j | ‘onion’ |
| | r-jet ^j | ‘get bent’ |
| | ʃĕ:ʒ | ‘garlic’ |
| | r-jetʃ | ‘shudder’ |
| | gĕn: ^j | ‘neck of’ |
| | r-jĕ:d ^j | ‘get frustrated’ |
| | ri-ʃĕ:l ^(j) | ‘open (it)’ |
| | r-jĕ:l ^j | ‘flourish’ |
| | ru-ʃetʃ | ‘shout’ |
| | gĕʃ | ‘avocado’ |
| | lĕ:(j) | ‘lock’ |
| | ʃĕ:(j) | ‘correctly’ |

On the other hand, several cases of lexical C_FiC_F sequences are also attested, which could have historically come from *e surrounded by the conditioning consonants, and then raised to /i/ due to this cooperative effect; in fact, *ri-ʒĩʃ* ‘get angry’ has *e in Kaufman’s (2016) reconstruction (*tze:7tzE):

- | | | |
|------|----------------------|------------------------|
| (56) | ʒĩ:ɖʒ | ‘pineapple’ |
| | ʃĩ:l ^j | ‘wing of’ |
| | ʒĩ:l ^j | ‘sheep’ |
| | ʃĩ:ʒ | ‘chepil’ |
| | guʃĩn: ^j | ‘night’ |
| | ʃĩk ^j | ‘once upon a time’ |
| | ru-ʃĩn: ^j | ‘defecate’ |
| | ri-ʒĩʃ | ‘get angry’ |
| | ru-ʃĩʃ | ‘make (someone) angry’ |

The cooperative effect is also not observed with the suffixation of the diminutive (which has a palatalized coda), even when the root is preceded by one of the conditioning consonants. Thus, in the (b) forms in the following examples, the open /ɛ/ of the stem does not alternate with /i/ even though this vowel is preceded by /j/ and followed by the palatalized consonant of the diminutive:

- (57) a. bikⁱɛ̃:
/bikⁱɛ̃:/
nit
‘nit’
- b. bikⁱɛ̃[?]n (*bikⁱɛ̃[?]n)
/bikⁱɛ̃:-[?]nⁱ/
nit-DIM
‘little nit’
- (58) a. gⁱɛ̃:
/gⁱɛ̃:/
stone
‘stone’
- b. ʃkⁱɛ̃[?]nⁱa
/ʃ-gⁱɛ̃:-[?]nⁱ=a/
POSS-stone-DIM=1SG
‘my little stone’

This cooperative raising discussed in this section can be formulated as follows. Again, see §2.1 for the characterization of the feature F associated with consonants adjacent to the vowel.

- (59) Cooperative raising to [i]
/ɛ/ → [e] ~ [i]/C_F_{C_F, /w/}

5 Neutralization in atonic positions

Another factor that conditions the [e] ~ [ɛ] alternation in Teotitlán Zapotec is accent: in atonic positions, especially in a closed syllable, we find the allophone [e].

In Teotitlán Zapotec, accent is culminative and obligatory; there is only one accent per phonological word (Picket 1951; Mock 2010: 202; Pérez Báez et al. 2015). The accent falls on the last syllable of the phonological word, which consists of a root (60) plus an optional prefix (61) or suffix (62), or of a compounded root (63). In the following examples, the position of the accent is represented with the IPA symbol for primary stress ['] before the tonic syllable, and the phonological word is circumscribed in parentheses

- (60) a. ('bi:)
‘air’
- b. ('ju:)
‘ground’
- (61) a. (ri'za:)
/ri-za:/
HAB-walk
‘walks’
- b. (gu'ri:)
/gu-ri:/
CMP-sit.down
‘sat down’
- (62) a. (gú'nɛ[?]n)
/gú[?]n-ɛ[?]n/
bull-DIM
‘little bull’
- b. (gubá'ni[?]n)
/gubá[?]nj-i[?]n/
broom-DIM
‘little broom’
- (63) a. (bedj'ngu:l)
/bɛ:dj-ngu:l/
chicken-male
‘turkey’
- b. (diz'za:)
/dɛ:dʒ-za:/
word-Zapotec
‘Zapotec language’

Since Teotitlán Zapotec is tonal, pitch is not a reliable acoustic correlate of accent. It has been proposed that the accent correlates more reliably with vowel duration (Picket 1951; Picket et al. 2001: 16; Chávez-Peón 2008; Mock 2010: 202). It could be the case that the most reliable acoustic correlate of accent is intensity (as claimed for one Central Valley Zapotec variety, San Lucas Quiaviní Zapotec; Chávez-Peón 2008). The full range of phonological contrasts is expressed within tonic syllables and is often neutralized in atonic syllables (Smith-Stark 2003: 25, 32; Chávez Peón 2015), which is cross-linguistically common (Gordon 2011): vowel duration (a contrast that is itself marginal), phonation and tonal contrasts are also neutralized in atonic positions.

In this section, we will first look at the neutralization of the mid-front vowel in atonic positions, especially in a closed syllable (§5.1); a cooperative effect between the consonant height and accent is also observed (§5.2).

5.1 Neutralization to [e] in atonic positions

In general, the closed-mid [e] is found in an atonic position. First, only [e], and not [ɛ], is found in proclitics and enclitics, which lack accent.

(64) Enclitics: =ēn ‘INANIMATE’, =en ‘DEITIC’, =ēn ‘FOCUS’

(65) Proclitics: kēd= ‘NEG’, te= ‘INDEFINITE’, té= ‘SUBORDINATOR’

Alternations between [e] and [ɛ] due to accent are also common. Thus, the andative and venitive prefixes, *-e* and *-ēd*, with closed [e], come from the lexical verbs *-ε:* ‘go’ and *-ē:d* ‘come’ (a), with open [ɛ]. When they function as prefixes, they lose accent and concomitantly open [ɛ] alternates with closed [e] (along with a shortening of the vowel), as in (b):

(66) a. *re:*
 /*r-ε:*/
 HAB-go
 ‘go’

b. *re'kā'n*
 /*r-ε-kā'=(ā)n*/
 HAB-AND-get=3SG.F
 ‘he goes to get’

(67) a. *rē:d*
 /*r-ē:d*/
 HAB-come
 ‘come’

b. *rēd'tá:w*
 /*r-ēd-'tá:w*/
 HAB-VEN-eat
 ‘come to eat’

Another case of alternation can be observed with the suffixation of the comitative *-nē:*. When a suffix is attached to the base, the suffix is incorporated into the phonological word along with the base and accent is assigned to the final syllable of the phonological word (the syllable of the suffix). The verb base */-usε:d* thus loses its accent and concomitantly open */ε/* optionally alternates with closed [e], along with neutralization of the creaky vowel with the modal vowel.

(68) a. *ru'sε:d*
 /*r-usε:d*/
 HAB-study
 ‘study’

b. *rused'nē:* (~ *rused'nē:*)
 /*r-usε:d-nē:*/
 HAB-study-COM
 ‘study with’

On the other hand, the [ɛ] ~ [e] alternation is not observed with the suffixation of the diminutive, which also causes a shift in the position of accent. In (69), the root */bɛl:/* ‘fish’ retains its open-mid-front vowel despite the loss of accent due to the suffixation of the diminutive.

(69) a. *bɛl:*
 /*bɛl:*/
 fish
 ‘fish’

b. *bɛ'l:ε'n* (**bɛ'l:ε'n*)
 /*bɛ'l:-ε'n*/
 fish-DIM
 ‘little fish’

The difference between the comitative suffix in (68) above and the diminutive in (69) could be due to the difference in the syllable structure, as we have seen in §3. Since the comitative suffix begins with a consonant, it does not affect the syllabification of the stem syllable; if the stem syllable is closed, it remains closed,¹³ and since a vowel in a closed syllable has a shorter duration than in an open syllable (Maddieson

¹³ We only have one vowel-final stem with the comitative suffix, *r-e-nē:* ‘take’. Here, the stem in isolation is *-ε:* ‘go’ and thus undergoes raising even though this vowel is in an open syllable. However, this suffixed form is highly lexicalized and the raising of the mid-front vowel in this case could be due to this lexicalization.

1985), the mid-front vowel fails to achieve its lower target of [ɛ] due to *undershoot* (Lindblom 1990; Moon & Lindblom 1994). On the other hand, the diminutive suffix is vowel-initial, and thus if the preceding stem ends in a consonant, as in (69b),¹⁴ the syllable structure is modified and now the mid-front vowel is in an open syllable, which affords the necessary time for the mid-front vowel to be realized as the lower allophone [ɛ].

The [ɛ] ~ [e] alternation due to accent can also be observed in some compounds. In compounds, more than one root constitutes a single phonological word and all roots, except for the final one, lose accent. Concomitantly, open [ɛ] alternates with closed [e] in atonic syllables, as in the following examples. The forms in (a) justify the vowel [ɛ] in isolation.

- | | | | |
|---------|---|----|---|
| (70) a. | gɛt
/gɛt/
tortilla
'tortilla' | b. | get'gū: (~ gɛt'gū:)
/gɛt+gū:/
tortilla+?
'tamal' |
| (71) a. | rizɛ:b ^j
/ri-zɛ:b ^j /
HAB-get.hanged
'is hanged' | b. | rizeb'lq̄:z (~ rizeb'lq̄:z)
/ri-zɛ:b ^j +lq̄:z/
HAB-get.hanged+essence
'yearn' |

However, the alternation is not observed in many cases of compounds. Thus, in the following compounded forms, even though the first member of the compound loses accent, it keeps its open-mid vowel [ɛ]:

- | | |
|------|---|
| (72) | re [?] re:n
/r-ɛ [?] +re:n ⁽ⁱ⁾ /
HAB-drink+blood
'cause evil eye' |
| (73) | g ⁱ ɛ'lats
/g ⁱ ɛ+lats/
stone+field
'Ocotlán' |

Here again, the difference between the cases where the mid-front vowel undergoes alternation as in (70) and (71) on the one hand, and where it does not as in (72) and (73) on the other, could be the syllable structure: in the former case the mid-front vowel in an atonic syllable is in a closed syllable, while in the latter it is in an open syllable. Thus, we may want to generalize that the realization of the mid-front vowel as [e] is only observed in an atonic syllable when this syllable is closed. However, a closed-mid [e] is also found in an open atonic syllable, as we have already seen: the proclitics *te=* 'indefinite' and *té=* 'subordinator', and the andative prefix *e-* which comes from the verb *-e:* 'go'. Thus, even though there is a strong preference for [e] in an atonic position to occur in a closed syllable, this is not absolute.

We now return to the puzzle of the mid-front vowel neutralizing to the conditioned allophone [e], rather than [ɛ]. As we saw in the preceding subsections, open [ɛ] is the regular historical reflex of proto *e, and this fact is also reflected in the synchronic phonology. First, [ɛ] occurs in fewer restricted segmental environments than [e], which is the conditioned allophone. Secondly, [ɛ] is more common than [e] in tonic syllables, as we saw above. In an atonic position, however, the mid-front vowel is realized as [e]. Here again, the raising in an atonic position may be due to articulatory *undershoot* (Lindblom 1990; Moon & Lindblom 1994). In §3.1, we argued that the realization as [e] in a closed syllable preceded by one of the

¹⁴ When the stem is vowel-final, the diminutive suffix fuses with the stem and thus the suffixed form becomes a closed syllable. In this case, the mid-front vowel in the stem is raised to [e] since the final consonant of the diminutive suffix is underlyingly palatalized, as we saw in §4.2: *de:* 'ash', *deⁿ(ⁱ)* 'little ash'.

conditioning consonants is due to undershoot; a vowel duration is shorter in a closed syllable and thus the jaw is not opened wide enough as in an open syllable. The same line of explanation could be valid for “raising” or “tensing” in an atonic position: atonic syllables have less prominence and thus less jaw movement (Erickson & Kawahara 2016), and therefore the vowel is realized as [e].

Another alternative explanation for the raising effect in an atonic position is *contrast enhancing reduction* (Crosswhite 2001, 2004; Gordon 2011): vowels in atonic positions become more peripheral (raising in the cases of /e/ → [i] and /o/ → [u] and lowering in the cases of /e/, /o/ → [a]). This maximizes the perception of the contrast in atonic contexts, where these vowels are perceptively more vulnerable, since peripheral vowels /i/, /u/ and /a/ have special status. Thus, reduction by tensing (/e/ → [e], /o/ → [o]) is cross-linguistically more common than the change in the opposite direction (Crosswhite 2004: 14) and is exactly what happens in Teotitlán Zapotec.

5.2 Cooperation of accent and consonant height

In §3 and §4, we saw the cooperative effect between the prevocalic consonant and the syllable structure in the allophonic alternation of the mid-front vowel. Another case of the cooperative effect is found when [e] is preceded by one of the conditioning consonants and in an atonic position, especially in a closed syllable. Thus, the [e] of the deictic pronominal enclitic =*en*, the inanimate pronominal enclitic =*ēn*, or the focus enclitic =*ēn* alternates with a high-front vowel [i] after one of the conditioning consonants.

- | | | |
|------|---|--|
| (74) | a. bé:dēn
/bé:d=ēn/
Pedro=FOC
'(it is) Pedro' | b. x ^w á:nīn
/x ^w á:n ⁱ =ēn/
Juan=FOC
'(it is) Juan' |
| (75) | a. r ⁱ ā:bēn
/r-ja:b=ēn/
HAB-fall=INAN
'it falls' | b. rā:līn
/r-ā:l ⁱ =ēn/
HAB-be.born=INAN
'it is born' |

This alternation is limited to certain cases. Thus, in the following cases, the sequence of a conditioning consonant and a mid-front vowel does not yield a high front vowel in an atonic syllable of compounds (i.e., all syllables except for the last one). Here the syllable structure does not seem to be a conditioning factor, since neither is raising to [i] observed in a closed syllable, as shown in (76).

- | | |
|------|---|
| (76) | r ⁱ ēt'nē: (*ritnē:)
/r-jet-nē:/
HAB-take.down-COM
'take (it) down' |
| (77) | r ⁱ e'nē: (*rinē:)
/r-jε:-nē:/
HAB-go.to.origin-COM
'take (it) to the origin' |
| (78) | k ⁱ e'ju? ~ k ⁱ ε'ju?
/k ⁱ ε:+ju?
head+house
'roof' |
| (79) | ri ^t e's ⁱ â:
/ri- ^t εs+jâ:/
HAB-jump+above
'skip' |

6 Summary

This paper has examined the complex phonological factors conditioning the allophony of the mid-front vowel in Teotitlán Zapotec. Even though speakers are well aware of the contrast, the distribution of [e] and [ɛ] is mostly predictable, which calls into question the phonemic, contrastive status of these vowels. Open [ɛ] is the regular reflex of the Proto-Zapotec *e and the distribution of [e] is more limited than that of [ɛ]. In a tonic syllable, [e] is found before a subset of consonants ((/j/, /tʃ/, /dʒ/, /ʃ/, /z/ or palatalized consonants), represented as C_F throughout the paper, or /w/ (§2). When the mid-front vowel is preceded by one of these consonants, [e] is found when this vowel is in a closed syllable (§3). When the mid-front vowel is preceded and followed by these consonants, the vowel can be raised further to a high-front vowel [i] in certain contexts (§4). In other contexts in a tonic syllable, [ɛ] is found. In an atonic syllable, the mid-front vowel is usually realized as [e], especially in a closed syllable, and when it is also preceded by one of the conditioning consonants, it may further raise to [i] (§5). Table 6 summarizes the distribution of [e] and [ɛ], in addition to [i], according to the accent, preceding consonant, syllable structure and the features of the consonants in the coda position

Table 6: Distribution of [e] and [ɛ] (as well as [i]) in Teotitlán Zapotec

accent	Preceding C	syllable	Following C	/ɛ/
tonic	/ C _F	closed	/ C _F and /w/	[i], [e]
			/	[e]
	/elsewhere	open	/ C _F and /w/	[e]
			/ elsewhere	[ɛ]
atonic	/ C _F	any		[i], [e]
	/elsewhere	closed		[e]
		open		[e], [ɛ]

The distribution of the allophones [e] and [ɛ] in Teotitlán Zapotec is mostly predictable from phonological factors and thus their distribution is complementary, but these factors are complex, involving the features of the adjacent consonants, syllable structure and accent. It could be the case that the fact that the difference between [e] and [ɛ] is salient for the speakers, despite their complementary distribution, is attributed to these complex phonological factors; it could be the case that memorizing each morpheme with either [e] and [ɛ] specified is no less ‘economical’ than acquiring all these complex phonological factors. A cross-linguistic study of allophony of complex distributions like the one governing [e] and [ɛ] in Teotitlán Zapotec would confirm if this is the case or not.

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