言語研究（*Gengo Kenkyu*）**168**: 27–56（2025） doi: 10.11435/gengo.168.0_27

# Rising tone in Teotitlán Zapotec

【Invited Article】

Hiroto Uchihara *Tokyo University of Foreign Studies*
Ambrocio Gutiérrez Lorenzo *University of Colorado Boulder*

**Abstract:** Crosslinguistically, contour tones are known to prefer phonetically longer vowels. In Teotitlán Zapotec, however, a rising tone consistently prefers a closed syllable over an open syllable both in the distribution and alternation (*Cǎ(:)]σ). Furthermore, loanword data suggests that this is not a fossilized constraint, but rather a synchronically active constraint for Zapotec speakers. Generally a vowel is phonetically longer in an open syllable rather than a closed syllable, so that the constraint against a rising tone on an open syllable represents an 'unnatural' sound pattern. We show that such a synchronically unnatural constraint finds a natural diachronic explanation that it resulted from an accumulation of phonetically natural sound changes.*

**Key words:** Zapotec, phonology, contour tone, syllable

## 1. Introduction

Crosslinguistically, contour tones are known to prefer phonetically longer vowels (Hyman 1988; Gordon 2001; Zhang 2004).[1] According to Gordon (2001)'s impli-

* We would like to thank the speakers of Teotitlán Zapotec for sharing their language with us. We are also grateful to Michael Swanton, Sebastian van Doesburg, Shun Nakamoto, Rosemary Beam, and Josh Benn for their valuable observations on the earlier version of this paper. An earlier version of this paper was presented at *The 5th Workshop on Sound Change*, University of California, Davis, in 2019. This project has been supported by the Institute of Philological Research, National Autonomous University of Mexico; Programa de Apoyo a Proyectos de Investigación e Innovación Tecnológica (PAPIIT), IN404019, National Autonomous University of Mexico; Japan Society for the Promotion of Science Kakenhi Grant number 22K19988, 'A cross-dialectal study of Tlapanec verb morphology' and 24K03837, 'Documentation of Tlapanec varieties'.

[1] Zhang (2004) further lists coda type, accent, position and word size as other factors that contour tones prefer. First, a contour tone prefers a resonant coda (CVR) rather than an obstruent coda (CVO). Secondly, a contour tone prefers a stressed syllable over an unstressed syllable. Thirdly, a contour tone prefers a final syllable over a non-final syllable. Finally, a contour tone prefers a shorter word over a longer word. These factors do play a role in the distribution of the rising tone in Teotitlán Zapotec – for instance, a rising tone only occurs on a tonic (stressed) syllable which is the final syllable of the phonological word (§2.4), and a rising tone may be more frequent with a lenis coda than a fortis coda (§3). However, we focus on the distribution and behavior of the rising tone in the tonic (final) syllable, so that we can concentrate on the role of the syllable structure in the distri-

cational hierarchy based on a crosslinguistic survey on the constraints on contour tones (1), if a language X allows a contour tone on an open syllable with a short vowel, it should also allow for a rising tone on a closed syllable with a short vowel or a syllable (open or closed) with a long vowel. In (1), R stands for a resonant and O for an obstruent:

(1) VV(C) > VR > VO > V

In Teotitlán del Valle Zapotec, an Otomanguean language spoken in the Central Valley of Oaxaca, Mexico, the most crucial factor for determining whether or not a syllable can host a rising tone is not phonetic vowel duration, as it is in (1), but the requirement that the syllable structure be closed (*Că(:)]$_{\sigma}$). As such, in Teotitlán del Valle Zapotec, there are some uninflected forms with a rising tone on a closed syllable (*gutĭp* 'wasp'; *dămm* 'owl'; *zŭnny* 'Tlacochahuaya (town name)'; *dʒă:n* 'deity', etc.), but a rising tone on an open syllable with a long vowel is restricted to inflected forms (*nă:* 'I am'; *rą̆:* 'I get cleaned'), and a rising tone never occurs on an open syllable with a short vowel. As a consequence of this constraint, the hierarchy of syllable types based on the occurrence of a rising tone in Teotitlán Zapotec appears to be idiosyncratic and exceptional from a typological point of view. The least restricted syllable type with regard to the occurrence of a rising tone is a closed syllable with a short vowel (VC), as will be observed in certain morphophonological alternations (§5). This is followed by a closed syllable with a long vowel (VVC). A rising tone on an open syllable with a long vowel (VV) only occurs in morphologically complex forms, and a rising tone on an open syllable with a short vowel (V) is never allowed.

(2) VC > VVC > VV > V

The hierarchy in (2) represents a case of an *unnatural* sound pattern, since it does not have a synchronically demonstrable phonetic basis (Bach & Harms 1972; Hellberg 1978; Anderson 1981; Blevins 2004: Ch.8; Beguš 2018, 2020). This hierarchy is idiosyncratic in two ways: first, the dominance of VC, and secondly, the overall dichotomy between closed syllables vs. open syllables, instead of phonetic vowel duration. The overall preference for a closed syllable over an open syllable is observed not only in the distribution in the native lexicon (§3), but also in phonological and morphophonological alternations (§4, §5) and recent loanwords (§6), where its pervasiveness suggests that this constraint is not merely a residue of historical changes, but that it is synchronically active (cf. Coetzee 2014).

Unnatural processes have received considerable attention in phonological literature (Kiparsky 2008; Blevins 2004; Blust 2005; Beguš 2018, 2022), since their existence has far-reaching consequences, as it bears on open questions in phonological theory and linguistic diachrony (Beguš & Dąbkowski 2024), such as to what degree is phonology influenced by phonetics (Hayes 1999), what is the right theory of sound change and how does sound change operate (Beguš 2022), or if

bution of the rising tone.

phonological typology is primarily influenced by historical (channel bias) or cognitive (analytic bias) factors (Moreton 2008).

The rest of this paper is structured as follows. §2 gives an overview of the basic information on the phonology of Teotitlán Zapotec that will be crucial in the discussion in this paper. §3 takes a look at the distribution of the rising tone in the native lexicon, which manifests a strong dispreference for a rising tone on an open syllable. §4 looks at a phonological process, Rising Tone Levelling, and §5 two morphophonological alternations, which further demonstrate that the constraint against a rising tone on an open syllable is not only a residue of sound changes, but is synchronically active. §6 looks at the distribution of a rising tone in loans, which further supports the synchronically active status of the constraint. §7 argues that the Teotitlán Zapotec rising tone is a case of unnatural synchronic constraint, and provides a possible historical path that has led to this constraint. §8 concludes with further implications.

## 2. Language background

Central Valley Zapotec varieties (ISO 639-3: [zab]) are spoken in the Mexican state of Oaxaca and belong to the Zapotecan language family. The Zapotecan language family in turn is one branch of the Otomanguean language stock. This paper focuses on the variety spoken in the community of Teotitlán del Valle (TdV). Data from Teotitlán Zapotec comes entirely from our field notes and from the second author who is a speaker of this variety.

This section first reviews basics of the Teotitlán Zapotec consonants (§2.1), vowels (§2.2), and tones (§2.3), as well as prosodic characteristics (§2.4).

### 2.1. Teotitlán Zapotec consonants

Zapotec varieties exhibit a contrast between a lenis series of consonants (the left phoneme in each pair in Table 1) and a fortis series (right phoneme in each pair), as in other Zapotec varieties (Nellis & Hollenbach 1980, Jaeger 1983, and Avelino 2004). Exceptions are glides and loan-specific *ʃ*, which does not come in pair (Arellanes 2009: Ch.4; Chávez-Peón 2010: Ch.2; Uchihara & Pérez Báez 2016). 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 the fortis and lenis series is duration. Table 1 shows the consonant phonemes in Teotitlán Zapotec. The consonant phonemes of Teotitlán Zapotec are listed in our orthographic representation in Table 1, and the data in this paper that come from other sources are transliterated into our orthography. Some phonemes are internally complex in that they are considered singletons even though they involve more than one place of articulation (Uchihara 2021). *ʃ* only occurs in loans, thus in parentheses.

Table 1 Consonant phonemes in Teotitlán Zapotec

| | LABIAL | | DENTAL/ ALVEOLAR | | PALATO-ALVEOLAR | | PALATAL | VELAR | | LABIO-VELAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PLOSIVE | b | p | d | t | | | | g | k | gw | kw |
| NASAL | | mm | n | nn | | | | | | | |
| TAP/FLAP | | | r | rr | | | | | | | |
| FRICATIVE | | (f) | z | s | ʒ | ʃ | | | x | | |
| LATERAL | | | l | ll | | | | | | | |
| AFFRICATE | | | ʣ | ʦ | ʤ | ʧ | | | | | |
| GLIDE | | | | | | | j | | | | w |
| | | | | | | | | | | | |

## 2.2. Teotitlán Zapotec Vowels

Teotitlán Zapotec has at least five monophthongs *a*, *ɛ*, *i*, *o* and *u*, but the contrast between *o* and *u* is marginal as in many varieties (Smith-Stark 2003: 226, 229; Beam de Azcona et al. 2019). In addition, Teotitlán Zapotec has a high central vowel *ɨ*, which is marginal (Arellanes et al. 2014). Teotitlán Zapotec also has closed-mid *e* and open-mid *ɛ*, the contrastive status of which is controversial (Uchihara & Gutiérrez 2020a).

Vowel duration is mostly predictable based on the position of accent (that is, the final syllable of the phonological word; §2.4) and the consonant that follows. In tonic syllables, the vowel is usually long when followed by a lenis consonant or no consonant. The vowel is short in any atonic syllable, or in a tonic syllable when followed by a fortis consonant.[2] However, this is not always the case, since all loanwords and some native words have a long vowel even though the tonic vowel is followed by a fortis consonant (e.g. *llú:py* 'Guadalupe', *ɟú:k* 'kiss', *gá:ti* 'not yet'). For this reason, we consider vowel length in Teotitlán Zapotec to be marginally contrastive. Vowel length is represented with a colon (:).

As in other varieties of Zapotec, Teotitlán Zapotec is 'laryngeally-complex' (Silverman 1997), in that it has both tone and phonation contrasts on their vowels. Teotitlán Zapotec contrasts three phonation types: modal (*a*), and two degrees of contrastive laryngealization. The first is a weakly laryngealized vowel, represented as *a̰* in this paper, which is realized as a creaky vowel [a̰], while the other is a strongly laryngealized vowel, represented as *aˀ*, realized as a vowel followed by a full glottal closure [aʔ], often followed by a rearticulated vowel in a tonic syllable. The contrast between these phonation types is justified by a triplet contrasting only in the phonation types: *ru:* 'cough', *rṵ:* 'carry', and *ruˀ* 'mouth'.

[2] For instance, Chávez-Peón (2008) reports that a tonic syllable not followed by a fortis consonant is more than three times longer than an atonic syllable for Quiaviní Zapotec (for a female speaker, the mean duration of an unstressed syllable is 55.88 ms while that of a stressed syllable is 168.88 ms), while Chávez-Peón (2010: 61) reports that for a male speaker in Quiaviní Zapotec, the mean duration of a tonic vowel before a lenis consonant is 158.51 ms while that of a tonic vowel before a fortis consonant is 82.61 ms.

## 2.3. Teotitlán Zapotec tones

Teotitlán Zapotec has low, high, rising, mid, and falling tones. High and falling tones occur relatively infrequently and mostly in inflected forms (§5) and loanwords (§6), possibly due to their secondary origins (cf. §7.2). The conventions for transcribing tones are as follows: low (*a*), mid (*ā*), high (*á*), rising (*ǎ*), and falling (*â*).

Figure 1 shows pitch traces of the tone contrasts in Teotitlán Zapotec. As can be seen, a low tone, exemplified by *za:*[3] 'grease' is phonetically a falling tone, while a mid tone (*zā:* 'cloud') is a level tone, which starts at the same pitch level as a low tone. A rising tone (*gǎ:b* 'mind') is a mid-to-high contour tone, a high tone is a level high tone (*gá:* 'will get ripe') and a falling tone (*gâ:* 'will cut/trim') is a high-to-low tone.

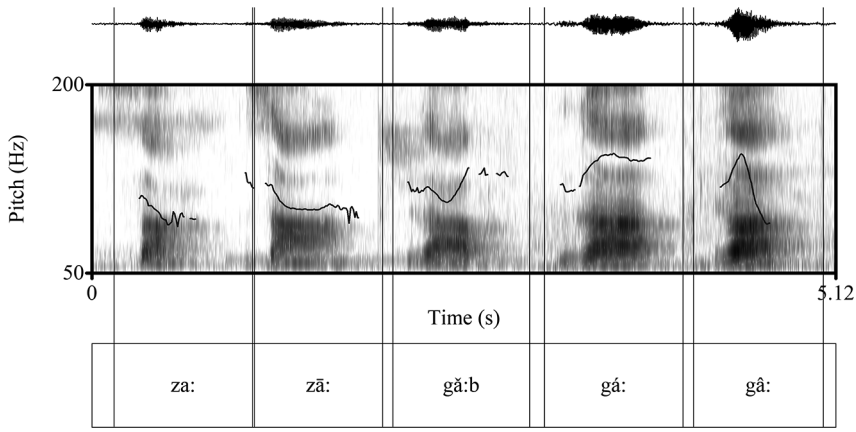



Figure 1 Pitch traces of tone contrasts in Teotitlán Zapotec

Tonal contrasts are justified by (near-)minimal pairs. The examples in (3) illustrate the contrast between low, mid, and high tones, while the triplet in (4) justifies the contrast between mid, high, and falling tones. The minimal pair in (5) also shows that the rising tone is contrastive with low tone, and the examples in (6) show that the falling tone contrasts with low tone and (7) shows that high contrasts with rising:[4]

[3] The pitch trace of this word is shorter than the rest; this is because a low tone is often realized with a breathy voice towards the end (Uchihara 2016).

[4] In the examples, the first lines represent the surface forms, and the second line with morpheme segmentation, followed by a gloss in the third line, and when necessary, free translation in the last line. Abbreviations: C = consonant; CAUS = causative; CMP = completive; COM = comitative; DIM = diminutive; HAB = habitual; Hz = hertz; IN = inclusive; INF = informal; L = low tone; M = mid tone; ms = millisecond, O = obstruent; PL = plural; PERT = pertensive; POT = potential; PROG = progressive; R = resonant; SG = singular; V= vowel; X =

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (3) | a | *za:* | b | *zā:* | c | *sá:* | |
| | | za: | | zā: | | sá: | |
| | | ‘grease’ | | ‘cloud’ | | ‘POT:walk’ | |
| (4) | a | *gā:* | b | *gá:* | c | *gâ:* | |
| | | gā: | | g-ˊa: | | Ø-ˊga: | |
| | | ‘basket’ | | ‘POT-get.ripe’ | | ‘POT-get.cut’ | |
| (5) | a | *gi:dj* | b | *gǐ:dj* | | | |
| | | gi:dj | | gǐ:dj | | | |
| | | ‘hide, leather’ | | ‘hen’ | | | |
| (6) | a | *ʤi:bj* | b | *ʤî:bj* | | | |
| | | ʤi:bj | | Ø-ˊʤi:bj | | | |
| | | ‘fear (noun)’ | | ‘POT-fear’ | | | |
| (7) | a | *gáʔ* | b | *gǎʔ* | | | |
| | | Ø-ˊgāʔ | | Ø-ˊgǎʔ | | | |
| | | ‘POT-get.trapped’ | | ‘POT-get.trapped:1SG’ | | | |

Tone is also contrastive on non-modal vowels, as can be seen in the minimal pair in (7) above. The examples in (8) show that a low, mid and falling tones contrast on a creaky vowel, while the (near-)quadruplet in (9) illustrates that a low, mid, high, and falling tones are contrastive on a glottalized vowel:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (8) | a | *ri'zɛ̰:bj* | b | *ri'zɛ̰̄:bj* | c | *ʒɻ̂:ʤ* | | |
| | | ri-zɛ̰:bj | | ri-zɛ̰̄:bj | | ʒɻ̂:ʤ | | |
| | | ‘HAB-get.hung’ | | ‘HAB-sink’ | | ‘pineapple’ | | |
| (9) | a | *ʒḭʔ* | b | *ri'ʒḭʔ* | c | *ʒḭ́ʔ* | d | *ʒḭ̂ʔ* |
| | | ʒḭʔ | | ri-ʒḭ̄ʔ | | Ø-ˊʒḭ̄ʔ | | ʒḭ̂ʔ |
| | | ‘nose’ | | ‘HAB-be.spilled’ | | ‘POT-be.spilled’ | | ‘flu’ |

The focus of this paper is on the rising tone. On a long vowel with no coda or lenis coda (*dǔ:d* ‘breast’), the rising tone manifests itself as a long rising pitch contour throughout the rhyme, as in Figure 2. On a short vowel followed by a fortis obstruent (*gu'tǐp* ‘wasp’), a rising tone is realized with an abrupt pitch rise as in Figure 3. On a short vowel followed by a fortis resonant (*dǎmm* ‘owl’), a rising tone is realized as a sequence of a mid tone on the vowel and a high tone on the fortis resonant, as in Figure 4.

any tone; W/O = without; 1 = 1st person; 2 = 2nd person; 3 = 3rd person.

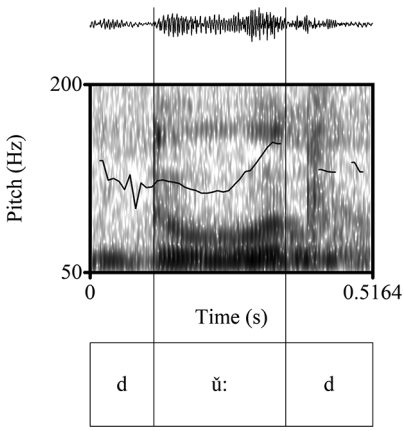



Figure 2 Pitch trace of *dŭ:d* 'breast'

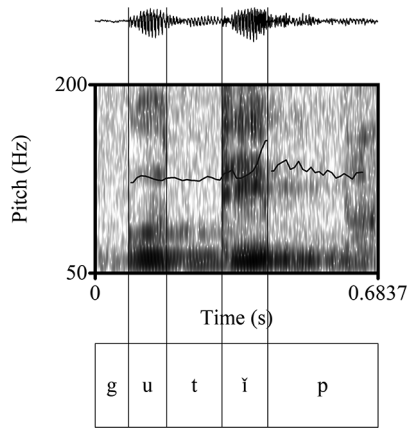



Figure 3 Pitch trace of *gu'tĭp* 'wasp'

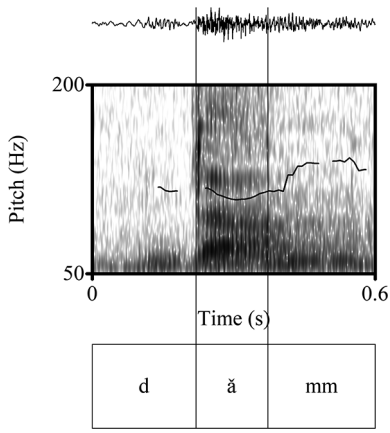



Figure 4 Pitch trace of *dămm* 'owl'

In Teotitlán Zapotec, A rising tone can only occur on a modal vowel in non-inflected forms. No non-modal vowels can carry a rising tone except in few inflected forms.[5] (10) is an example of a rising tone on a creaky vowel, and (11) on a glottalized vowel. The restrictions on the syllable types for a rising tone will be discussed throughout this paper.

[5] In (10), the mid tone on the root vowel assigns a high tone to the vowel of the enclitic, the combination of which results in a rising tone. In the 1st person forms the stems can have a rising tone as in (11), whether on a modal vowel or a non-modal vowel, due to tonal alternation, as will be discussed in §5.2.

(10) *gu'lɇ̌ː̀w*
gu-lɇ̄ː=u
CMP- CMP:take.out=2SG
'You took out'

(11) *rɛ̌ˀ*
r-ɛ̌ˀ
HAB-drink:1SG
'I drink'

## 2.4. Prosody

In Teotitlán Zapotec, a single, obligatory accent is assigned to the final syllable of a phonological word. A phonological word can consist of a monomorphemic root (12), a prefix + a root (13), or a root + a suffix, which can be diminutive (14) or comitative (15). In the following examples, phonological word boundaries are indicated with parentheses followed by ω:

(12) a (*'biː*)$_{ω}$ 'air'
b (*'juː*)$_{ω}$ 'ground'
c (*'geːj*)$_{ω}$ 'ice'

(13) a (*riˈzaː*)$_{ω}$
ri-za:
HAB-walk
'walks'
b (*guˈriː*)$_{ω}$
gu-ri:
CMP-sit.down
'sat down'
c (*káˈjaːw*)$_{ω}$
káy-a:w
PROG-eat
'is eating'

(14) a (*gúˈnɛˈn*)$_{ω}$
gûˀn-ɛˀn
bull-DIM
'little bull'
b (*gubáˈniˈn*)$_{ω}$
gubâˀny-iˀn
broom-DIM
'little broom'
c (*bitɛˈzɛˈn*)$_{ω}$
bitɛ̰:z-ɛˀn
nest-DIM
'little nest'

(15) a (*rusēdˈnɛ̄ː*)$_{ω}$
r-u-sɛ̰:d-nɛ̄:
HAB-CAUS-practice-COM
'studies with'
b (*rutāˀwˈnɛ̄ː*)$_{ω}$
r-u-taˀw-nɛ̄:
HAB-CAUS-sell-COM
'sells with'

The syllable structure of Proto-Zapotecan is (C)CV, with vowel length, nasalization, glottalization, and tonal contrasts on the vowel (Kaufman 1989: 20; 2015: 7). This syllable structure is fairly conservatively reflected in some varieties such as Chichicapan Zapotec (except for nasalization), but other varieties allow initial clusters and coda consonants due to the loss of atonic vowels, thus C(C)V(:)(C) (Uchihara 2021). The onset is obligatory except for very few native words (e.g. *iːz* 'year') and recent loanwords (e.g. *áːnn* 'Ana'). In older loans, an onset is inserted when the source form has no onset: *gúːr* 'hour (< Sp. hora ['o.ɾa])', *jáːn* 'Ana (< Sp. Ana ['a.na])'. There are a limited number of initial consonant clusters, such as sibilant + *C* clusters (*ʃtjéːʒ* 'garlic', *stúːj* 'another/once more'),[6] C + *j* clusters (*gjɛː*

[6] Many such sequences result from the pertensive prefix *ʃ-* or the multiplicative prefix *s-* + a root initial consonant.

'stone'), or a nasal + a homorganic lenis consonant (*ngâ'* 'blue', *ngi:w* 'man'). Any consonant may occur in the coda position, and coda clusters are uncommon except for a consonant + *j* sequences (*xāllj* 'twenty').

The canonical root shape of Proto-Zapotec is either disyllabic (C)VCV or monosyllabic (C)V and the canonical shape of the affixes or clitics is monosyllabic (C)V (Kaufman 2015, 2016). This is fairly stably conserved again in Chichicapan Zapotec, but most other varieties have lost the vowel of the atonic syllable (i.e. the second syllable) of disyllabic stems and therefore most roots are monosyllabic, of the shape (C)V(C). This can be illustrated by following cognate sets from Chichicapan Zapotec and Teotitlán Zapotec.[7]

| | | | Chichicapan | | Teotitlán |
|---|---|---|---|---|---|
| (16) | 'sweet potato' | a | *gu:* | b | *gu:* |
| (17) | 'squash' | a | *'ʤitu* | b | *git* |
| (18) | 'priest' | a | *bi'ʃo:za* | b | *bi'ʃu:z* |

(16) is a monosyllabic root, both in Chichicapan (a) and Teotitlán (b); (17) is a disyllabic root in Chichicapan (a) but monosyllabic in Teotitlán (b), due to the loss of the final vowel; finally, (18) is a disyllabic root with a fossilized 'animate' prefix *bi-* in Chichicapan (a) while a prefixed monosyllabic form in Teotitlán (b).

## 3. Distribution of the rising tone in native lexicon

The preference of a rising tone for a closed syllable can first be observed in the lexical distribution of the rising tone in the native lexicon. This is manifested as an absolute absence of such a form in non-inflected words (*Că(:)]$_{\sigma}$) in Teotitlán Zapotec. That is, in non-inflected forms of nouns or verbs, rising tones are not found in open syllables. Below is an exhaustive list from our database of non-inflected forms of native nouns in Teotitlán Zapotec. Note that native words with a rising tone in non-inflected forms occur infrequently in Teotitlán Zapotec due to a historical reason to be discussed in §7.2.2:

(19) Fortis obstruents
*nis'kǐʃ* 'urine'; *kǐʃ* 'bladder'; *bĕts* 'buzzard'; *bi'gĭʧ* 'fly'; *gu'tĭp* 'wasp';

(20) Lenis obstruents
*ʃi'gă:b* 'thought'; *dŭ:d* 'breast'; *djă:g* 'hare'; *gĭ:dj* 'hen'; *ʒĭ:g* 'black wasp'; *ʒŭ:b* 'corn'; *bĕ:z* 'toad'

(21) Fortis resonants
*dămm* 'owl'; *ga'rŭll* 'half'; *gwĕll* 'youngest son'; *zŭnnj* 'Tlacochahuaya'

(22) Lenis resonants
*bi'ʤĭ:jn* 'deer'; *bi'ʃjŏ:n* 'coral snake'; *ʤă:n* 'deity'; *kŭ:l* 'grandfather'; *mmă:jn* 'animal'

(23) Glides
*bĕ:w* 'coyote'; *gu'ră:gw* 'lizard'; *kwĭ:w* 'huitlacoche'; *lă:j* 'middle'; *ʃkă:j* 'grey

[7] The Chichicapan data comes from Smith-Stark (2002, 2003, 2007).

cloud'

(24) No coda
none

Table 2 summarizes the distribution of a rising tone in the tonic position of non-inflected native nouns in Teotitlán Zapotec with respect to the overall distribution of the coda types (present vs. absent, manner of articulation, and lenis vs. fortis) in all (synchronically monomorphemic) native nouns in Teotitlán Zapotec. Here, what is striking is the total absence of a rising tone in open syllables, even though the open syllable in general occurs quite frequently (28% of all native nouns).

Table 2 Distribution of a rising tone in non-inflected nouns in Teotitlán Zapotec

| Coda | | tokens of all native nouns | tokens of native nouns with a rising tone | observed/ expected ratio |
|---|---|---|---|---|
| Obstruents | fortis | 52 (16%) | 5 (19%) | 1.19 |
| | lenis | 79 (24%) | 7 (27%) | 1.13 |
| Resonants | fortis | 20 (6%) | 4 (15%) | 2.50 |
| | lenis | 59 (18%) | 5 (19%) | 1.06 |
| Glides | | 29 (9%) | 5 (19%) | 2.11 |
| No coda | | 93 (28%) | 0 (0%) | 0.00 |
| Total | | 332 | 26 | |

A rising tone in an open syllable with a long vowel is attested only on inflected forms, such as noun or verb stems in their 1SG forms:

(25) *nă:*
nā=a
COPULA=1SG
'I am'

(26) *r̰ă:*
r-ā̰:=a
HAB-wipe=1SG
'I get cleaned'

(27) *nj̰ă:*
*nj̰ă:*
hand:1SG
'my hand'

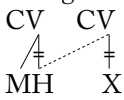
In Teotitlán Zapotec, an open syllable with a short vowel is only found in an atonic syllable, such as a prefix or a clitic. A rising tone is never found in such syllables in Teotitlán Zapotec.

## 4. Rising Tone Levelling

Rising Tone Levelling is a tonal process that applies when a vowel-initial morpheme follows a stem with a rising tone. In such cases a rising tone is split into a

mid tone on one syllable and a high tone on the next syllable, which has an underlying low or mid tone:

(28) Rising Tone Levelling




The following examples illustrate Rising Tone Levelling. The forms in (a) are without a following morpheme and have a rising tone. The forms in (b), on the other hand, have a vowel initial morpheme after the stems, and thus Rising Tone Levelling is applied. Note that Rising Tone Levelling is observed not only when the coda consonant is lenis as in (29)–(31) but also when it is fortis as in (32):

| | | | | |
|---|---|---|---|---|
| (29) | a | *ri'gǐ:b*[8] | b | *ri'gī:bú* |
| | | ri-gǐ:b | | ri-gǐ:b=u |
| | | HAB-sew | | HAB-sew=2SG |
| | | 'sew' | | 'you sew' |
| (30) | a | *ʒǎ:n* | b | *'ʒā:nú* |
| | | ʒǎ:n | | ʒǎ:n=u |
| | | PERT:mother | | PERT:mother=2SG |
| | | 'mother' | | 'your mother' |
| (31) | a | *ʃkǔ:l* | b | *'ʃkū:lán* |
| | | ʃ-kǔ:l | | ʃ-kǔ:l=an |
| | | PERT-grandfather | | PERT-grandfather=3SG.INF |
| | | 'grandfather' | | 'his grandfather' |
| (32) | a | *ri'ʃěkj* | b | *ri'ʃēkjú* |
| | | ri-ʃěkj | | ri-ʃěkj=u |
| | | HAB-untie | | HAB-untie=2SG.INF |
| | | 'unties' | | 'you untie' |

Rising Tone Levelling is motivated by the avoidance of a rising tone in an open syllable. When a vowel-initial morpheme follows a closed syllable with a rising tone, that closed syllable now becomes open since the coda consonant is parsed as the onset in the following syllable.[9] That Rising Tone Levelling is motivated by avoidance of a rising tone on an open syllable is confirmed by the fact that when the following morpheme begins with a consonant, Rising Tone Levelling does not

[8] The bare forms without the pronominal enclitics can be obtained when a full noun phrase accompanies the verb as the argument (such as 'María sews').

[9] Coda fortis resonants have been considered ambisyllabic when a vowel initial morpheme is added (Chávez-Peón 2015). However, in this paper, we argue that both lenis and fortis consonants are parsed as the onset of the following syllable. The only reason a fortis consonant has to be considered ambisyllabic is to assure that the vowel does not get lengthened when a vowel-initial morpheme follows. However, if one considers that the vowel length is marginally contrastive, as we argue here (§2.2), there is no motivation to stipulate that fortis consonants are ambisyllabic.

apply since the syllable with a rising tone remains closed:

| (33) | a | *ʒŭ:b* | b | *ˈʃŭ:b.tū* (**ʃū:b.tú*) |
|---|---|---|---|---|
| | | ʒŭ:b | | ʃ-ʒŭ:b=tū |
| | | corn | | PERT-corn=2PL.INF |
| | | ‘corn’ | | ‘your (PL) corn’ |

Rising Tone Levelling is a further support for the constraint *Că(:)]$_{\sigma}$, and shows that this constraint is not merely a static distributional tendency, but also a synchronically active constraint that motivates alternations in Zapotec grammar.

## 5. Morphophonological alternations

So far, we have seen that the constraint against a rising tone on an open syllable is operative in the native lexicon (§3) and is a motivation of a phonological process (§4). The pervasiveness of this constraint in Teotitlán Zapotec is also evident in two morphophonological alternations that involve a tonal component: potential aspect inflection (§5.1) and 1st person inflection (§5.2). In these forms, a rising tone is generally preferred when the coda is fortis (and thus the preceding vowel is short) and not when there is no coda or when the coda is lenis (and thus the vowel is long). This is contrary to the universal implicational hierarchy, in which vowels that are part of open syllables and long are the most likely bearers of rising tone. In this section, we will focus on Teotitlán Zapotec.

### 5.1. Tone change in the potential aspect

Depending on verb class, potential forms are encoded by a segmental prefix *g-*, a consonant mutation, or no segmental prefix. In each case, there is an accompanying tone change. The Zapotecan verb classes are conjugation classes based on the allomorphy of the habitual, completive, and potential prefixes (cf. Smith-Stark 2002, Beam de Azcona 2004; 2009; 2019; Campbell 2011, Pérez Báez & Kaufman 2016). The tone of the potential aspect form depends on the following factors: the phonation type and lexical tone of the root, whether the root is vowel-initial or consonant-initial, and verb class. Here, we concentrate on cases where the root vowel is modal, since a rising tone is never observed on non-modal vowels in potential forms.

When the root vowel has a low tone, the tone of the potential form is conditioned by the nature of the coda consonant: when the coda is fortis, the lexical low tone alternates with a rising tone (unless the verb has a voice prefix, in which case the low tone alternates with a falling tone), when the verb belongs to the class A, C, or D (and not class B). This is observed in (34)–(37). When the verb belongs to the class B, the root syllable is not assigned a rising tone even when the coda consonant is fortis, and is instead assigned a falling tone, as in (38). When the coda is absent or lenis, the tone of the potential forms is never a rising tone, but rather is either high or falling, depending on whether the root is vowel-initial or conso-

nant-initial and also on the verb class, as can be seen in (39)–(44).[10] The examples in (39) and (40) show verb roots with an open syllable, and those in (41)–(44) show verb roots with a lenis coda:

| | | HABITUAL | | POTENTIAL |
|---|---|---|---|---|
| (34) | a | *r-ak* 'happen' | b | *g-ǎk* 'will happen' (class C) |
| (35) | a | *ri-'git* 'play' | b | *kǐt* 'will play' (class D) |
| (36) | a | *ri-'ʈɛs* 'jump over' | b | *těs* 'will jump over' (class C) |
| (37) | a | *r-ull* 'sing' | b | *g-ŭll* 'will sing' (class A) |
| (38) | a | *ri-'bif* 'turn around' | b | *bîf* 'will turn around' (class B) |
| (39) | a | *ri-'ʤa:* 'get filled' | b | *ʧá:* 'will get filled' (class C) |
| (40) | a | *ri-'ga:* 'get trimmed' | b | *gâ:* 'will get trimmed' (class A) |
| (41) | a | *ri-'ʤi:by* 'get frightened' | b | *ʤî:by* 'will get frightened' (class A) |
| (42) | a | *ri-'be:ʤ* 'call out loud' | b | *kwé:ʤ* 'will call out loud' (class D) |
| (43) | a | *ri-'lu:ʒ* 'get finished' | b | *llú:ʒ* 'will get finished' (class C) |
| (44) | a | *r-u:jn* 'do' | b | *g-ú:jn* 'will do' (class A) |

The morphological alternations shown in this data illustrate a synchronic preference for the rising tone to occur on short vowels that precede a fortis consonant, since it is not found at all in potential forms with a long vowel, whether the coda is lenis or absent.

### 5.2. Tone ablaut in the 1st person forms

Teotitlán Zapotec exhibits a stem alternation in 1st person forms with agentive verbs (Uchihara & Gutiérrez 2020b). These 1st person stem alternations can take the form of a tone alternation, a phonation alternation, a prefix alternation, or suppletion, and a tonal alternation nearly always accompanies the other types of alternations. 1SG and 1PL forms undergo the same tonal alternation, so we will only discuss the 1SG forms here.

In 1SG forms, the nature of the tone alternation depends on the phonation type and the lexical tone of the stem, as well as the coda type. Here, we will only focus on the cases where the stem has a modal vowel with a lexical low tone, since they are the only cases where a rising tone can be observed in the 1SG forms. A modal vowel with a low tone in the verb stem alternates with a high tone when there is no coda ((45), (46)) or when the coda is lenis ((47), (48)), but it alternates with a rising tone when the coda is fortis ((49), (50)). When eliciting 1SG forms, speakers usually provide the forms with the 1SG enclitic *=a*, which can provoke various productive phonological processes, such as Rising Tone Levelling (cf. §4) that can obscure the underlying tone. However, in the Covert Subject Construction (Butler 1976; Beam de Azcona 2004: 335–339), where a subject noun phrase is deleted

[10] A falling tone is found when the root is consonant-initial and belongs to class A or B (where historically the potential prefix is *ki-; Kaufman 1989), while a high tone is found when the root is vowel-initial or when the root is consonant-initial and belongs to class C or D (where historically the potential prefix is *k-; Kaufman 1989).

when it is coreferential with a possessor NP somewhere else in the clause, the 1sg enclitic is omitted, making it possible to observe the underlying tones. Forms that appear in the Covert Subject Construction are provided in column (c) below.

| | | No person | | 1sg with enclitic | | 1sg w/o enclitic |
|---|---|---|---|---|---|---|
| (45) | a | *r-u-'zu:* 'plant' | b | *r-u-'zwa̰:* 'I plant' | c | *r-u-'zú:* |
| (46) | a | *r-u-'gwa:* 'trim' | b | *r-u-'gwa̰:* 'I trim (it)' | c | *r-u-'gwá:* |
| (47) | a | *ri-'gi:ʒ* 'pay' | b | *ri-'gḭ:ʒ=a* 'I pay' | c | *ri-'gí:ʒ* |
| (48) | a | *ri-'be:ʤ* 'call out loud' | b | *ri-'bḛ:ʤ=a* 'I call out loud' | c | *ri-'bé:ʤ* |
| (49) | a | *ri-'giʃ* 'lay (it) down' | b | *ri-'gḭʃ=á* 'I lay (it) down' | c | *ri-'gǐʃ* |
| (50) | a | *r-ɛpj* 'go up' | b | *'r-ɛ̄pj=á* 'I go up' | c | *r-ɛ̄pj* |

These data show that in the 1st person forms, a low tone on the stem alternates with a rising tone only when the coda consonant is fortis and the preceding vowel is short (cf. §2.1); a high tone is assigned when the coda is absent or lenis and the preceding vowel is long. This is the same pattern observed in the potential verb forms (§5.1).

## 6. Loanwords

The distribution of a rising tone observed in the native lexicon in §3 is also observed in loanwords: a rising tone can only occur on a closed syllable, regardless of vowel length (all loans in Teotitlán Zapotec have a long vowel regardless of the coda type). The patterns that emerge in loanword adaptation can reveal aspects of native speakers' knowledge (Hyman 1970; Holden 1976; Kang 2011). In this case, the overall ban of a rising tone on an open syllable in recent loans reflects the synchronic active status of the constraint against a rising tone on an open syllable, *Că(:)]$_{\sigma}$.

In Teotitlán Zapotec, most recent Spanish loans have a high or rising tone, whereby a rising tone regularly occurs if the stress in the donor word is on a closed penultimate syllable, and a high tone occurs elsewhere, regardless of the syllabic structure of the adapted Zapotec forms. This tendency is motivated not only by avoidance of a rising tone on an open syllable in the adapted forms in Zapotec after modification of the original Spanish forms to a canonical word structure in Teotitlán Zapotec, (CV-)'CV(C) (cf. §2.4), but also by avoidance of a rising tone in an open syllable in *the original Spanish forms*.

In this section, the factors which condition the assignment of a rising tone in a loanword will be examined in detail: the chronology of borrowing (§6.1), whether the position of the stressed syllable in the original Spanish forms is non-final (§6.2) or final (§6.3), and whether the original stressed syllable is open or closed.

### 6.1. Chronology of borrowing

In Teotitlán Zapotec, the chronology of loans plays a crucial role in determining the tones of loans: new loans appear to obey more strictly the constraint *Că(:)]$_{\sigma}$ than old loans. This could be because this constraint has become stronger in the historical development of the loans.

The chronology of borrowing can be inferred both from semantics and phonology of a given loan. Semantically, old loans may come from obsolete forms that are no longer in use in modern Mexican Spanish. Such examples include *mĕ:dj* 'money', from Spanish *medio* (Smith-Stark 2007: 25), which is no longer used for currency; *tu'bjă:rmm* 'pint', which comes from a combination of *tu:bj* 'one' + Spanish *arroba*,[11] which is a historical Spanish weight measure now out of use in Mexico. Phonologically, the antiquity of loans is reflected in the reflexes of sibilants, in the sound represented by the Spanish orthographic *j*, and in the adaptation of voiced and voiceless plosives of Spanish into Zapotec (Smith-Stark 2007; Operstein 2016). The following paragraphs describe each of these cases in detail.

First, in the 15th century Spanish (as described in Nebrija 1492), orthographic *s* represented apicoalveolar fricatives [s̻] or [z̻]; thus, we can deduce that Zapotec loans which have *ʃ* or *ʒ* corresponding to Spanish *s* ([s] in modern Mexican Spanish) should be older loans (Smith-Stark 2007: 20–22). The following Teotitlán Zapotec loans are old since they have *ʒ* or *ʃ* corresponding to Spanish orthographic *s*: *guʒ'tĭ:sj* 'justice (< Sp. justicia)'; *ga'mmĭ:ʒ* 'blouse (< Sp. camisa)'; *mmĕ:ʒ* 'table (< Sp. mesa)'; *ʒĭ:lj* 'mount (horse) (< Sp. silla)'; *bé:ʒ* 'peso (of currency)'; *ʃtjé:ʒ* 'garlic (< *ʒetj* 'onion' + Sp. ajo)'; *ʃkwí:lj* 'school (< Sp. escuela)'; *ʃmmá:n* 'week (< Sp. semana)'; *ʃndá:n* 'Santa Ana del Valle (town name)'.

Secondly, in the 15th century Spanish, the orthographic *j* ([x] in modern Mexican Spanish) represented postalveolar fricatives [ʃ] or [ʒ] (Smith-Stark 2007: 22; Operstein 2016: 222), and thus those Zapotec loans containing *ʃ* or *ʒ* corresponding to Spanish orthographic *j* should be old loans: *ʒwă:n* 'Juana'; *ʃtjé:ʒ* 'garlic (< Sp. ajo)'; *nna'rá:ʒ* 'orange (< Sp. naranja)'.

Thirdly, both Spanish voiced and voiceless plosives were adapted as lenis consonants in early loans (Kaufman 1989:18; Smith-Stark 2007: 27ff.; Operstein 2016: 219ff., 224ff.); this is because the fortis-lenis contrast in earlier Zapotec was that of singleton vs. geminate, while in most current Zapotec varieties the contrast also accompanies difference in voicing (cf. §2.1). Loans with such characteristics are: *guʒ'tĭ:sj* 'justice (< Sp. justicia)'; *zĭ:k* 'Francisca (< Sp. Chica?)'; *ga'mmĭ:ʒ* 'blouse (< Sp. camisa)', *ʒĭt* 'cat (Wanderwort,[12] < Sp. chito)'; *bă:j* 'scarf, shawl (< Sp. paño)'; *djĕ:nd* 'store (< Sp. tienda)'; *bá:g* 'cow (< Sp. vaca)'; *plă:d* 'plate (< Sp. plato)'; *bé:ʒ* 'peso'; *bé:d* 'Peter (< Sp. Pedro)'; *sa'bá:d* 'shoe (< Sp. zapato)'; *gu'ʧí:l* 'knife (< Sp. cuchillo)'; *ndú:jn* 'Anthony (< Sp. Antonio)'; *ʃndá:n* 'Santa Ana del Valle'.

The following subsections first show that when the original tonic syllable is non-final, recent loans tend to have a rising tone when their tonic syllable is closed, and a high tone when their tonic syllable is open (§6.2). When the original tonic syllable is final, loans tend to have a high tone regardless of syllable type (§6.3).

[11] Etymology suggested by Michael Swanton.

[12] A *Wanderwort* is a loanword which is spread to many languages but whose origin is unknown (Haynie et al. 2014). Wherever possible, likely source languages and etymological forms are provided for reference.

### 6.2. Original tonic syllable non-final

#### 6.2.1. Original tonic non-final syllable closed

When the original non-final tonic syllable is closed, loans tend to have a rising tone, regardless of the chronology of their borrowing. This is evident from the following sets of data. In the examples in (51), it may appear that the conditioning factor is whether the receptor language (Zapotec) has a complex coda or not, rather than the syllable structure of the source language, but as we will see below in the examples (53), this is not the case. New loans are presented first in (a), followed by old loans in (b). Loans were judged to be old when they satisfy the criteria in §6.1 or when they undergo unusual changes not observed in recent loans, such as the adaptation of *r* as *ʃ* in *ʃsó:n* 'reason' or the loss of *n* in *pá:* 'bread'.

(51) Original tonic syllable closed (non-final): rising tone in Zapotec

a. new *du'ră:zn* 'peach (< Sp. durazno [du.ˈɾaz.no])'; *bŭ:lls* 'bag (< Sp. bolsa ['bol.sa])'; *jwĕ:rs* 'effort (< Sp. esfuerzo [es.ˈfweɾ.so])'; *kre'sĕ:nsj* '< Sp. Crescencio [kre.ˈsen.sjo]'; *kă:nʧ* 'court (< Sp. cancha ['kaŋ.ʧa])'; *pă:nʧ* 'Francisco (< Sp. Pancho ['pan.ʧo])'; *pri'stĕ:nt* 'president (< Sp. president [pɾe.si.ˈðen.te])'; *bŭ:lt* 'bundle (< Sp. bulto ['bul.to])'; *kwă:rt* 'quarter (< Sp. cuarto ['kwaɾ.to])'; *pă:rk* 'park (< Sp. parque ['paɾ.ke])'; *pwĕ:rt* 'door (< Sp. puerta [pweɾ.ta])'; *rră:nʧ* 'Benito Juarez, Oaxaca (< Sp. rancho ['raŋ.ʧo])'; *de'lă:nt* 'ahead (< Sp. Adelante [a.de.ˈlan.te])'; *kwê:nt* 'story (< Sp. cuento ['kwen.to])'; *kwa'dĕ:rn* 'notebook (< Sp. cuaderno [kwa.ˈðeɾ.no])'; *ʃtrŏ:mm* 'top (toy) (< Sp. trompo ['trom.po])';

b. old *ʃtă:d* 'dad (Wanderwort, *ʃ-* PERT + cf. Nahua *tah-tli*)'; *nă:n* 'miss (Wanderwort, cf. Nahua *nān-tli* 'mother'[13])'; *ʒă:n* 'mother (< *ʒ-* PERT + Nahua *nān-tli* 'mother')'; *ʒmmĭ:ngw* 'Santo Domingo Díaz Órdaz (< Sp. Santo Domingo [san.to.ðo.ˈmiŋ.go])'; *djĕ:nd* 'store (< Sp. tienda ['tjen.da])'

Loans with a high tone and a non-final closed tonic syllable in the original forms are minority:

(52) Original tonic syllable closed (non-final): high tone in Zapotec

a. new *rro'bá:ns* 'chickpea (< Sp. garbanzo [gaɾ.ˈβan.so])'; *mmá:ngw* '< Sp. mango ['maŋ.go]'; *mmwé:s* 'teacher (< Sp. maes.tro [ma.ˈes.tɾo] ~ ['majs.tɾo])'

b. old *nna'rá:ʒ* 'orange (< Sp. naranja [na.ˈɾaŋ.xa])'

In sum, out of 25 new loans with original non-final closed tonic syllable, 21 forms (84%) have a rising tone while only 4 forms (16%) have a high tone.

#### 6.2.2. Original tonic non-final syllable open

When the original tonic syllable is open, the majority of loans, whether new or old, tend to have a high tone, as seen in the examples below.

[13] Nahua forms come from Karttunen (1983).

(53) Original tonic syllable open (non-final): high tone in Zapotec

a. new *ʧí:kl* 'chewing gum (< Sp. chicle ['ʧi.kle] or Nahua *tzic-tli*)'; *llí:tr* 'litter (< Sp. litro ['li.tro])'; *mmé:tr* 'meter (< Sp. metro ['me.tro])'; *swé:tr* 'sweater (< Sp. suéter ['swe.ter])'; *llí:br* 'book (< Sp. libro ['li.βro])'; *pwé:bl* 'Puebla (state) (< Sp. puebla ['pwe.βla])'; *ʃ-ta'swé:gr*[14] 'PERT-father-in-law (< Sp. suegro (de) ['swe.ɣro])'; *sá:bd* 'Saturday (< Sp. sábado ['sa.βa.ðo])'; *a'rró:s* 'rice (< Sp. arroz [a.'ros])'; *ké:s* 'cheese (< Sp. queso ['ke.so])'; *múm:s* 'worker (< Sp. mozo ['mo.so])'; *pí:s* 'floor (< Sp. piso ['pi.so])'; *pré:s* 'dam (< Sp. presa ['pre.sa])'; *bá:s* 'glass (< Sp. vaso ['ba.so])'; *bó:t* 'jar (< Sp. bote ['bo.te])'; *bó:ʧ*[15] 'Ambrocio (< Sp. Bocho ['bo.ʧo])'; *frú:t* 'fruit (< Sp. fruta ['fru.ta])'; *kwé:t* 'fireworks (Sp. cuete, cohete ['kwe.te])'; *llá:pj* 'pencil (< Sp. lápiz ['la.pis])'; *llé:ʧ* 'milk (< Sp. leche ['le.ʧe])'; *llí:ʧ* 'Felicitas (< Sp. Felícitas, Licha ['li.ʧa])'; *llú:pj* 'Guadalupe (< Sp. Lupe ['lu.pe])'; *pa'ní:t* 'handkerchief (< Sp. pañuelo [pa.ɲwe.lo])'; *pe'ló:t* 'ball (< Sp. pelota [pe.'lo.ta])'; *sé:tj* 'oil (< Sp. aceite [a.'sej.te])'; *ʧí:kw* 'Francisco (< Sp. Chico ['ʧi.ko])'; *gló:b* 'balloon (< Sp. globo ['glo.βo])'; *xú:g* 'juice (< Sp. jugo ['xu.ɣo])'; *kwé:b* 'cave (< Sp. cueva ['kwe.βa])'; *mma'ndá:d* 'chore (< Sp. mandado [man.'da.ðo])'; *rrá:dj* 'radio (< Sp. radio ['ra.ðjo])'; *ʃmmí:gw* 'friend of (< *ʃ-* PERT + Sp. amigo [a.'mi.ɣo])'; *bú:rr* 'donkey (< Sp. burro ['bu.ro])'; *gó:rr* 'cap (< Sp. gorra ['go.ra])'; *xé:nnj* 'Genaro (< Sp. ['xe.no])'; *sí:nn* 'cinema (< Sp. cine ['si.ne])' ; *ʧa'mmá:rr* 'jacket (< Sp. chamarra [ʧa.'ma.ra])'; *bjá:n* 'Vivian (< Sp. Viviana [bi.'βja.na])'; *gá:n* 'wish (< Sp. gana ['ga.na])' *kar'té:r* 'wallet (< Sp. cartera [kaɾ.'te.ra])'; *mmá:rj* 'Mario (< Sp. Mario ['ma.rjo])'; *mma'nsá:n* 'apple (< Sp. manzana [man.'sa.na])'; *mmo'ʧí:ll* 'backpack (< Sp. mochila [mo.'ʧi.la])'; *mú:llj* 'mole (< Nahua *mōl-li* or Sp. mole ['mo.le])'; *pé:r* 'pear (Sp. pera ['pe.ɾa])'; *plú:mm* 'pen (< Sp. pluma ['plu.ma])'; *se'prí:n* 'Zeferino (< Sp. Zeferino [se.fe.'ɾi.no])'; *kommputa'dó:r* 'computer (< Sp. computadora [kom.pu.ta.'ðo.ɾa])'; *mmanda'rí:n* 'mandarin orange (< Sp. mandarína [man.da.ɾi.na])'; *sekun'dá:rj* 'secondary school (< Sp. secundaria [se.kun.'da.ɾja])'; *mmu'sé:w* 'museum (< Sp. museo [mu.'se.o])'; *mma'rjé:* 'Mary (< Sp. María [ma.'ɾi.a])'.

b. old *bá:g* 'cow (< Sp. vaca ['ba.ka])'; *bé:ʒ* 'peso (< Sp. peso ['pe.so])'; *ʃtjé:ʒ* 'garlic (< Sp. ajo ['a.jo])'; *bé:d* 'Peter (< Sp. Pedro ['pe.ðro])'; *sa'bá:d* 'shoe (< Sp. zapato [sa.'pa.to])'; *gu'ʧí:l* 'knife (< Sp. cuchillo [ku.'ʧi.jo])'; *ndú:jn* 'Anthony (< Sp. Antonio [an.'to.njo])'; *ʃkwí:ly* 'school (< Sp. escuela [es.'kwe.la])'; *ʃmmá:n* 'week (< Sp. semana [se.'ma.na])'; *ʃndá:n* 'Santa Ana del Valle (< Sp. Sant(a) Ana [san.'ta.na])'; *mbá:lj* 'compadre (Wanderwort, < Nahua < Sp. compadre)'; *mmá:lj* 'comadre (Wanderwort, < Nahua < Sp. comadre)'; *ljé:j* 'lock (< Sp. llave ['ja.βe])'; *ljé:* 'Mary (< Sp. María [ma.'ɾi.a])'; *ʒndjé:* 'watermelon (< Sp. sandía [san.'di.a])'; *já:n ~ á:nn* 'Ana (<

[14] The first element *ta-* may come from Nahua *tah-tli* 'father'.

[15] A variant form is *mbŏ:ʧ* with a rising tone.

Sp. Ana ['a.na])'; *(g)ú:r* 'hour (< Sp. hora ['o.ɾa])';

In the following examples, the original forms have an open non-final tonic syllable, yet have a rising tone in Teotitlán Zapotec. As seen in (54), the majority of these are old loans (12 out of 19 forms), though some recent loans also have this pattern.

(54) Original tonic syllable open (non-final): rising tone in Zapotec

a. new *mmě:xjkw* 'Mexico (< Sp. México ['me.xi.ko])'; *bǐ:sj* 'bicycle (< Sp. bici ['bi.si])'; *kŏ:k* 'coconut, Coke (< Sp. coco ['ko.ko], Coka ['ko.ka])'; *kŭ:ʧ* 'pork (< Sp. cuche ['ku.ʧe])'; *rǐ:kw* 'Frederick (< Sp. Federico [fe.ðe.'ɾi.ko])'; *ʧa'lê:kw* 'vest (< Sp. chaleco [ʧa.'le.ko])'; *ʤǐ:b* 'goat (< Sp. chivo ['ʧi.βo])' ; *sŏ:p* 'soup (< Sp. sopa ['so.pa])'

b. old *guʒ'tǐ:sj* 'justice (< Sp. justicia [xus.'ti.sja])'; *plă:d* 'plate (< Sp. plato ['pla.to])'; *zǐ:k* 'Francisca (< Sp. Chica ['ʧi.ka])'; *ga'mmǐ:ʒ* 'blouse (< Sp. camisa [ka.'mi.sa])'; *mmě:ʒ* 'table (< Sp. mesa ['me.sa])'; *ʒwă:n* 'Juana (< Sp. Juana ['xwa.na])' ; *ʒǐ:lj* 'mount (of horse) (< Sp. silla ['si.ja])'; *bă:j* 'shawl (< Sp. paño ['pa.ɲo])'; *mmămm* 'horseback (< Nahua *māma-* 'carry')'; *mě:dj* 'money (< Sp. medio ['me.djo])'; *tu'bjă:rmm* 'pint (< *tubj* 'one' + Sp. arroba [a.'ro.βa])'; *kwă:ʧ* 'twin (< Nahua *cōā-tl* 'snake, twin')'; *ʒǐt* 'cat (Wanderwort, < Sp. chito ['ʧi.to])'[16]

In sum, out of all the 89 forms in which the original Spanish has an open non-final tonic syllable, 68 (76%) have a high tone while 21 (24%) have a rising tone, 13 of which are old loans.

### 6.2.3. Original tonic non-final syllable: summary

The following table summarizes the findings in this subsection so far. When the original (non-final) tonic syllable is closed (in the left columns), a rising tone is more frequent (84%), and this tendency is equally strong with new loans (84%) and old loans (83%). On the other hand, when the original non-final tonic syllable is open (in the right columns), a high tone is more frequent (79%), though this tendency is stronger with new loans (88%) than with old loans (60%), where rising tone is observed in 40% of such loans.

Table 3 Distribution of tone in loanwords where the original tonic syllable is non-final

| original tonic syllable | closed | | | open | | |
|---|---|---|---|---|---|---|
| chronology of borrowing | new & old combined | new | old | new & old combined | new | old |
| Rising | 21 (84%) | 16 (84%) | 5 (83%) | 21 (24%) | 8 (14%) | 13 (40%) |
| High | 4 (16%) | 3 (16%) | 1 (17%) | 68 (76%) | 51 (86%) | 17 (60%) |
| Falling | 0 | 0 | 0 | 0 | 0 | 0 |
| total | 25 | 19 | 6 | 89 | 59 | 30 |

[16] Etymology suggested by Sebastian van Doesburg.

### 6.3. Original tonic syllable final

When the original Spanish tonic syllable is final, a rising tone is never encountered in the adapted forms in Zapotec. (55) presents loans where the original tonic syllable is open, while the examples in (56) have a closed original tonic syllable. In both cases, either a high tone (b) or a falling tone (c) is found, and the factor conditioning which of those two tones is assigned is yet unknown. In the following forms, old loans are indicated with an asterisk.

(55) Original tonic syllable open (final)
a. R none
b. H *ka'fé:* 'coffee (< Sp. café [ka.'fe])'; *té:* 'tea (< Sp. té ['te])'.
c. HF none

(56) Original tonic syllable closed (final)
a. R none
b. H *kamm'pyú:jn* 'cemetery (< Sp. campo santo)'; *ka'mmjú:n* 'car (< Sp. camion [ka.'mjon])'; *kan'sjó:n* 'song (< Sp. cancion [kan.'sjon])'; *ko'ló:r* 'color (< Sp. color [ko.'lor])'; *mma'ská:lj* '< Sp. mezcal [mes.'kal]'; *né:lj* '< Sp. Manuel [ma.'nwel]'; *pan'tlú:n* 'pants (< Sp. pantalón [pan.ta.'lon])'; *sellu'llá:r* 'celular (phone) (< Sp. celular [se.lu.'lar])'; **ʃsó:n* 'reason (< Sp. razón [ra.'son])'; *xwá:jn* 'John (< Sp. Juan ['xwan])'; **pá:* 'bread (< Sp. pan ['pan])'; *ʧú:k* 'kiss (< Mixe?[17])'
c. HF *trâ:lj* 'loom (< Sp. telar [te.'lar])'; **gu'râ:lj* 'fence (< Sp. corral [ko.'ral])'; **ʃmmi'gê:lj* 'San Miguel del Valle (< Sp. San Miguel [sa(m).mi.'gel])'

### 6.4. Summary

In this section, we have seen that the tone on loanwords is conditioned by the position of the tonic syllable in the original forms, whether this syllable is closed or not, and the chronology of borrowing. It was shown that when the original tonic syllable is non-final, the adapted forms in Zapotec tend to have a high tone when this syllable is open in the original form, while they tend to have a rising tone when this syllable is closed in the original form (§6.2). This tendency is especially strong with recent loans. When the original tonic syllable is final, the adapted Zapotec forms never have a rising tone (§6.3).

These tendencies can be understood to be due to a conspiracy to avoid a rising tone in an open syllable, not only in the adapted Zapotec forms but also in the original Spanish forms. First, no loans in Teotitlán Zapotec have a rising tone on an open syllable, as is evident from the data above. The only situation where

[17] Possible etymology suggested by Godofredo Santiago. For instance, in Coatlán Mixe, the verb 'to kiss' is *tzücx* (Hoogshagen & Hoogshagen 1997: 267). Another possibility is pointed out by Rosemary Beam de Azcona that the form for 'saliva' is reconstructed as *tso?kki-ɬ (not possessed) ~ *ʃi-tso?kki ɬ based on forms found in the Sierra Sur and that this word can be related to the word in question.

an adapted Zapotec form would have an open syllable is when the original forms have a final open tonic syllable (such as *café* [ka.ˈfe] > *ka'fɛ̃:* 'coffee'), and in such instances a rising tone is never found.[18] Otherwise, the adapted Zapotec forms have a closed syllable, either because the original form already has a closed syllable as in the cases when the original tonic syllable is closed and final (such as *camión* [ka.ˈmjon] > *ka'mmjú:n* 'car') or closed and non-final (such as *parque* [ˈpaɾ.ke] > *pă:rk* 'park'), or due to the clipping of the final vowel when the original tonic syllable is open and non-final (such as *leche* [ˈle.ʧe] > *llé:ʧ* 'milk').

Secondly, these tendencies suggest that Zapotec speakers prefer not to impose a rising tone on a syllable that is open in the *original Spanish form*, even if the adapted Zapotec form has a closed syllable. This is the case in the forms where the original Spanish forms have a non-final open tonic syllable and the adapted Zapotec forms have a closed syllable with a high tone, such as *leche* [ˈle.ʧe] > *llé:ʧ* 'milk'. A rising tone on such forms should be perfectly licit, since it constitutes a closed syllable in Teotitlán Zapotec, but after taking into consideration the syllable structure of the original Spanish forms, it is clear why these loans prefer a high tone rather than a rising tone. This is in line with the proposal that adaptation can take place during the perception of foreign input and not in the computation of the production grammar (Silverman 1992; Peperkamp et al. 2008; Boersma & Hamann 2009; and Calabrese 2009).

The dispreference of a rising tone on an open syllable in Teotitlán Zapotec loanwords is unlikely to be entirely due to the pitch realization of the stressed syllables in the original Spanish. Prieto & Torreira (2007) report that in Spanish the pitch peak is delayed further with an open syllable (around the end of the accented vowel) than with a closed syllable, where the peak is around the beginning-mid part of the sonorant coda, but still far from the syllable boundary. This tendency in the original Spanish predicts that a rising tone would be preferred in the adapted Zapotec form when the original non-final tonic syllable is open and the peak is delayed further, or at least that the rising tone will be found with equal frequency in original open syllable as well as closed syllable. However, what we observe is the opposite: we find a rising tone only when the original non-final tonic syllable is closed.

The fact that this constraint is operative in recent loans and possibly even in the original Spanish forms suggests that the preference of a rising tone for a closed syllable is not only a residue of historical changes, but also a synchronically active constraint in speakers' minds.

## 7. Discussion

In the preceding sections, we have seen that the constraint against a rising tone

[18] Another alternative account is that it could also be due to the phonetic realization of stress in the original Spanish forms: Prieto et al. (1995) reports that the within-word position tends to have a significant effect on peak delay than word-final position in Mexican Spanish (440ff.).

on an open syllable, *Că(:)]$_{\sigma}$, is pervasive throughout the Teotitlán Zapotec lexicon (§3) and grammar, motivating a productive phonological process (§4) as well as morphophonological alternations (§5). This suggests that the constraint is regular and productive in the synchronic language. Furthermore, this constraint is operative in recent loans and possibly even in the original Spanish forms which the speakers perceive (§6), further confirming its internalized status in the synchronic grammar. In this section, we will argue that the constraint against a rising tone on an open syllable is an *unnatural* constraint (§7.1), and §7.2 provides a possible historical explanation for its existence in Teotitlán Zapotec.

### 7.1. *Că(:)]σ as an unnatural constraint

The constraint *Că(:)]$_{\sigma}$ goes against a typological tendency that contour tones prefer longer vowels (Gordon 2001; Zhang 2004). Furthermore, this constraint, combined with the preference of a shorter vowel for a rising tone to occur in the morphophonological alternations discussed in §5, results in the language-specific hierarchy VC > VVC > VV > V, contradicting the universal implicational hierarchy VV > VR > VO > V (Gordon 2001: 428; Zhang 2004: 167). Specifically, Teotitlán Zapotec contradicts Gordon's (2001) implicational law (b), which states that "if CVO can carry contour tones, then CVR and CVV can carry contour tones with equal or greater complexity." In fact, a language such as Teotitlán Zapotec, which allows a rising tone in a syllable with a coda consonant but not in open syllables, is excluded as a possibility from Gordon's (2001) or Zhang's (2004) factorial typology.

One might still attempt to save the universal implication hierarchy proposed by Gordon (2001) and Zhang (2004) by considering that the long vowel in Teotitlán Zapotec is underlyingly short; in fact, such an analysis is the traditional and standard analysis in Zapotec linguistics (for instance, see Picket 1951; Arellanes 2009, Chávez-Peón 2010, among others). One might argue that [V:] is less optimal to carry a rising tone than VR or VO, because it is underlyingly short, /V/, thus obeying the relevant part of the implicational hierarchy, VR > VO > V. However, such an analysis is unlikely. First, this universal implicational hierarchy reflects observations based on the phonetic vowel duration, rather than phonemic vowel length. In fact, the goal of Zhang's (2004) study is to demonstrate that what is crucial in the distribution of a rising tone is the phonetic vowel duration, whether it stems from phonemic designation or from phonetic lengthening due to its position within the word or due to accent Secondly, as was mentioned in §2.2, it is highly likely that vowel length is at least marginally contrastive in some varieties of Central Valley Zapotec.

The exceptional status of a rising tone in Teotitlán Zapotec can neither be accounted for by language-specific durational properties motivated by other phonetic properties influencing the energy values crucial for determining the ability of a syllable to support contour tones, as was proposed by Gordon (2001) for Hausa or Cantonese which appear to go against the implicational hierarchy. It is not the case that a vowel is lengthened in a closed syllable compared to an open syllable

in Teotitlán Zapotec. This is illustrated in Figures 5, 6, and 7, with spectrograms of *bɛ:* 'mold', *bɛ̄:gw* 'comb' and *bɛkw* 'dog', all from a male speaker. Here, the vowel duration of *bɛ:* is around 330 ms, that of *bɛ̄:gw* 290 ms, and that of *bɛkw* 140 ms; we clearly see that it is not the case that the vowel is categorically longer when the coda is present (compared to where there is none), whether it is lenis or fortis.

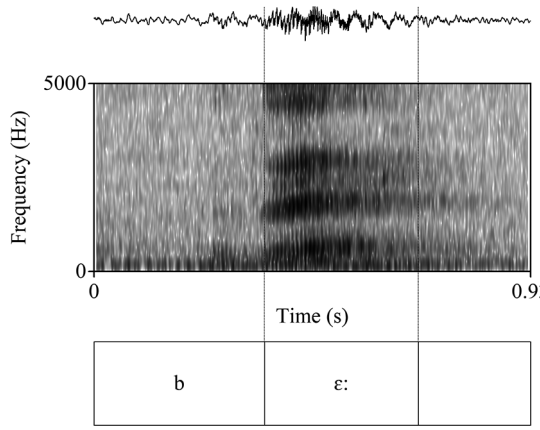



Figure 5 Spectrogram of *bɛ:* 'mold'

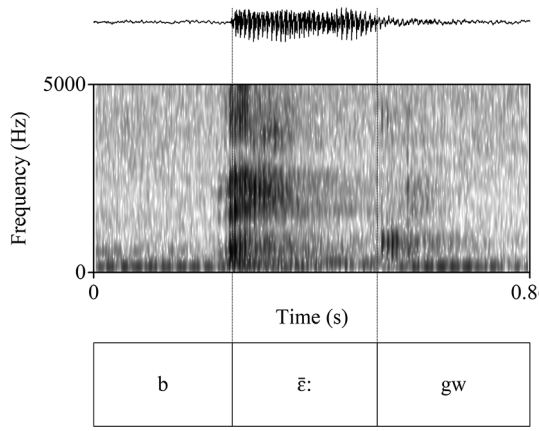



Figure 6 Spectrogram of *bɛ̄:gw* 'comb'

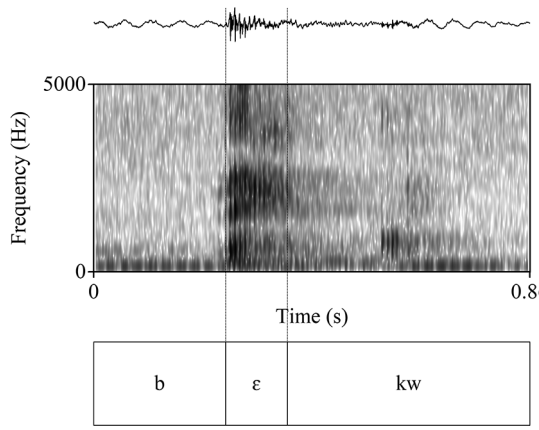



Figure 7 Spectrogram of *bɛkw* 'dog'

A further troublesome fact is that unlike a rising tone, a falling tone, another contour tone, does not have any restrictions on the coda type in the Teotitlán Zapotec varieties. In general, it takes longer to implement a pitch rise than a pitch fall of the same extent (Ohala 1978; Sundberg 1979; Xu & Sun 2002), and thus a rising tone is predicted to prefer a longer vowel than a falling tone. This is not the case in Teotitlán Zapotec, however. Thus, any attempt to look for a synchronic phonetic explanation would be unsuccessful. The next subsection looks at a possible historical account of this synchronically *unnatural* constraint.

### 7.2. A possible historical explanation

The presence of the unnatural constraint against a rising tone on an open syllable in Teotitlán Zapotec, *Că(:)]$_{\sigma}$ can be explained by means of phonetically natural sound changes. In this case, the main source for a rising tone in monosyllabic Teotitlán Zapotec is a process of apocope of the final atonic syllable and the maintenance and migration of the tones of both syllables.

In Proto-Central Valley Zapotec, the majority of the disyllabic roots had the low-low pattern (*CaCa*), as in *geta 'tortilla' or the low-rising pattern (*CaCă*), as in *daně 'hill' although rising-low (*CăCa*) and rising-rising (*CăCă*) patterns were also found more rarely. This is the pattern faithfully preserved in San Baltazar Chichicapan Zapotec (see Stage 1 below). At this stage, the high tone did not participate much in the tonal system; it could be the case that a high tone did not contrast with the rising tone at this stage, and that the rising tone came from the original high tone in Pre-Proto Central Valley Zapotec, which resulted from the delay of the pitch rise of the original high tone. This could possibly be due to the requirement that tone and non-modal phonation be sequenced with respect to one another, in order to maximize the contrast of both (Silverman 1997).

In Teotitlán Zapotec, after the first stage, the pitch rise of the rising tone started

to delay further, to the point where the high portion is not realized until the next syllable (stage 2). The syllable which originally carried the rising tone now carries a mid tone, which is a new tonal category (see (59)–(62) below). When the rising tone is on the last syllable, the high portion is realized on the next morpheme or word. This floating high tone is represented with a superscript H, as in: *ˈCaCă > *ˈCaCāᴴ in (59)b; *ˈCă > Cāᴴ in (60)b; *ˈCăCă > *CăCāᴴ in (62)b. When the rising tone is on the non-final syllable, a high tone is realized on the next syllable within the same word, as long as that syllable does not have a marked tone (i.e. low tone): *ˈCăCa > *ˈCāCá in (61)b. If the second syllable has a marked tone (in this case, a mid tone), the rising tone cannot split and remains rising (62). Subsequently (stage 3), the atonic vowel (the $V_2$) of the original disyllabic root was lost, and the tones on the original $V_2$ migrated to the $V_1$, to preserve the original tonal contrast. Displacement of the tone from the second syllable to the first syllable resulted in the fusion of the tones on the first and the second syllables. When the first syllable had an unmarked low tone, the mid tone on the second syllable simply displaced the low tone on the first syllable (59). In (61), a high tone on the second syllable fused with a mid tone on the first syllable to create a rising tone.[19] Finally, in (62), a mid tone on the second syllable and the rising tone on the first syllable fused to create a high tone.

| | | Stage 1 | | | Stage 2 | | | Stage 3 |
|---|---|---|---|---|---|---|---|---|
| | | Chichicapan | | | Pre-Teotitlán | | | Teotitlán |
| (57) | a | ˈCaCa | > | b | ˈCaCa | > | c | CaC |
| | | *'geta* 'tortilla' | | | *ˈgeta | | | *gɛt* |
| (58) | a | ˈCa | > | b | ˈCa | > | c | Ca |
| | | *'ʤi:* 'fire' | | | *ˈgi: | | | *gi:* |
| (59) | a | ˈCaCă | > | b | ˈCaCāᴴ | > | c | CāCᴴ |
| | | *'da:nĭ* 'hill' | | | *ˈda:nīᴴ | | | *dā:jn*ᴴ |
| (60) | a | ˈCă | > | b | ˈCāᴴ | > | c | Cāᴴ |
| | | *'bjă'* 'cactus' | | | *ˈbjā:ᴴ | | | *bjā:*ᴴ |
| (61) | a | ˈCăCa | > | b | ˈCāCá | > | c | CăC |
| | | *gu-'ră:gu* 'lizard' | | | *gu-ˈrā:gú | | | *gu-'ră:gw* |
| (62) | a | ˈCăCă | > | b | ˈCăCāᴴ | > | c | CáCᴴ |
| | | *'bĭ:bĭ* 'jojoba' | | | *bĭ:bīᴴ | | | *bí̱:by*ᴴ |

These historical changes led to a situation where none of the open syllables carry a rising tone: a rising tone on the final atonic syllable in stage 1 resulted in a closed syllable with a mid tone associated with a floating high tone (59);[20] a rising tone

[19] The chronology of sound changes proposed here goes against Occam's razor since a rising tone in stage 1 changes to something else in stage 2 and then changing back again to a rising tone in stage 3. However, the stage 2 is attested in Juchitán Zapotec (the cognate of (61) is *gu-ra:gû*; Picket et al. 2007: 77) and this diachronic path is not unlikely.

[20] This floating high tone triggers tone sandhi on the next syllable (Uchihara 2016). For instance, after a low-tone verb *rɛ:bj* 'said to', a low-toned word *bɛkw* 'dog' is not affected and

on a monosyllabic open syllable resulted in a mid tone associated with a floating high tone (60).[21] A rising tone on a non-final tonic syllable resulted in a rising tone on a closed syllable (61). Finally, rising tone on the non-final and final syllables of a disyllabic word resulted in a high tone associated with a floating high tone (62).[22]

In general, a model based on historical explanation is better equipped to account for *unnatural* sound patterns (Bach & Harms 1972; Hellberg 1978; Anderson 1981; Blevins 2004: Ch.8; Scheer 2015; Beguš 2018; 2020; Beguš & Dąbkowski 2024). According to such a model, languages have rules which are plausible or which can be derived from plausible rules by a sequence of steps involving simplification, but in the process those rules can become highly implausible; such a case is known as a rule telescoping (Bach & Harms 1972: 6; Anderson 1981: 521). In particular, Beguš (2018, 2020) proposes that unnatural rules such as intervocalic devoicing arise from the *blurring process,* which involves at least three phonetically motivated sound changes which follows the general schema in (63).

(63) Blurring process (Beguš 2018, 2020)
- i A set of segments enters complementary distribution.
- ii A sound change occurs that operates on the changed/unchanged subset of those segments.
- iii Another sound change occurs that blurs the original complementary distribution.

In the case of Teotitlán Zapotec, stage (i) corresponds to the delay of the peak of the rising tone, which resulted in ˈCăCa > ˈCāCá and ˈCă > ˈCā$^{H}$. Then, stage (ii) corresponds to the loss of the final (atonic) vowel from disyllables, and stage (iii) to the migration of the high tone to the preceding syllable. Each of these processes are phonetically natural.

The fact that languages have plausible rules is merely the result of strong naturalness constraints on the initiation of phonetic rules (Bach & Harms 1972: 18; Hellberg 1978). Whether the rules or constraints are *natural* or *unnatural*, children simply set up rules in order to cover systematic variation in the inherited language and do not care for the phonetic naturalness of these rules. Such *unnatural* sound patterns underscore the importance of recognizing the essential independence of the phonological effects from rigid deterministic control by the phonetic effects (Anderson 1981: 509).

---

remains low (*rɛ:bj bɛkw* 'the dog said to'), while after a mid-tone verb *rē:bj* 'swallow', *bɛkw* 'dog' is assigned a falling tone (*rē:bj bēkw* 'the dog swallows').

[21] In Teotitlán Zapotec, native monosyllabic words with an open syllable with a high tone are attested but rare, and mainly found in adjectives such as *ʤá:* 'full', *ní:* 'sour' or *ʃnjá:* 'red'; otherwise, we have only two such words in our database: *rá:* 'all' and *ʒí:* 'tomorrow'. The historical source of such forms is unknown, except that in adjectives there could have been a stative prefix which changed the tone of the root.

[22] It is not the case that the assignment of a high tone after a high tone is due to high tone spreading; in Teotitlán Zapotec, a high tone associated with a floating high tone contrasts with a high tone that is not associated with a high tone, such as *rá:* 'all'.

## 8. Conclusion

In this paper, we have shown that Teotitlán Zapotec has a crosslinguistically unnatural constraint against a rising tone on an open syllable, *Că(:)]$_{\sigma}$, and that it is not merely a residue of historical sound changes, but rather it is still synchronically active, motivating some phonological and morphophonological processes (§4, §5) and applying to recent loans (§6). This may suggest that this constraint is learned as a grammatical constraint by the speakers (Coetzee 2014). This constraint, combined with the fact that certain morphophonological alternations prefer a rising tone on a short closed syllable over long syllables (§5), results in the hierarchy VC > VVC > VV > V, which contradicts Gordon's (2001) universal hierarchy of rising tones, VV(C) > VR > VO > V. A strong restriction on a rising tone in Teotitlán Zapotec, in its distribution (§3) as well as in the existence of Rising Tone Levelling which remedies a rising tone on an open syllable (§4) on the other, are the direct consequences of the historical sound change (§7.2): in Teotitlán Zapotec the only source for a rising tone is a rising tone on a tonic syllable of a disyllabic stem with a following non-rising tone. In this sense, this constraint against a rising tone on an open syllable, *Că(:)]$_{\sigma}$, represents a case of a synchronically *unnatural* constraint which finds a natural diachronic explanation.

One intriguing aspect of this *unnatural* constraint in Teotitlán Zapotec is its stability. According to Blevins (2004: 192), unnatural sound patterns are expected to be eliminated by instances of Change, Chance, or Choice (Blevins 2004: 193). However, this constraint is synchronically active and pervasive. The constraint is stable across the monosyllabic Central Valley Zapotec varieties, and there is no indication that it is subject to pressure from phonetic naturalness, that is the preference of a contour tone for a phonetically longer vowel.

### References

Anderson, Stephen (1981) Why phonology isn't natural. *Linguistic Inquiry* 12: 493–539.

Arellanes, Francisco (2009) *El sistema fonológico y las propiedades fonéticas del Zapoteco de San Pablo Güilá*. Ph.D. dissertation, El Colegio de México.

Arellanes, Francisco, Mario Chávez-Peón, Adela Covarrubias, Mario Hernández, Miriam Manzano, Sofia Morales, Rosa María Rojas, Carolos Wagner, and Victoria Zárate (2014) Hacia una dialectología de base fónica en el zapoteco del valle: el caso de la sexta vocal [ɨ]. In: L. Orozco y A. Guerrero eds., *Cambio y Variación Lingüística: estudios de variación geolingüística*, 365–398. Mexico City: Instituto Nacional de Antropología e Historia.

Avelino, Heriberto (2004) *Topics in Yalálag Zapotec, with particular reference to its phonetic structures*. Ph.D. dissertation, University of California at Los Angeles.

Bach, Emmon and Robert T. Harms (1972) How do languages get crazy rules. In: R. Stockwell and R. Macaulay eds., *Linguistic Change and Generative Theory*, 1–21. Bloomington: Indiana University Press.

Beam de Azcona, Rosemary (2004) *A Coatlán-Loxicha Zapotec grammar*. Ph.D. dissertation, University of California, Berkeley.

Beam de Azcona, Rosemary (2019) Southern Zapotec verb classes. In: Enrique Palancar,

Matthew Baerman and Timothy Feist eds, *Inflectional class complexity in the Oto-Manguean languages*. *Amerindia* 41: 121–166.

Beam de Azcona, Rosemary, Francisco Arellanes Arellanes, Mario Chávez-Peón, Mario Hernández Luna, Sofía Gabriela Morales Camacho, Carlos de Jesús Wagner Oviedo, and Miriam Itzel Manzano Corona (2019) Umlaut (armonía vocálica) en el desarrollo histórico de las lenguas zapotecas. In: Lucero Meléndez and Marcela San Giacomo, eds. *Debates en torno a la lingüística histórica indomexicana*, 39–83. México: IIA-UNAM.

Beguš, Gašper (2018) *Unnatural phonology: a synchrony-diachrony interface approach*. Ph.D. dissertation, Harvard University.

Beguš, Gašper (2020) Estimating historical probabilities of natural and unnatural processes. *Phonology* 37(4): 515–549.

Beguš, Gašper (2022) Distinguishing cognitive from historical influences in phonology. *Language* 98(1): 1–34. url: https://muse.jhu.edu/article/849525.

Beguš, Gašper, and Maksymilian Dąbkowski (2024) The blurring history of intervocalic devoicing. *Journal of Linguistics* Published online 2024: 1–20. doi: 10.1017/S0022226724000197.

Blevins, Juliette (2004) *Evolutionary phonology*. Cambridge: Cambridge University Press.

Blust, Robert (2005) Must sound change be linguistically motivated? *Diachronica* 22.2: 219–269.

Boersma, Paul & Silke Hamann (2009) Loanword adaptation as first-language phonological perception. In: Calabrese, Andrea and W. Leo Wetzels eds., *Loan phonology*, 11–58. Amsterdam & Philadelphia: John Benjamins.

Butler, Inez M. (1976) Reflexive constructions of Yatzachi Zapotec. *International Journal of American Linguistics* 42: 331–337.

Calabrese, Andrea (2009) Perception, production and acoustic inputs in loanword phonology. In: Calabrese, Andrea and W. Leo Wetzels eds., *Loan phonology*, 59–114. Amsterdam & Philadelphia: John Benjamins.

Campbell, Eric (2011) Zenzontepec Chatino aspect morphology and Zapotecan verb classes. *International Journal of American Linguistics* 77.2: 219–246.

Chávez-Peón, Mario E. (2008) Phonetic cues to stress in a tonal language: prosodic prominence in San Lucas Quiaviní Zapotec. In: Susie Jones ed., *Actes du congrès de l'Association canadienne de linguistique 2008*, 1–13.

Chávez-Peón, Mario E. (2010) *The interaction of metrical structure, tone and phonation types in Quiaviní Zapotec*. Ph.D. dissertation, the University of British Columbia.

Chávez-Peón, Mario E. (2015) Morfología prosódica en el zapoteco de Quiaviní. In: Esther Herrera Zendejas ed., *Tono, acento y estructuras métricas en lenguas mexicanas*, 207–234. Mexico City: El Colegio de México.

Coetzee, Andries W. (2014) Grammatical change through lexical accumulation: voicing cooccurrence restrictions in Afrikaans. *Language* 90.3: 693–721.

Gordon, Matthew (2001) A typology of contour tones. *Studies in Language* 25.3: 423–462.

Hayes, Bruce (1999) Phonetically-driven phonology: The role of Optimality Theory and inductive grounding. In: Michael Darnell and Edith Moravscik eds., *Functionalism and Formalism in Linguistics*, Volume I: General Papers, 243–285. Amsterdam: John Benjamins.

Haynie, Hannah, Claire Bowern, Patience Epps, Jane Hill, Patrick McConvell (2014) Wanderwörter in languages of the Americas and Australia. *Ampersand* 1: 1–18.

Hellberg, Staffan (1978) Unnatural phonology. *Journal of Linguistics* 14: 157–177.

Holden, Kyril (1976) Assimilation rates of borrowings and phonological productivity. *Lan-*

*guage* 52: 131–147.
Hoogshagen Noordy, Searle and Hilda Halloran de Hoogshagen (1997) *Diccionario mixe de Coatlán, Oaxaca*. México, D.F.: Instituto Lingüístico de Verano, A.C.
Hyman, Larry (1970) The role of borrowing in the justification of phonological grammars. *Studies in African Linguistics* 1: 1–48.
Hyman, Larry (1988) Syllable structure constraints on tonal contours. *Linguistique Africaine* 1: 49–60.
Jaeger, Jeri (1983) The fortis/lenis question: evidence from Zapotec and Jawoñ. *Journal of Phonetics* 11: 177–189.
Kang, Yoonjung (2011) Loanword phonology. In: Ch. 95 of Van Oostendorp, Marc, Colin J. Ewen, Elizabeth Hume and Keren Rice eds., *The Blackwell companion to phonology*, 2258–2282. Blackwell.
Karttunen, Frances (1983) *An analytical dictionary of Nahuatl*. Norman: University of Oklahoma Press.
Kaufman, Terrence (1989) *The phonology and morphology of Zapotec verbs*. ms.
Kaufman, Terrence (2015) *A typologically odd phonological reconstruction for proto-Sapotekan: stem-final *k*. Albany, NY: PDLMA Publications.
Kaufman, Terrence (2016) *Proto-Sapotek(an) reconstructions*. Albany, NY: PDLMA Publications.
Kiparsky, Paul (2008) Universals constrain change, change results in typological generalizations. In: Jeff Good ed., *Linguistic universals and language change*, 23–53. Oxford: Oxford University Press.
Moreton, Elliott (2008) Analytic bias and phonological typology. *Phonology* 25.1: 83–127.
de Nebrija, Antonio (1492) *Gramática castellana (Grammatica Antonii Nebrissensis*).
Nellis, Donald G. and Barbara E. Hollenbach (1980) Fortis versus lenis in Cajonos Zapotec phonology. *International Journal of American Linguistics* 46: 92–105.
Ohala, John (1978) Production of tone. In: Victoria Fromkin ed., *Tone: A linguistic survey*, 5–29. New York: Academic Press.
Operstein, Natalie (2016) Phonological adaptation of Spanish loanwords in Zaniza Zapotec. *International Journal of American Linguistics* 82.2: 211–238.
Peperkamp, Sharon, Inga Vendelin and Kimihiro Nakamura (2008) On the perceptual origin of loanword adaptations: Experimental evidence from Japanese. *Phonology* 25: 129–164.
Pérez Báez, Gabriela and Terrence Kaufman (2016) Verb classes in Juchitán Zapotec. *Anthropological Linguistics* 58.3: 217–257.
Picket, Velma (1951) Nonphonemic stress: a problem in stress placement in Isthmus Zapotec. *Word* 7: 60–65.
Picket, Velma et al (2007). *Vocabulario zapoteco del Istmo. Español-zapoteco y zapoteco-español. Quinta Edición*. D.F.: Instituto Lingüístico de Verano, A.C.
Prieto, Pilar, Jan van Santen and Julia Hirschberg (1995) Tonal alignment patterns in Spanish. *Journal of Phonetics* 23: 429–451.
Prieto, Pilar and Francisco Torreira (2007) The segmental anchoring hypothesis revisted: Syllable structure and speech rate effects on peak timing in Spanish. *Journal of Phonetics* 35: 473–500.
Scheer, Tobias (2015). How diachronic is synchronic grammar? Crazy rules, regularity, and naturalness. In Patrick Honeybone & Joseph Salmons eds., *The Oxford handbook of historical phonology*, 313–336. Oxford: Oxford University Press.
Silverman, Daniel (1992) Multiple scansions in loanword phonology: Evidence from Can-

tonese. *Phonology* 9: 289–328.
Silverman, Daniel (1997) Laryngeal complexity in Otomanguean vowels. *Phonology* 14: 235–261.
Smith-Stark, Thomas (2002) Las clases verbales del zapoteco de Chichicapan. In: Zarina Estrada Fernández and Rosa María Ortiz Ciscomani eds., *Las actas del VI Encuentro Internacional de Lingüística en el Noroeste* v. II, 165–212. Hermosillo, Universidad de Sonora.
Smith-Stark, Thomas (2003) Tipos prosódicos de sílabas en el zapoteco de San Baltasar Chichicapan. In Esther Zendejas. and Pedro Butragueño eds., *La tonía: dimensiones fonéticas y fonológicas*, 111–139. Mexico City: El Colegio de México.
Smith-Stark, Thomas (2007) Los préstamos entre el español y el zapoteco de San Baltasar Chichicapan. *UniverSOS* 4: 9–39.
Sundberg, Johan (1979) Maximum speech of pitch changes in singers and untrained subjects. *Journal of Phonetics* 7: 71–79.
Uchihara, Hiroto (2016) Tone and registrogenesis in Quiaviní Zapotec. *Diachronica* 33.2: 220–254.
Uchihara, Hiroto (2021) La pérdida de la vocal átona en el zapoteco central. In: Francisco Arellanes and Lilián Guerrero eds., Estudios lingüísticos y filológicos en lenguas indígenas mexicanas: Celebración por los 30 años de Seminario de Lenguas Indígenas, 347–393. Mexico City: Instituto de Investigaciones Filológicas, UNAM.
Uchihara, Hiroto and Ambrocio Gutiérrez (2020a) Open and closed mid-front vowels in Teotitlán Zapotec. *Phonological Data & Analysis* 2.7: 1–22. DOI: 10,3765/pda.v2art7.42.
Uchihara, Hiroto and Ambrocio Gutiérrez (2020b) Subject and agentivity in Teotitlán Zapotec. *Studies in Language* 44.3: 548–605.
Uchihara, Hiroto and Gabriela Pérez Báez (2016) Fortis/lenis, glides and vowels in Quiaviní Zapotec. *Glossa: a journal of general linguistics* 1(1): 27. 1–24.
Xu, Yi and Xuejing Sun (2002) Maximum speed of pitch change and how it may relate to speech. *Journal of the Acoustical Society of America* 111.3: 1399–1413.
Zhang, Jie (2004) The role of contrast-specific and language-specific phonetics in contour tone distribution. In: Hayes, Bruce, Robert Kirchner, and Donca Steriade eds., *Phonetically based phonology*, 157–190. New York, NY: Cambridge University Press.

執筆者連絡先：
内原洋人（東京外国語大学）
e-mail: hiroto.uchihara [at] tufs.ac.jp
アンブロシオ・グティエレス（コロラド大学ボルダー校）
e-mail: Ambrocio.GUTIERREZLORENZO [at] colorado.edu

[Received September 10 2024;
Accepted January 21 2025]

【要　旨】

## サポテク語テオティトラン・デル・バジェ方言における上昇調

内　原　洋　人　　アンブロシオ・グティエレス
東京外国語大学　　コロラド大学ボルダー校

通言語的に，曲声調は音声的に長い母音を好むことが知られている。しかし，サポテク語テオティトラン・デル・バジェ方言では，分布と交替の両方において，上昇調は一貫して開音節よりも閉音節を好む（*C$\breve{\text{a}}$(:)]$_{\sigma}$）。更に，借用語のデータからすると，この制約は化石化したものではなく，サポテク語の話者にとって共時的にアクティブなものであることが示唆される。一般的に母音は閉音節よりも開音節で音声的に長いことに鑑みると，サポテク語の上昇調に対する制約は「不自然な」音声パターンを示している。本稿では，このように共時的に「不自然な」制約も，通時的に見れば音声学的に自然な変化の積み重ねによるものであることを示す。