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Interpretation of Ambiguous Segments in the Zo'é Language

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Abstract

This study, conducted as part of a project at the Federal University of Western Pará, re-evaluates the phonological system of the Zo'é language to address discrepancies in phonetic and phonological interpretations identified since the 1990s. Central to this research is the reinterpretation of ambiguous sounds, such as affricates, labialized, and palatalized consonants, as well as approximants. Utilizing historical data and recent recordings, the study identifies systematic processes preserving syllable patterns, including syllable restructuring at morpheme boundaries. The findings propose that sounds like [kʲ], [gʲ], [ŋʲ], [pʲ], [bʲ], [hʲ], [mʲ], [kw], [ʧw], [gw], [ʧ], and [ʤ] function as simple sounds. Additionally, the study explores the complex role of glides [w] and [j], suggesting their dual interpretation as consonants in onset positions and vowels in coda positions. By resolving phonological ambiguities and establishing a cohesive phonetic framework, this research lays the groundwork for a unified orthographic system for the Zo'é language, contributing significantly to its linguistic documentation and preservation.

Keywords: Zo'é language, phonological system, ambiguous sounds, syllable patterns, orthographic development.

1. Introduction

This study is part of the research project titled *Revisiting the Phonological System of the Zo'é Language towards the Development of a Unified Orthographic System*, currently underway at the Federal University of Western Pará in collaboration with a researcher from the University of Arizona (Hitotuzi et al., 2020). The endeavor seeks to reconcile certain discrepancies in phonological descriptions of this language identified in publications since the latter part of the 20th century.

Within studies on the Zo'é language published from 1993 onwards, diverse interpretations concerning its phonetics and phonology have emerged (Hitotuzi et al., 2020). A salient area of divergence lies in the characterization of the Zo'é's vowel system. Some linguists have proposed differing numbers of vowel phonemes. For instance, Cabral (2000, 2009, 2013) and Cabral et al. (2010) posited six phonemes, while Cabral (1998) identified eight, and further studies by Cabral (1996a, 1996b) and Souza (2003) suggested 12 vowel phonemes. Additional variations extend to 14 phonemes in works by Castro and Carvalho (1998) and Castro (2017, 2018).

Similarly, discrepancies arise in the depiction of consonants in the Zo'é language. Research by Hitotuzi, Silva, and Castro (2020) unveils distinct sets of consonants: Souza (2003) identifies 12 phonemes, Cabral (1996a, b, 2000, 2013) mentions 13, and references extend to 14 (Cabral 2009; Cabral et al. 2010), 16 (Cabral 1998; Castro 2018), and even 19 phonemes (Castro & Carvalho 1998; Castro 2017, 2018). Moreover, inconsistencies arise not merely in quantity but also in the symbols employed to denote these phonemes, as evidenced within works by a single author, such as Cabral (2000) and Cabral (2013).

Despite the significance of analyzing these discrepancies, a phonological reassessment necessitates the reinterpretation of ambiguous sounds of Zo'é, which have been a primary point of contention among researchers of this language. Upon resolving this challenge, the precise number of phonemes delineated in publications over the years will be addressed in a subsequent study, already in progress. Furthermore, reinterpreting these ambiguous sounds will serve as a foundation for other phonetic-phonological descriptions inherent to the reevaluation of the Zo'é language's phonological inventory.

Despite access restrictions to some Indigenous Lands due to the COVID-19 pandemic's health emergency, this reassessment remains feasible, thanks to data compiled by three researchers between 1987 and 1991, encompassing cassette tape recordings and personal notes. These primary sources, augmented by digital recordings from 2011 and 2013, facilitated an analysis of these sounds in transcriptions stemming from extended interactions with native speakers, cross-referenced with audio records to ensure precise phonetic articulation understanding.

Drawing upon the foundational frameworks of Pike (1947, 2015) and Burquest (2001), this study offers a phonetic reinterpretation of the Zo'é language, with a particular focus on its syllabic patterns in pretonic and tonic syllables. Previous research has largely overlooked this critical aspect of its phonology. By analyzing morphophonological processes, contrast

neutralization, and considering diachronic data influencing phonetic-phonological shifts in this language (Castro, 2018, Castro et al., 2020), uncertainties related to sound interpretation have been clarified as will be demonstrated in the forthcoming sections of this paper. To delineate the trajectory of the phonetic reinterpretation, this study centers on two pivotal axes: a) mechanisms preserving the syllabic pattern, and b) interpretation of ambivalent segments and sequences.

2. Processes Preserving the Syllable Pattern in Zo'é

To facilitate a deeper understanding of the forthcoming reinterpretation of ambiguous sounds of Zo'é – encompassing the affricates /ʧ/ and /ʤ/, the labialized [kw], [ʧw], and [gw], the palatalized [kʲ], [gʲ], [ŋʲ], [pʲ], [bʲ], [hʲ], and [mʲ], and the approximants [j] and [w] – this section initially identifies ethical segments, encompassing the phonological hierarchy and syllable restructuring of the language.

2.1 Phonological Hierarchy

The analysis of some of the data collected by Castro and his colleagues (Castro et al., 2020) reveals three significant aspects concerning the phonological hierarchy of the Zo'é language. Firstly, breath groups in this language are composed of one or more rhythmic segments, with primary stress on the final rhythmic segment (ˈRS)[1]. Secondly, rhythmic segments consist of one or more syllabic segments, with stress on the final syllabic segment (ˈSS). Thirdly, specific patterns emerge within syllabic segments: the CV pattern is discernible in BG3 - RS1, while the V pattern is consistently identified in BG5 - RS1 across all positions. Additionally, VC and CVC configurations exclusively appear in final positions, specifically within tonic syllables, as highlighted in BG1 - RS2, BG3 - RS3, RS5, and BG6 - RS1. These findings are exemplified in examples (1a) – (6c).

(1a) /ɔˈhɔdɛɾɛˈsak/

'He went to see you.'

/ɔˈhɔ+dɛɾɛˈsak/

BG1 – RS ˈRS

(1b) /ɔ.ˈhɔ/

'He went.'

RS1 – SS ˈSS

SS1 – /ɔ/ V

SS2 – /hɔ/ CV

(1c) /dɛ. ɾɛ.ˈsak/

'See you.'

RS2 – SS SSˈSS

SS1 – /dɛ/ CV

SS2 – /ɾɛ/ CV

SS3 – /sak/ CVC

(2) /**ɛˈɾɛ**/

'Do it. See.'

BG2 – RS

RS3 – SSˈSS

SS1 – /ɛ/ V

SS2 – /ɾɛ/ CV

(3a) /**mõrɛtadekiɾ+iɾi(ɛ)ɾɛhaɸɔˈtat**/

'After how many sleeping turns will you go?'

/mõɾɛˈta+deˈkiɾ+iˈɾi+ɛ.ɾɛˈha+ɸɔˈtat/

BG3 – RS RS RS RSˈRS

(3b) /**mõ.ɾɛ.ˈta**/

'How much? How many?'

RS1 – SS SSˈSS

SS1 – /mõ/ CV

SS2 – /ɾɛ/ CV

SS2 – /ta/ CV

(3c) /**de.ˈkiɾ**/

'your sleep.'

RS2 –SS ˈSS

SS1 – /dɛ/ CV

SS2 – /kit/ CVC

(3d) /**i.ˈɾi**/

'after that'

RS3 –SS ˈSS

SS1 – /i/ V

SS2 – /iɾi/ CV

(3e) /**ɛ.ɾɛ.ˈhá**/

'you to go'

RS4 – SS SS ˈSS

SS1 – /ɛ/ V

SS2 – /ɾɛ/ CV

SS2 – /ha/ CV

(3f) /**ɸɔ.ˈtat**/

FUT MKR

RS5 – SSˈSS

SS1 – /βo/ CV

SS2 – /tat/ CVC

(4a) /**dɛao**ˈ**so**/

'Did you tell him?'

/dɛaˈo+ˈso/

BG4 – RS ˈRS

(4b) /**dɛ.a.**ˈ**o**/

'Did you tell it?'

RS1 – SS SS ˈSS

SS1 – /dɛ/ CV

SS2 – /a/ V

SS3 – /ˈo/ V

(4c) /**so**/

INTER PTC

RS2 – SS SS ˈSS

RS2 –SS

SS1 – /so/ CV

(5) /**ɛa**ˈ**o**/

'I did (I told him).'

BG5 – ˈRS

/ɛ.a.ˈo/

RS1 – SS SS ˈSS

SS1 – /ɛ/ V

SS2 – /a/ V

SS3 – /ˈo/ V

(6a) /**urɔsoˈʔ o**/

'Berne bit him.'

/urɔ + soˈʔ oʔ /

BG6 – RS ˈRS

(6b) /**ut**/

'Berne'

RS1 – SS SS ˈSS

SS1 – /ut/ VC

(6c) /**ɔ.so.ˈ ʔo**/

RS2 – SS SS ˈSS

SS1 – /ɔ/ V

SS2 – /so/ CV

SS3 – /ʔo/ CV

Breath groups 1 to 6 illustrate the syllable patterns in Zo'é across initial pretonic, medial pretonic, and tonic positions, as summarized in Table 1. Importantly, primary stress in this language typically falls on the final syllable.

Table 1. Syllable patterns of Zo'é

Breath group	Rhythmic segment	Syllable pattern		
		Initial pretonic	Medial pretonic	Tonic
BG1	RS1	V		CV
	RS2	CV	CV	CVC
BG2	RS1	V		CV
BG3	RS1	CV	CV	CV
	RS2	CV		CVC
	RS3	V		CV
	RS4	V	CV	CV
	RS5	CV		CVC
BG4	RS1	CV	V	V
	RS2			CV
BG4	RS1	V	CV	
BG6	RS1			VC
	RS2	V	CV	CV
Summary		V, CV	V, CV	V, CV, VC, CVC

These syllable patterns are consistent with the hypothesis formulated by Cabral (1996a) in her preliminary analysis of the Zo'é language.

2.2 Syllable Restructuring in Zo'é

To maintain the syllable pattern in the Zo'é language, a phonetic syllable restructuring occurs at the boundaries of morphemes and words. At the boundary of words, when forming noun phrases, an epenthetic vowel (nominal morpheme {-a}) is added, with rhotacization of the stop /t/ and with voicing of velar /k/ in the final syllable of the first word, forming a new phonetic syllable in this environment. This process gives rise to a new phonetic syllable in this context, as exemplified by instances (7)-(9).

(7) i-pɛ.'wa**t**-kã → i.pɛ.'wa**.ɾ a**.'kã
3-husband-PL 'her husband'

(8) ʔõ**ŋ**-ða → ʔõ.**ŋ a**.'ða ɔ.ða.'pɔ
this-like 'He made one like this.'

(9) ða.'to**k**-kã → ða.'to.**g a**.'kã
PN-PL 'The Dato*k*s' (Dato*k* and his household/family)

On the other hand, in the formation of verb phrases, as exemplified in (10)-(13), the final consonant of the first word is elided. This occurs while maintaining the same number of phonetic syllables.

(10) i-pɛ.'wa**t**-kã → i.pɛ.'wa 'kã

3-husband-PL ‘They have husband.’ (They are married.)

(11) ʔõ**ŋ**-ða → ʔõ.'ða ɔ.ða.'pɔ
this-like ‘It is similar to this the one he made.’

(12) a-a.'p*ɨ***k**-pu.'ku → a.a.'pɨ pu.'ku
1SG-sit-long ‘I sat for a long time.’

(13) a-ɛ.'sa**k**-tɛ'nã na → a.e.'sa te'nã na
1SG-see ‘I only saw.’

When morphemes combine to form phrases like those in (14)-(17), where a consonant-final word precedes a vowel-initial word, the phonetic environment triggers two sound changes: rhotacization of the final [t] and voicing of [k] in the first word. These changes, in turn, also induce a syllabic restructuring, as evidenced by the examples.

(14) ta.ɾa.wi**t-ɔ**.’o → ta.ɾa.'wi.**ɾ ɔ.**’o

PN.3-eat ‘Tarawit ate.’

(15) ða.'to**k-ɔ**.'hɔ → ða.'to.**g ɔ**.'hɔ

PN.3-leave ‘Dat*ok* left.’

(16) a-ki**t-u**hu → a.'ki.**ɾ u**.'hu

1SG-sleep-large ‘I slept heavily.’

(17) a-pa**k-a**nɛ → a.'pa.**g a**.'nɛ

1SG-wake up-truly ‘I truly woke up.’

At the boundary of morphemes, when a vowel-initial prefix or suffix precedes a root that begins with a non-low vowel [i], [ɨ], [ɛ], the mid and high vowels are syllabified as a falling diphthong, as shown in examples (18)-(21).

(18) a-ɛ.'sak → **aj**.'sak

1SG-see ‘I saw him.’

(19) ɔ-bɔ-ɛ.'dɨk → ɔ.**bɔj**.'dɨk

3-CAUS-bright ‘to make it shine’ (turn on)

(20) ɔ.bɔ-i.ʧa

3-CAUS-be in motion (move) → ɔ.**bɔj**.'ʧa

'to move it'

(21) a.bɔ.i̱.u

1SG-CAUS-drink → a.**boj**.u

'I made him drink.'

The same phenomenon occurs when a suffix formed by the high front vowel [i], or beginning with it, is attached to words ending in other vowels, as indicated in (22)-(24).

(22) d-a.ku.'ha-i → da-ku.'h**aj**

NEG-1SG.know-NEG 'I don't know.'

(23) ku'pɛ-i → ku'p**ej**

behind-INTS 'far behind'

(24) a-'ha-i.'ʧa → a.h**aj**'ʧa

1SG-go-be in motion 'I'm going.'

Examples (25)-(28) demonstrate, however, that vowel fusion occurs in both prefixation and suffixation when homophonic vowels intersect.

(25) a-a.'p*i̱k* → **a**.'pi̱k

1SG-sit 'I sat.'

(26) ɛ.ɾɛ-e.'sak → ɛ.**ɾɛ**.'sak

2SG-see 'You saw.'

(27) d-ɔ.'pi-i → d-ɔ.'p**i**

NEG-3.bite-NEG 'It didn't bite.'

(28) d-ɔ.ki.'si-i → d-ɔ.ki.'s**i**

NEG-3.cut-NEG 'It didn't cut.'

Overall, the maintenance of the syllable pattern in the Zo'é language arises from multiple and systematic processes of syllable restructuring at the boundaries of morphemes and words. When forming noun phrases, the insertion of an epenthetic vowel, together with rhotacization and voicing, leads to the formation of an additional phonetic syllable, as demonstrated by the examples (7)–(9). In verbal phrases, as highlighted in (10)–(13), the elimination of the final consonant of the first word is observed yet maintaining the same number of phonetic syllables. The analysis of examples (14)–(28) underscores the complexity of syllable restructuring across various contexts, revealing sound transformations in the combination of words into phrases and the syllabification of mid and high vowels in formation of words by affixation. This process of syllable restructuring is also evident in vowel fusion when homophonous vowels meet, reiterating its varied and systematic nature.

3. Interpretation of Ambiguous Segments and Sequences

3.1 Consonants

The ambivalent affricates [ʧ] and [ʤ], labialized consonants [kw], [ʧw], and [gw], and palatalized consonants [kʲ], [gʲ], [ŋʲ], [pʲ], [bʲ], [hʲ], and [mʲ] frequently occur in the onset position of syllables in the Zo'é language. They can be interpreted either as complex sounds or as two or more sounds in a consonantal sequence in that position.

3.1.1 Affricates [ʧ] and [ʤ]

The affricates [ʧ] and [ʤ] occupy the onset of syllables that receive primary stress (tonic syllables), as shown in Table 2.

Table 2. Zo'é affricates [ʧ] and [ʤ] in tonic syllables

ʧi	'like this'
aj.'ʧi	'here'
ɔj.'ʧi	'get in'
arasi'ʧu	'araticum' (a type of fruit)
ʤɨ	'metal'
ɔ.ki.'ʤi	'was fearful' / 'is fearful'
pɨ.ɾi.'ʤɨ	(the name of a type of bamboo used to make arrows)
ku.si.'ʧe	(a type of wasp, hornet)

These affricates are also found in the onset of medial pretonic syllables in Zo'é, as can be seen in Tables 3.

Table 3. Zo'é affricates [ʧ] and [ʤ] in medial pretonic syllables

ta.ʧi.'to	'catitu' (wild boar)
ti.ʧɨ.'ɾɨ	(a type of worm)
i.ʧi.ne.'ʔã	'tired'
i.ʧu.ʤe.'ho	'dawning'
a.ʤi.'ɾe	'after'
ɔ.ʤi.'ut	'came back' / 'comes back'
a.ʤi.ɾe.'βɛ	'even so'
ɔ.ʤi.bu.'ɾik	'dived' / 'dives'

Finally, as demonstrated in Table 4, the affricates [ʧ] and [ʤ] also appear in the onset of initial pretonic syllables.

Table 4. Zo'é affricates [ʧ] and [ʤ] in initial pretonic syllables

ʧi.'ʔɛ	'just like this'
ʤa.'o	'spoke' / 'speaks'
ʤa.^{h}'pa^{t}	'is crooked'
ʤe.'ða	'inajá' (fruit of a palm tree)
ʤu.'k^{j}ɨ^{t}	'salt' / 'lye' (liquid extracted from ash for making soap)

The affricate consonants [ʧ] and [ʤ] occur where simple sounds occur. They are considered complex consonants [ʧ͡] and [ʤ̃].

3.1.2 The Labialized Consonants [kw], [ʧw], and [gw]

Table 5 shows some occurrences of three labialized consonants in Zo'é: [kw], [ʧw], and [gw].

Table 5. Zo'é labialized consonant [kw], [ʧw], and [gw]

kwa.'hɛ	'yesterday'
kwa.'si	'coati'
ɛ.ɾɛ.'kwa^{t}	'his wife'
ɛ.ri.kwa'tɛ	'number four'
i.'ʧwɛ^{t}	'he has a hole'
tej.'ʧwɛ^{t}	'anus'
i.'ʧwãm	'liar'
bɔ.'gwa	'to make pass'
bɔ.gwa.'ha	'sieve'

These consonants also occur where simple sounds occur. They are also considered complex consonants [k^{w}], [ʧ^{w}], and [g^{w}].

3.1.3 Palatalized Consonants [k^{j}], [g^{j}], [ŋ^{j}], [p^{j}], [b^{j}], [h^{j}], and [m^{j}]

Occurrences of each one of the palatalized consonants [k^{j}], [g^{j}], [ŋ^{j}], [p^{j}], [b^{j}], [h^{j}], and [m^{j}] are demonstrated in Table 6.

Table 6. Zo'é palatalized consonants [kʲ], [gʲ], [ŋʲ], [pʲ], [bʲ], [hʲ], and [mʲ]

kʲa.'ra	(a type of fish from the cichlid family)
ma.ɾa.**kʲ**a.'nã	'blue-winged macaw'
a.**kʲ**ɛ̃.do.'waj	'Y-shaped branch' (fork)
tũ.'**kʲ**ãn	'toucan'
i.'**kʲ**ɛt	'to search'
a.pɨ.'**kʲ**e	'stool' / 'bench'
i.'**gʲ**e	'inga' (a type of fruit)
ã.ʔã.'**ŋʲ**e	'his imitation'
si.'**pʲ**e	(name of a beetle with horns on its back)
taj.si.'**pʲ**ɛ	'blue-beaked toucan'
i.**bʲ**u.'si	'it is corroded'
i.'**hʲ**u	'deer'
ta.pi.'**mʲ**ã	'cooking pot'

The palatalized consonants [kʲ], [gʲ], [ŋʲ], [pʲ], [bʲ], [hʲ], and [mʲ] also occur in positions where simple sounds are found. Like the consonants exemplified in Table 4 and Table 5, these palatalized consonants are also considered complex sounds.

As demonstrated before, the analysis of Zo'é syllabic patterns revealed a that CV syllables dominate in pretonic positions (initial and medial), while CVC syllables exclusively occur in tonic positions (final). In light of this pattern, we argue that the palatalized consonants [kʲ], [gʲ], [ŋʲ], [pʲ], [bʲ], [hʲ], and [mʲ] should be categorized as complex segments in both these contexts. This aligns with the established behavior of other consonants occupying the onset position of Zo'é syllables, lending further support to the argument that all palatalized consonants function as single segments, akin to their non-palatalized counterparts in identical positions.

3.2 Approximants

Approximant sounds introduce considerably more intricate ambiguities, rendering the task of interpreting them a challenging undertaking. As posited by Pike (1947, pp. 129–130):

> Occasionally the investigator finds it difficult to decide how to handle certain of the nonsyllabic, suspicious vocoids because there are conflicting structural pressures in the language or because the structural pressure is not clear. Such a difficulty occurs in English, with nonsyllabic, postsyllabic [i] or [ɪ] in [ại], [ạu], [ọi]. It is difficult to determine whether the second element of one of these sequences is a consonant or a vowel.

In the case of the Zo'é language, this interpretation is quite complex and may require the assistance of morphology, syntax, diachronic data, and even the current orthography in use in the surroundings of the language under analysis, as suggested by Pike (1947, p. 130), as tools for interpreting these sounds:

If the investigator of a language unreduced to writing meets a situation with pressures which

are not clear, he will be forced to make an orthographical decision on the basis of the practical situation. Factors to be considered would be prevailing orthographies in the region, the attitude of other investigators, ease of printing, morphological relationships, and the like.

3.2.1 The Approximant Sound [j]

In the Tupi-Guarani protolanguage and other languages belonging to this family, the [j] sound has a broad allophonic interpretation. However, in Zo'é, due to historical factors of phonological change (Castro, 2018), this allophony has been reduced or even eliminated in some contexts. The following analysis gives a new interpretation to this sound.

3.2.1.1 Occurrences of [j] as Onset in Tonic and Pretonic Syllables

In the corpus of speech samples from Zo'é speakers that were analyzed, there are no instances of the sound [j] occurring as the onset of initial syllables. However, it should be noted that three roots, along with their inflections and derivations, were found where this sound appears to occur as the onset of medial and final syllables (Table 7).

Table 7. Occurrence of [j] at the beginning of medial and final syllables

-**ju**	'to drink'	→	a.'**ju**	'I drank'
		→	a.bɔ.'**ju**	'I gave him (water) to drink.'
-nɔ.pɨ.'**jã**	'knee'	→	ɛ.nɔ.pɨ.'**jã**	'my knee'
-pɨ.**ja^{h}**.'pɨ	'forearm'	→	ðɔ.pɨ.**ja^{h}**.'pɨ	'forearm of people'

Another plausible interpretation is that, rather than functioning as the onset of a medial or final syllable, [j] may constitute the coda of the preceding syllable, as illustrated in Table 8.

Table 8. Occurrence of [j] in the coda of a previous syllable

aj.'u	'I drank'
ɛ.nɔ.**pɨj**.'ã	'my knee'
ðɔ.**pɨj**.a^{h}.'pɨ	'forearm of people'

3.2.1.2 Free Variation Between [ɨ] and [ɨj]

The comparison of the occurrence of [ɨ] with [ɨj] in pretonic syllables following the bilabials [p], [b], [m], and [w], in the words [ɛ.nɔ.pɨ.'jã] / [ɛ.nɔ.pɨj.'ã] 'my knee' and [ðɔ.pɨ.ja^{h}.'pɨ] / [ðɔ.pɨj.a^{h}.'pɨ] 'forearm of people,' revealed a pattern of free variation of [j] in these environments, as shown in Table 9.

Table 9. Occurrence of free variation between [ɨ] and [ɨj]

pɨj.'hew / pɨ.	'hew 'night'
ɔ-pɨj.'ta / ɔpɨ. 'ta	'stopped'
bɨj.'ta / bɨ.'ta	'wait (hunting)'
mɨj.'tũ / mɨ.'tũ	'mutum'

These occurrences suggest an ongoing process of diphthongization in some Zo'é words derived from the protolanguage. Table 10 showcases examples of diphthongized sounds in Zo'é words alongside their cognates in Tupi-Guarani and Waiampi (Jensen, 1984). These comparisons suggest a pattern in the placement of the [j] sound, potentially shedding light on its historical development in Zo'é.

Table 10. Diphthongized sounds in Zo'é: evidence from cognates

Zo'é		Tupi-Guarani	Waiampi
pɨj.'tõn	'dark'	pɨ'cũn	pɨtũ
pɨj.a.hô	'new'	pɨca'cú	pɨau
pɨj.'hew	'night'	pɨ'ca	pɨa
ɛ.nɔ.pɨj.'ã	'my knee'	ɛnɨpɨ'ʔã	ɛnɨpɨʔã

Source: Jensen, 1984.

Note that the [j] sound consistently follows the [ɨ] vowel in these Zo'é words, suggesting that [j] is more likely to constitute or be part of the coda of the preceding syllable rather than the onset of the next one, as previously illustrated in Table 8.

In the case of the root {-ju} 'to drink' (see Table 7), it is understood that it is a root formed by the process of nominal incorporation into a verbal root (as in examples (29)-(31)), quite common in this language (Table 11).

Table 11. Nominal incorporation into Zo'é verbal roots

pat	+	e.'da	→	pa.rɛ.'da	'place to keep arrows'
'arrow'		'leave'			
ɛ.'pɔ	+	-ku.'tok	→	ɛ.pɔ.ku.'tok	'I washed my hand.'
'my hand'		'wash'			
pi.'rɛ	+	-pɔj	→	pi.rɛ.'pɔj	'to fish'
'fish'		'feed'			
ʔɨ	+	-ʔo	→	-ju / -ɨ.'u	'to drink / ingest liquid'
'water'		'eat' / 'ingest'			

(29) aj.u → a-ɨ.u ‘I drank / ingested liquid.’

1SG-liquid.ingest

(30) kʲaɸɛrɨ aj.'u ɸɔ.'tat → kaperɨ a-ɨ.u ‘I drank coffee.’

coffee 1SG-liquid.ingest

(31) ʔɨ aj.'u ɸɔ.'tat → ʔɨ a-ɨ.u potat ‘I will drink water.’

water 1SG-liquid.ingest FUT MKR

This fact can be confirmed by its occurrence in other Tupi-Guarani languages, as demonstrated in examples (32)-(34).

(32) Tapirapé (Praça, 2007, p. 133):

xiwã’ã-Ø mĩ **a-‘y-‘o** ‘yopai-pe

Peccary-REFER HAB 3.I-water-ingest lake-LOC

‘The peccary always drinks water at the lake.’

(33) Parakanã (Silva, 2003, 58):

o’y’o ‘to drink‘

o- **’y** ’o

3 water eat

(34) Guajajara (Harrison; Harrison, 2013, p. 156)

ui'u intransitive verb (*sic*) ‘to drink water’

Analysis: **u-'y-'u** class: **I**

3-water-ingest

Based on these data, it can be concluded that the verbal root {-ju} is formed by the incorporation of the noun [ʔɨ] ‘water’ into the verbal root {-ʔo} ‘eat / ingest,’ generating a new root {-ɨ.u} ‘to drink.’ Moreover, a meticulous examination of the corpus of past recordings revealed the following statement (35).

(35)

a-'ha t-aj.'u → a-'ha t-a.i.'u ‘I went to drink.’[2]

1SG-go PURP-1SG-ingest

Additionally, when this verbal root is prefixed by personal markers {a-}, {ɛɾɛ-}, and {ɔ-}, for example, the process of assimilation and diphthongization occurs, resulting in [aj'u] ‘I drank,’ [ɛɾɛj'u] ‘you drank,’ [ɔj'u] ‘he/she drank,’ among other examples, which will be addressed later.

In light of this analysis, it seems that [j] does not occur as an unambiguous segment in the onset position in this language.

3.2.1.3 Occurrences of [j] in Internal and External Coda Positions

In the Zo'é language corpus gathered so far, there is a wide occurrence of [j] in internal and external coda positions, predominantly appearing in pretonic initial and medial syllables, as demonstrated in Table 12.

Table 12. /j/ coda in internal and external positions

aj.'sak	'I saw him.'	ɔj.ʧ	'is in motion'
aj.'do	'I heard'	ɔj.'ða	'left'
aj.'u	'I drank'	ɛj.'kʲɨj	'pull' (imperative)
ɔj.'kʲe	'hunted'	ɔj.'kʲɨj	'pulled'
ɔj.'kʲɛt	'looked for'	ɔ-bɔj.'do	'made him hear'
ɔj.'ʧi	'entered'	ɔ-bɔj.'ʧi	'inserted; made him enter'

Although phonetically the occurrence of this sound is easily perceived in pretonic initial and medial positions in this language, considering it as a consonant in this environment is problematic because it would create an unwanted consonantal cluster, whose syllable pattern in these positions is typically V and CV. In this case, there is the possibility of interpreting these ambiguous sequences as complex vowels or as a sequence of two vowels. Phonetic analysis allows us to consider these sequences as complex vowels [aⁱ, ɛⁱ, eⁱ, ɨⁱ, ɔⁱ, oⁱ, uⁱ]. However, from a phonemic perspective, interpreting these segments as a single vowel becomes problematic, as it would add another seven vocalic phonemes /aⁱ, ɛⁱ, eⁱ, ɨⁱ, ɔⁱ, oⁱ, uⁱ/ to the phonological inventory of the Zo'é language, which, according to Burquest (2001, p. 160), may not be advisable:

> In particular, such vowel sequences may be interpreted as single vowels (referred to as DIPHTHONGS typically with one of the vowels being high), or as vowel sequences. If there is a fairly unrestricted set of such segments or sequences, such that most unambiguous vowel phonemes can occur indiscriminately in the first or second vowel slot, then a VV interpretation is usually called for. This is, again, the preferred analysis in order to avoid positing a plethora of vowel phonemes in the language.
>
> Furthermore, considering that this language allows for the occurrence of vowel sequences in distinct syllables /V.V/, such as [ɛ.a.o] 'I speak', [ɔ.a.ta] 'he walks', [a.ũj] 'there', [ɛ.rɛ.a.ɾaj] 'I forgot,' it seems plausible to consider these data as vowel sequences [a.ɛ, ɔ.ɛ, a.ɨ, ɛ.ɨ, ɔ.ɨ a.i, ɛ.i, e.i, ɨ.i, ɔ.i, o.i, u.i].

Moreover, looking at the occurrences of the verbs displayed in Table 12 and as illustrated in examples (36)–(41), concerning object marking, serial verb constructions, and subordinate clauses, it becomes apparent that their roots are characterized by the V.CV pattern, which

evince the occurrence of pretonic syllables formed by a single vowel.

(36)

a-'ha Ø-**ɛ**.'sak 'I went to see him.'

1SG-go 3-see

(37)

ɛ-'rot Ø- **ɛ**.'da 'Bring and leave it.'

IMP-bring -leave

(38)

ɔ-'hɔ Ø-**i**.'ʧi 'He went and entered.'

3-go 3-enter

(39)

ɔ-'hɔ Ø-**i**.'kʲe 'He went to hunt it (monkey).'

3-go 3-hunt

(40)

Ø-**ɛ**.do rame Ø-ehe ɔ-kuha 'When he heard about it, he knew (he found out).'

3-hear when 3-about 3-know

(41)

Ø-**ɛ**.'ða ramɛ a-pɨ.'hɨk 'When he left him, I took it.'

3-leave when 1SG-take

3.2.1.4 Phonetic Realization of /ɛ/, /i/, and /ɨ/ as [j]

Given the evidence in Table 13, Table 14, and Table 15, it is possible to establish that the phonemes /ɛ/, /i/, and /ɨ/, in morpheme boundaries, are realized phonetically as the glide [j] through the process of diphthongization.

Table 13. Phonetic realization of the phonemes /ɛ/, /i/ in verbal morpheme boundaries

[aj.'sak]	/a-ɛ.'sak/	'I saw him.'
[aj.'do]	/a-ɛ.'do/	'I heard him.'
[ɔj.'ða]	/ɔ-ɛ.'ða/	'He left.'
[ɔj.'ʧa]	/ɔ-i.'ʧa/	'He is in motion.'
[ɔj.'ʧi]	/ɔ-i.'ʧi/	'He entered.'
[ɔj.'kʲet]	/ɔ-i.'kʲe/	'He hunted.'
[ɛj.'kʲɨj]	/ɛ-i.'kʲɨj/	'Pull it.' (imperative)

Table 14. Phonetic realization of the phoneme /ɨ/ in the incorporation of an object into the verbal root

[aj.'u]	/ a.ɨ.'u/	'He drank.'
[a-bɔj.u]	/ a-bɔ.ɨ.'u/	'I made him drink.'

Table 15. Phonetic realization of the phoneme /i/ at the boundary of non-verbal words

[aj.'ʧi]	/a.i.'ʧi/	'here'
[aj.'be]	/a.i.'be/	'sharp'
[aj.'nãm]	/a.i.'nãm/	'Ainam (name of a river)
[tej.'bɛ]	/te.i.'bɛ/	'pet'
[paj.'wat]	/pa.i.'wat/	'husband'

While it occurs more convincingly in morpheme boundaries in verbs, a similar process involving the phonemes /ɛ/ and /i/ can be observed in the formation of the new words listed in Table 16.

Table 16. The process of diphthongization of /ɛ/ and /i/ in non-verbal words

aɛ	+	ʧi	→	[aj.'ʧi]	'here'
He		near			
aɛ	+	pɛ	→	[aj.'bɛ]	'sharp'
He		flat/flattened			
aɛ	+	nãm	→	[aj.'nãm]	'Ainam' (name of a river / place where a
he		dense/thick			forest is dense)
kei	+	hĩjã	→	[kej.'ɲã]	'Keinã' (name of one of the indigenous
burn		particle of repulsion			villages)
pa.'i	+	wat	→	[paj.'wat]	'husband' (he who possesses me; he who is
daddy		AGNLZ			with me)
affectionate term used by a woman for men in her immediate family					

Following the example of [paj.'wat] 'husband', it is understood that this interpretation is consistent with Jensen's (1990, pp. 49–50, the translation from Portuguese is ours (Note 1)) analysis for Waiampi when she says:

> The term **emireko** is derived from the object nominalizer (…) combined with the verb *eko 'to be (in motion)' in its causative-comitative form **er-eko**, whereas **erekʷa** is derived from the agent nominalizer (…) with the same verb:

emi + er + eko → emireko ‘object that one makes to be with oneself’

er + eko + er → erekwar (through assimilation) → erekwa ‘one who makes (someone) be with oneself’

Table 17 presents words for which the morphophonological process remains undescribed due to insufficient corroborative evidence in the data available. Nonetheless, it is plausible that this process underlies their formation or is inherent in their phonetic realization.

Table 17. Residue

[ðaj.'d͡ʒe]	→	/ða.i.'d͡ʒe/	‘scarification instrument’
[tej.'dɨt]	→	/te.i.'dɨt/	‘sister’ (biological)
[toj.'pe]	→	/to.i.'pe/	‘Toipe’ (proper name)
[koj.tĩ]	→	/ko.i.tĩ/	‘two’
[taj.'mĩ]	→	/ta.i.'mĩ/	‘old; elderly’
[tej.'pɒt]	→	/te.i.'pɒt/	‘entrails’
[uj.'tu]	→	/u.i.'tu/	‘wind’

3.2.1.5 Occurrences of [j] in Final Syllables

As illustrated in Table 18, within the coda of syllables bearing primary stress – always the final syllable in Zo’é words – the approximant [j] consistently appears and combines with the syllabic patterns VC and CVC in this position, akin to unambiguous sounds in this context.

Table 18. Words containing [j] in final syllables

[a.'kaj]	‘that’ (already mentioned)	[ɔ.pɨ.'kej]	‘shouted’
[a.'ũj]	‘that’ (for all genres)	[ɔ.pɨ.'kʲẽj]	‘dug’
[da.ku.'haj]	‘I don’t know.’	[ɔ-pɨ.'kuj]	‘rowed’
[dɔj.'doj]	‘S/he/it didn’t hear.’	[ɔ.'pɔj]	‘fed’
[kuj]	‘gourd’	[pi.'rãj]	‘piranha’ (a type of fish)
[ɔ.'kuj]	‘fell; plummeted’	[wɨ̃j]	‘there’

Some examples of unambiguous sounds in similar context are shown in Table 19.

Table 19. Unambiguous sounds in Zo'é final syllabus

[a.'mãn]	'rain'	[ot]	'(S/he/it came'
[a.'nãm]	'kin'	[pak]'paca'	
[a.'naŋ]	'Anan' (a supernatual being)	[pat]	'arrow'
[ba.de.'ʔɔk]	'manioc'	[pi.'rãŋ]	'red'
[ɔ.'pɔt]	'meat'	[ta.pi.'ʔit]	'tapir'

Although the approximant [j] is present in this position and conforms to the syllable pattern in this context, a thorough examination of further structural data in this language is necessary for a more reliable conclusion. This includes close attention to morphophonological processes, particularly at morpheme and word boundaries, as discussed in section 1.2 of this paper. However, the patterns demonstrated in that section are not adhered to when the sound [j] occurs at the end of the verbal root, leading to regressive vowel assimilation and alteration of {-ha} and {-hat} to {-hɛ} and {-hɛt}, as examples (42) and (43) demonstrate.

(42)

-pu'kej + -hɛ → [pu.kej.'hɛ] 'shout'

shout- CIRNLZ

(43)

-pu'kej + -hɛt → [ɔ-pu.kej.'hɛt] 'shouter'

shout-AGNLZ

Moreover, given the morphophonological evidence that the high front vowel [i] induces regressive assimilation of [a] to [ɛ] in this language (e.g., [tawa] 'yellow', [i-tɛwa] 'It's yellow'), it is plausible to interpret [j] as a vowel rather than a consonant.

Thus, while the occurrence of [j] in the coda of an external syllable conforms to the V, VC and CVC syllable patterns in this language, interpreting this final sound as a consonant at word and morpheme boundaries poses challenges, as it deviates from the pattern of syllable restructuring and deletion of final consonants observed for unambiguous sounds.

Considering the data and by analogy with how [j] functions within internal syllables as part of the coda, it could also be interpreted as a vowel in this context, i.e., V.V. This interpretation would make its role symmetrical in both internal and external syllables, given that diphthongization in these environments occurs only at the phonetic level.

This same process of phonetic diphthongization also occurs in an identical environment involving sentence negation formed by the combination of the discontinuous morpheme {d-/n- ...-i}, as illustrated in examples (44)–(46).

(44)

[a-kuha] 'I know' → [d-a-ku.haj] /**d**-a-ku.ha-**i**/ 'I don't know.'

1SG-know NEG-1SG-know-NEG

(45)

[a-ʔo rahɨ] 'I want to eat' → [d-a-o ra.hɨj] /**d**-a-i.do ra.hɨ-**i**/ 'I don't want to eat.'

1SG-want DES NEG-1SG-want DES-NEG

(46)

[ɔ-nupã] 'She/he hit him/her' → [n-ɔ-nu.pãj] /**n**-ɔ-nu.pã-**i**/ 'didn't hit'

3SG-bater NEG-3SG-hit-NEG

3.2.2 The Approximant [w]

The analysis of the data reveals a high frequency of the approximant [w] in this language. However, due to its potential ambiguity, a closer examination of its distribution across different contexts is necessary. In onset position, for instance, this approximant regularly occurs at the beginning of syllables, following the pattern CV in pretonic syllables and CV and CVC in tonic syllables, as demonstrated in Table 20. Therefore, in this position, it can be considered a consonant (e.g., [wa, wɛ, wi, wĩ, wɨ, wɨ̃, wɔ, wõ, wã, wũ...]).

Table 20. The approximant [w] in onset position

[ka.pi.'wɛt]	'capybara'	[ða.'wat]	'jaguar'
[ɨ.wɨ.'sɔk]	'descent'	[sɔ.wɔ.'ʔi]	'earthworm'
[ɔ.ni.'wãn]	'covered oneself'	[ta.ra.'wit]	'gecko' (a person's name)
[ɔ.sõ.'wĩn]	'fetches water'	[wa.'ra]	'Wara' (proper name)
[ɔ.ɲĩ.'wũ]	'to hit the target with an arrow'	[wa.'tɛ]	'high'
[pi.da.'wa]	'bacaba palm'		

It is important to point out, however, that at the morpheme boundary, when the third person {ɔ} occurs in the personal marking of A (subjects of transitive verbs) and S (subjects of other types of verbs) of verbs, preceding roots beginning with the open vowels [a] and [ɛ], there is a phonetic variation: the sounds in this environment are pronounced as a rising diphthong in normal speech. Therefore, in this specific case, the sound [w] is not interpreted as a consonant but as a vowel, i.e., as a variant of the vowel [ɔ] in normal speech, as demonstrated in Table 21.

Table 21. Phonetic variation of third person {ɔ-} in personal marking of A and S verbs

[**w**-a.'ho]	<	/**ɔ**-a.'ho/	'separates'
[**w**-aʰ.'pɨk]	<	/**ɔ**-a.'pɨk/	'sits'
[**w**-ɛ.'ʤɨ]	<	/**ɔ**-ɛ.'ʤɨ/	'descended'
[**w**-ɛ'rot]	<	/**ɔ**-ɛ.'rot/	'brings'

In coda position, there is a limited number of occurrences of [w], being three in internal syllables and four in external syllables, as shown in Table 22.

Table 22. The approximant [w] in coda position

In internal syllables		In external syllables	
kʲe**w**.'rɛ taj.'mĩ	'companion of Rarok'	[ɔ.'pe**w**]	'inclined'
ɾa**w**.'ri	'large hairy spider'	[ɔ.'βi**w**]	'cracked / broke'
wa**w**.bu.bu.'ru	'type of wood'	[ɔ.'sa**w**]	'dislocated'
		[pɨj.'hɛ**w**]	'night'

Note. This anomaly was found in the data: [ta**w** / ta.'ʔo] 'for me to eat' (free variation of [ta.ʔo] in faster pronunciation).

Given the syllable pattern of Zo'é, interpreting [w] as a glide in these few words, similarly to the occurrences of [j] in this environment, is problematic. To maintain a consistent analysis, this occurrence of [w] should be phonologically interpreted in the same way as those of [j], i.e., as a process of phonetic diphthongization, as observed in other contexts in this language. In light of this, it is understood that the few occurrences of [w] in the coda of internal syllables result from this morphophonological process, with this sound also being considered a vowel (V), following the V and CV syllable patterns in this environment (see examples (49)-(51)).

(49)

/ɾau.'ɾi/ 'large hairy spider'

(50)

/wau.bu.bu.'ɾu/ 'waububuru' (type of wood)

(51)

/kʲeu.ɾɛ taj.mĩ/ 'Kieuretaimin' (companion of Rarok)

PN.kieuretaimin

From the four instances of [w] occurring in external syllables, displayed in Table 22, it would be plausible to interpret this sound as a consonant in that environment because it follows the

CVC syllable pattern where unambiguous sounds occur.

However, similarly to what happens with the palatal approximant [j], when the expressions [ɔ.'βiw], [ɔ.'pew], [ɔ.'saw] and [pɨj.'hɛw] are followed by others beginning with a consonant at a word boundary, the [w] sound is not deleted as normally occurs with the other final consonants, making this interpretation difficult, as shown in Table 23.

Table 23. Non-deletion of [w] before expressions beginning with a consonant

[ɔ.'βiw + pu.'ku]	→	[ɔ.'βiw	pu.'ku]	'cracked for a long time'
[ɔ.'pew + ba.'ða]	→	[ɔ.'pew	ba.'ða]	'must be inclined'
[ɔ.'saw + ɸɔ.'tat]	→	[ɔ.'saw	ɸɔ.'tat]	'will dislocate'
[ɔ.'pew + ba.'ða]	→	[ɔ.'pew	ba.'ða]	'must be inclined'

Similarly, as exemplified in Table 24, in the morpheme junction, [w] is not deleted when followed by a suffix also starting with a consonant.

Table 24. Non-deletion of [w] followed by a suffix beginning with a consonant

ɔ.bɔ.'bew + ha	→	[ɔ.bɔ.pew.'ha]	'learning'
ɔ.bɔ.'bew + hat	→	[ɔ.pew.'hat]	'breaker'
ɔ.bɔ.'βiw + ha	→	[ɔ.bɔ.βiw.'ha]	'inclination'
ɔ.bɔ.'βiw + hat	→	[ɔ.βiw.'hat]	'breaker'

Based on this analysis, it is concluded that the sound [w] can be interpreted as a consonant only in onset position, following the syllable pattern CV in pretonic syllables and CVC in tonic syllables. However, in the coda of both pretonic and tonic syllables, it should be interpreted as a vowel to avoid generating a restricted consonantal encounter in this language, as already described previously for the [j] sound.

4. Concluding Remarks

This study has provided a phonological reassessment of specific aspects of the Zo'é language, particularly focusing on its vowel and consonant systems. Drawing on data gathered by three researchers in the late 1980s and early 1990s, the study aimed to clarify longstanding discrepancies in these areas. Through the reinterpretation of ambiguous sounds and analysis of syllable patterns across pretonic and tonic contexts, this study enhances the understanding of Zo'é's phonetic and phonological frameworks.

Systematic processes such as syllable restructuring at morpheme and word boundaries have been identified. These processes, which include the insertion of epenthetic vowels, rhotacization, and voicing, are essential for maintaining the Zo'é language's characteristic

phonological patterns. The examination of affricates, labialized, and palatalized consonants further confirms their status as complex yet integral components of the Zo'é phonological inventory.

The analysis categorizes palatalized sounds like [kʲ], [gʲ], [ŋʲ], [pʲ], [bʲ], [hʲ], [mʲ], as well as labialized sounds [kw], [ʧw], [gw], and affricates [ʧ] and [ʤ], as simple sounds. This categorization is justified by their typical positioning as full consonants and by the language's constraints on consonant clusters, which preclude the possibility of classifying these sounds as consonantal combinations.

A particularly intricate aspect of this study is the interpretation of glides [w] and [j]. The findings reveal that [w] consistently functions as an onset across syllable positions, whereas in the coda of internal syllables, both [w] and [j] align with the vowels [u] and [i], respectively. This adaptation adheres to Zo'é's limitations on consonant clustering. Although parallels with the proto-language and other Tupi-Guarani languages might suggest a consonantal role in external syllable codas, the morphophonological processes occurring at word boundaries more coherently align these sounds with vowel categorization, consistent with their internal syllable roles.

Overall, this study not only resolves major phonological ambiguities but also establishes a foundational basis for the development of a unified orthographic system for the Zo'é language. By delineating and addressing phonetic-phonological processes and their reinterpretations, the research contributes to a more accurate and cohesive representation of Zo'é. This advancement supports linguistic documentation and preservation efforts, ensuring that future research will continue to refine the phonological inventory and strive toward establishing a consistent orthographic alphabet for the Zo'é language.

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Notes

Note 1. A palara **emireko** é derivada a partir do nominalizador do objeto (…) com o verbo *eko ‘estar (em movimento)’ em sua forma causativo-comitativa **er-eko**, enquanto **erek^{w}a** é derivado a partir do nominalizador do agente (…) com o mesmo verbo:

emi + er + eko → emireko ‘objeto que se faz estar consigo’

er + eko + er → erekwar (assilabação) → erek^{w}a ‘aquele que faz (alguém) fiar consigo’

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