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Santa Barbara

Non-moraicity and weight augmentation in Shiwilu (Kawapanan)

A Thesis submitted in partial satisfaction of the
requirements for the degree Master of Arts
in Linguistics

by

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June 2021

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Matthew K. Gordon, Committee Chair

June 2021

Non-moraicity and weight augmentation in Shiwilu (Kawapanan)

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Alonso Vásquez-Aguilar

Dedicado a la dulce memoria

de Julita Inuma Inuma

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ABSTRACT

Non-moraicity and weight augmentation in Shiwilu (Kawapanan)

by

Alonso Vásquez-Aguilar

This thesis proposes that that the mid-central vowel /ə/ is non-moraic in Shiwilu (Kawapanan), following Moraic Theory (Hyman 1985, Hayes 1989) using quantitative methods and naturalistic data. The main proposal of this thesis is that the ability of this vowel to be stressed, or even to surface, is due to a mora augmentation strategy consisting of the gemination of the following segment in syllables having the mid-central vowel as a nucleus. This strategy satisfies a licensing requirement that all syllables be moraic. The thesis situates Shiwilu within a broader typology of central vowels along two dimensions: stress and position in the word. Additionally, I present a brief typology of repair strategies employed by languages to increase the mora count of syllables; Shiwilu is unique in this typology in employing gemination to turn a non-moraic syllable into a monomoraic one. This thesis also addresses a long-standing issue in research on the phonetics-phonology interface: the role of naturalistic as opposed to laboratory-based data in the evaluation of the relationship between gradient phonetic patterns and phonological categories. A quantitative demonstration of the link between moraic structure and its phonetic exponents provides support for the view that phonological weight patterns are evident even in noisy data. Results from the current study enrich both typological knowledge about the phonological behavior of central vowels and the diverse mora augmentation strategies observed cross-linguistically.

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1. Introduction

The present study propounds that the mid-central vowel /ə/ is non-moraic in Shiwilu, a Kawapanan language spoken in Northwestern Peruvian Amazonia. This hypothesis is consistent with a proposal initially advanced by Hyman (1985): that certain vowels can be non-moraic on a language-specific basis. To test this hypothesis for Shiwilu, the present study relies on the application of quantitative methods to naturalistic data. Two pieces of evidence are considered: the duration of the mid-central vowel relative to other vowels, and the gemination of the consonant following the mid-central vowel /ə/ (which always occurs in closed syllables), analyzed as a mora augmentation strategy applying in open syllables to compensate for the underlying lack of moraic status of /ə/. Because gemination is not permissible across word boundaries, schwa is consequently banned in word-final position. Results from the current study enrich both typological knowledge about the phonological behavior of schwa (and, by extension, central vowels in general) and the diverse mora augmentation strategies observed cross-linguistically.

In contrast to many non-moraic schwas in the literature, the mid-central vowel in Shiwilu can bear stress. The main proposal of this thesis is that the ability of the mid-central vowel to be stressed, or indeed even to surface, is due to the mora augmentation strategy of gemination, which satisfies a licensing requirement that all syllables be moraic.

Many languages tend to treat light and heavy syllables differently with respect to stress. In languages with weight-sensitive stress, heavier syllables tend to attract stress and lighter syllables tend to reject stress (Gordon 2016: 181). In certain languages, schwa (and other non-low central vowels) is treated as a light syllable that avoids stress, if at all possible, though absence of other more suitable vowels in a word may necessitate that schwa be stressed in some cases (Silverman 2011). Central vowels may conversely result from a lack of stress as in many languages, e.g.,

English (Lehiste & Peterson 1959, Flemming & Johson 2007) or Dutch (van Oostendorp 1995), in which unstressed vowels reduce to schwa motivated by target undershoot (Lindblom 1963, Liljecrants & Lindblom 1972), a phenomenon occurring when the articulatory organs do not reach their intended targets, deriving in a distorted final sound. Although the central vowel in Shiwilu neither rejects stress nor is the product of unstressed vowel reduction, the requirement that syllables containing the mid-central vowel /ə/ need a coda to be moraic is consistent with the notion that schwa often has a prosodically lighter status than other vowels.

At the end of the present thesis, I situate Shiwilu within a broader typology of central vowels along two dimensions: stress and position in the word.

Additionally, I present a brief typology of repair strategies employed by languages to increase the weight, i.e., mora count, of syllables. In this typology, the Shiwilu case is unique in employing gemination to turn a non-moraic syllable into a monomoraic one. Shiwilu is also typologically unusual in adopting mora augmentation as a syllable repair strategy even in unstressed positions. Where this strategy is unavailable, namely in word-final position, schwa is unlicensed. This thesis thus contributes to a better understanding of mora enhancement effects and, more broadly, syllable weight effects typologically.

This thesis also addresses a long-standing issue in research on the phonetics-phonology interface: the role of naturalistic as opposed to laboratory-based data in the evaluation of the relationship between gradient phonetic patterns and phonological categories. It is shown that the phonetic manifestations of non-moraicity and its repair are robust even in natural speech, an expansion of results that had previously been limited to controlled experimental conditions (e.g., Broselow et al. 1997, Gordon 2002). A quantitative demonstration of the link between moraic

structure and its phonetic exponents provides support for the view that phonological weight patterns are evident even in noisy data.

2. Background

This section provides the theoretical backdrop for explaining the features of the mid-central vowel in Shiwilu. The core of the discussion is couched within moraic theory (Hyman 1985, Hayes 1989) (§2.1), which assumes that moraic quantity determines duration (e.g., Hubbard 1995, Broselow et al. 1997). This section also addresses non-moraic schwas in the literature (§2.2) in order to compare what has already been said with what can be observed in Shiwilu. Essentially, schwas can be non-moraic (Kager 1989), and this absence of moras is manifested by different features, such as short duration (which is particularly relevant for the present thesis), the avoidance of stress, and greater variance in vowel quality (Shih 2018a, 2018b).

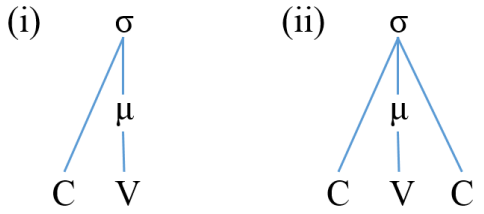
2.1.Moraic Theory

A mora (usually symbolized as μ) is a phonological unit used to determine syllable weight. It is usually assumed that onsets are non-moraic and that contrasts in duration between short segments and long segments can be represented as differences in mora count (Hyman 1985, Hayes 1989). Short vowels receive only one mora in moraic theory, while long vowels receive two. Geminate consonants are underlying associated with a mora, while singleton consonants are non-moraic underlyingly, though they may receive a mora on the surface in one of the two ways. In many languages, coda consonants are moraic, which is captured by Hayes' (1989) Weight-by-Adjunction parameter, in which the author proposes that the coda consonant is adjunct to the preceding mora. A consonant may also become moraic through gemination, a strategy observed in Shiwilu.

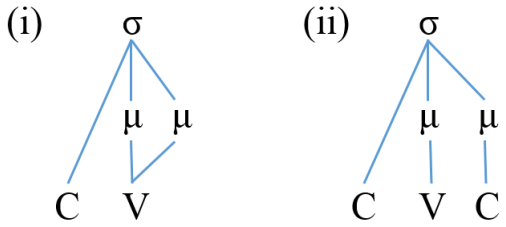
The distinction between light and heavy syllables can also be explained in terms of moras: syllables with more than one mora are considered heavy, while syllables with only one mora are light. In summary, the theory of phonological weight (Hyman 1985, Hayes 1989) distinguishes syllables according to the number of moras that they may contain. These distinctions are summarized in Figure 2.1 where the status of CVC as monomoraic or bimoraic is language-specific:

Figure 2.1. Syllable weight typology

a. Monomoraic or light syllables (σ_{μ})



b. Bimoraic or heavy syllables ($\sigma_{\mu\mu}$)



As can be inferred from Figure 2.1, moraic theory assumes that moras are projected from segments in the rime as a function of their length and sonority (Gordon 2016: 159). Theories differ as to which sonority-driven weight effects are encoded in mora count (see Shih 2018a, 2018b), and

stress assignment is typically taken as one of the most important diagnostics for syllable weight. In Shiwilu, however, stress is fixed (see §3) and thus does not diagnose weight.

Phonological weight theory assumes that all CV syllables are monomoraic, and CVV syllables are bimoraic. However, the classification of CVC syllables as monomoraic or bimoraic can vary across languages because of differences in the moraic status of coda consonants (Hayes 1989, Broselow et al. 1997). Since vowels in Shiwilu do not show a functional length contrast, syllable weight cannot depend on vowel length. Given this situation, syllable weight is based on the nucleus of the syllable and of its coda. It is often assumed that every well-formed syllable must have at least one mora (Hyman 1985). The current study adopts this assumption for Shiwilu and further assumes that the mid-central vowel is non-moraic while consonant codas are moraic. This presumed weight profile will be shown to offer an account of the distribution of schwa in Shiwilu and its durational relationship with the following consonant.

Phonological weight can be diagnosed through various properties. In Gordon (2006), six weight-sensitive phenomena are examined: (a) weight-sensitive stress, (b) weight-sensitive tone, (c) minimal word requirements, (d) metrics, (e) compensatory lengthening, and (f) syllable template phenomena (i.e., closed syllable vowel shortening). Some of these phenomena are not present in Shiwilu. For instance, the fixed position of the stress indicates that weight-sensitive stress is not probative for diagnosing weight. Furthermore, no evidence for weight-sensitive metrics, whether from recited or sung verse, has thus far been discovered. Since Shiwilu is not a tonal language, weight-sensitive tone needs to be discarded as well.

Word minimality, however, offers insight into weight in Shiwilu. Every monosyllabic content word consisting of an open syllable must contain a vowel other than the mid-central /ə/,

and /ə/ may only occur in a closed monosyllable. The words in (1-8) provide a representative sample of permitted monosyllabic content words in Shiwilu.

(1) [pən]	'fire'	(5) [pi]	'fruit'
(2) [ð̩ək]	'water'	(6) [ʌin]	'name'
(3) [la]	'vagina'	(7) [ð̩u]	'nettle'
(4) [jaʔ]	'yesterday'	(8) [nun]	'canoe'

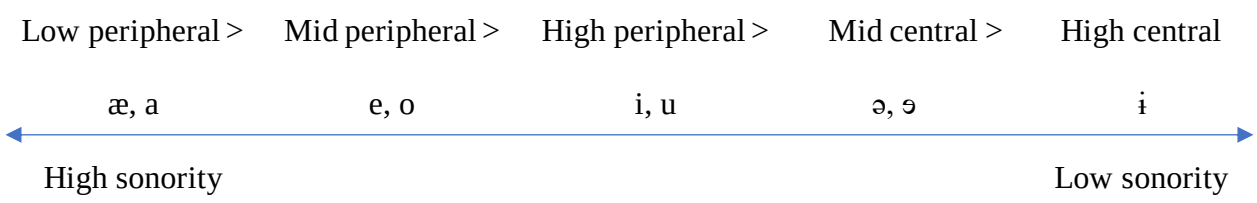
The distribution of monosyllabic words follows from the non-moraicity of /ə/. Words, or even syllables, of the form Cə are prohibited because they lack a mora and are thus prosodically unlicensed.

2.2.Non-moraic schwas in the literature

Shih (2018b) proposes an enriched representation for central vowels, focusing on schwas but also applicable to other non-low central vowels. Thus, although the mid-central vowel in Shiwilu that is the focus of this thesis is slightly higher than canonical schwa (Valenzuela & Gussenhoven 2013), the schwa representation in Shih (2018b) can be extended to this vowel. In line with the language-specific parametrization of weight, Shih states that schwas can be either non-moraic, monomoraic, or bimoraic. In fact, these three different types of schwas can appear in the same phonological inventory, such as in Piuma Paiwan (Shih 2018a, 2018b).

Schwa vowels appear in a very low position in the sonority scale of vowels, based on height and centrality of vowels, as presented in Figure 2.2 (adapted from Kenstowicz 1997, de Lacy 2002, Gordon 2006).

Figure 2.2. Sonority hierarchy for vowels



Non-moraicity of schwa follows from its low position in the sonority hierarchy relative to peripheral vowels (Kager 1989, Shih 2018b). As Gordon et al. (2012) mention, the phonetic founding of this scale or hierarchy may not be reducible to a single acoustic parameter (except for the correlation between vowel height and both duration and intensity, in that lower vowels are longer and more intense than higher vowels (Lehiste 1970, in Gordon et al. 2012).

However, the non-moraicity of schwas (and other central vowels) is plausibly articulatorily grounded (Shih 2018b: 21-22), since the tongue position associated with this vowel is closer to the default center of the vocal tract, thus requiring less movement of the tongue and less effort to reach its target in contrast to its peripheral counterparts (Gordon 2012). Its centrality in the vowel space thus potentially affects its duration and thus its moraic status.

Hyman (1985) proposed that schwa can be either 'weight-bearing or 'non-weight bearing'. That is, schwas can be either moraic or non-moraic. Shih (2018b) found that non-moraic schwas can be present in Piuma Paiwan, forming so-called 'minor syllables' (after Matteson 1965, Lin 1998, among others). These syllables are often called 'defective syllables' and lack some crucial elements of a regular syllable (Shih 2018b: 63), such as the nucleus, the mora, the syllable node, and vocalic features of the nucleus. Shiwilu contradicts this pattern in that syllables that contain the mid-central vowel have a coda, either underlyingly or through gemination of the following

onset; so, despite its non-moraic status, syllables with mid-central vowels in Shiwilu are not minor syllables.

It is well established that the moraic status of schwa (or any other central vowel) is detectable via duration and variation in vowel quality (F1 and F2). Non-moraic schwas have minimal duration (Shih 2018b finds that the duration of a non-moraic schwa in Piuma Paiwan is around 50ms, in contrast to the 70-80ms of monomoraic schwas in the same language; see also Crosswhite 1999) and greater quality variance than other vowels (or moraic counterparts of schwa, as happens in Piuma Paiwan). While the first feature is in line with the findings of this study (see §5), the second one is left for future studies.

The non-moraic behavior of vowels is often linked to their epenthetic status. An epenthetic vowel can be defined as a vowel added to an utterance to "repair an input that does not meet a language's structural requirements" (Hall 2011: 1576). According to Piggot (1995), some epenthetic vowels are weightless; thus, they lack a mora. However, in contrast to being linked to epenthesis, the mid-central vowel in Shiwilu is weightless despite *not* being considered epenthetic, as shown in §5.

3. Shiwilu phonetics, phonology, and phonotactics

This section explores some phonetic and phonological features of Shiwilu that are relevant for this thesis's purposes. §3.1. explores the segmental phonology, in which the consonants and vowels of Shiwilu are sketched, emphasizing the mid-central vowel, which I transcribe as /ə/ following Valenzuela & Gussenhoven (2103), a study that is especially relevant to the present thesis. §3.2. explores the phonotactics, syllabification, and stress patterns in Shiwilu.

3.1.Segmental phonology

This section explores consonants (§3.1.1) and vowels (§3.1.2) in Shiwilu, focusing in particular on the mid-central vowel /ə/.

3.1.1. Consonants

Shiwilu has a set of 18 consonants, which are shown in Table 3.1. The practical orthography is provided in angled brackets. As can be seen, voicing is not distinctive for Shiwilu consonants.

Table 3.1: Shiwilu consonants (adapted from Valenzuela forthcoming)

	Labial	Alveolar	Palatal	Velar	Glottal
Plosive	p <p>	t <t>		k<k>, kʷ <ku>	ʔ <'>
Affricate			t͡ʃ <ch>		
Nasal	m <m>	n <n>	ɲ <ñ>		
Fricative		s <s>	ʃ <sh>		
Trill		ɾ <r>, ʔɾ <r'>			
Lateral		l <l>	ʎ <ll>		
Approximant	w <w, u>	ð̞ <d>	j <y>		

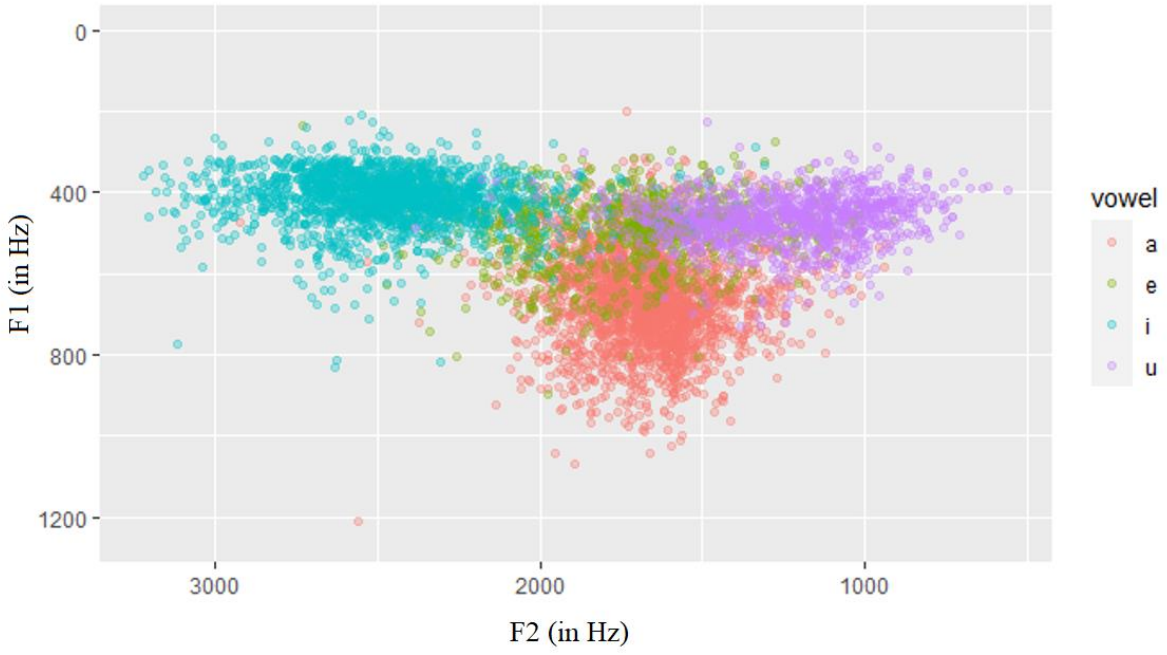
It is important to notice that /ɾ/ and /ʔɾ/ are contrastive word-internally and word-finally, as mentioned by Valenzuela & Gussenhoven (2013: 99). The latter segment's glottalization can be lost word-finally, leading to neutralization between these two sounds in this position. Nonetheless, /ʔɾ/ only occurs after the vowel /ə/, whose status is the focus of this thesis. Bendor-Samuel (1961: 21) indicates that the glottalization of the segment /ʔɾ/ constitutes a prosodic feature in syllables having the mid-central vowel /ə/ as its nucleus. According to the same author (op. cit.), glottalization can also occur after /k/ as an alternative realization of this consonant's gemination between the mid-central vowel and another vowel. The prosodic nature of glottalization is also assumed by Madalengoitia Barúa (2013), but in a following work (Madalengoitia Barúa 2018),

this author included not only /ʔ/, but also /ˀɾ/ as part of the Shiwilu consonant inventory, saying that more evidence was needed to prove the hypothesis of glottalization as a prosodic feature in Shiwilu.

3.1.2. Vowels

Shiwilu has a set of four distinctive vowels. Two are high: /i/ and /u/[1], one is mid: /ə/, and one is low: /a/. Vowels have no quantity or nasality contrasts, and all of them can appear as the nucleus of a syllable. The distribution of the Shiwilu vowels is presented in Figure 3.1, which plots first and second formant values from 7 female speakers.

Figure 3.1. Vowel Spaces for Shiwilu



[1] Occasionally, the vowel /o/ is found in loanwords from Spanish and in some native Shiwilu words. Nonetheless, Valenzuela & Gussenhoven (2013: 101) find that the pronunciation of /u/ varies from [ʉ̞] to [ọ]. In the present work, these two sounds are treated as allophones of the phoneme /u/.

The mean values for F1 and F2 for each vowel are presented in Table 3.2.

Table 3.2: F1 and F2 values of Shiwilu vowels (in Hertz)[2]

Vowel	F1 means	F1 CI [5%, 95%]	F2 means	F2 CI [5%, 95%]
/i/	421	[418, 425]	2446	[2433, 2458]
/u/	472	[469, 476]	1278	[1264, 1292]
/ə/	506	[501, 510]	1772	[1757, 1787]
/a/	667	[663, 672]	1689	[1683, 1696]

The mid-central vowel /ə/, which is the focus of the present research, has exceptional phonetic and phonological features that differentiate it from the other vowels in Shiwilu (more about this in §5). This vowel is extremely short, being often only 50ms long (Valenzuela & Gussenhoven (2013) found in their corpus an even shorter average duration, between 20-40ms), and sometimes it completely disappears, leading to a sequence of consonants that, in typical situations, would be disallowed (see §3.2.1).

In the present corpus, the mid-central vowel /ə/ never appears before a glottal stop, a characteristic also found in Valenzuela & Gussenhoven (2013). Another interesting feature of this vowel is that it is the only vowel in the Shiwilu inventory that can never appear in an open syllable. Thus, when the mid-central vowel /ə/ underlyingly occurs before some consonants that belong to the following syllable (occurring, then, as the nucleus of an open syllable), these consonants are geminated, and the first half of the geminated segment functions as the coda of the syllable with the mid-central vowel /ə/ as its nucleus. The consonants that can undergo gemination under this context are /k/ <k>, /t͡ʃ/ <ch>, /ʎ/ <ll>, /n/ <n>, and /ɲ/ <ñ>. When /n/ or /ɲ/ is geminated, the first

[2] Values were rounded up to correspond to integer values. 95 % Confidence intervals format correspond to [LL, UL], where LL= lower limit and UL= upper limit of the confidence interval.

half of the geminated segment is usually realized as a velar nasal stop /ŋ/. The other consonants of the consonant inventory presented in Table 3.1 were not found after the vowel /ə/, except for /ɾ/ and /ˀɾ/, which may occur after /ə/ but do not geminate. In the gemination of the affricate consonant /t͡ʃ/, only the plosive segment /t/ is lengthened. The consonant /ɲ/ sometimes geminates as /ŋ/, while the first half of the geminated outcome of /k/ can occur as [t]. The present study will treat these cases of consonant lengthening as a mora augmentation/enhancing strategy (§5.2). Since we see that in some cases the quality of the consonant from singleton to geminate change (as in the /k/ case), it can be argued that these cases should not be considered as gemination, but as epenthesis. For ease of exposition, I will call all these mora-increasing strategies "gemination", although it is important to keep in mind this differentiation, which may be topics of future research.

The gemination of intervocalic consonants after /ə/ occurs regardless of the position of the stress (§3.2.2.). Some examples of this gemination process are shown below (12, 13, and 15 taken from Valenzuela 2014):

(11) [ˈə**ʎ.ʎ**a] 'renaco tree (Ficus trigona)'

(12) [tə**k.**ˈ**k**wa.tək] 'cowardly, fearful'

(13) [ə**t.**ˈ**t͡ʃ**ə.la] 'termite'

(14) [lan.ˈɣə**ŋ.n**a] 'fish gills'

(15) [lan.ˈsə**ŋ.ɲ**a] 'sugar cane'

As mentioned above, evidence that gemination occurs in response to the non-moraicity of the mid-central vowel /ə/ in Shiwilu is developed further in §5.2. The sequence /wə/ is sometimes reduced to /u/, which seems to be one of the few sources of variation among speakers found in Shiwilu.

These characteristics of the mid-central vowel /ə/ in Shiwilu are further explored in §5, since they constitute evidence for the hypothesis of non-moraicity discussed in this thesis.

3.2.Phonotactics and syllabification patterns

The present section explains the phonotactics and the syllabification patterns that govern the phonology of Shiwilu. § 3.2.1 describes the possible syllable structures in Shiwilu, §3.2.2 explains the stress patterns of Shiwilu, and §3.3.3 explains syllable weight in Shiwilu.

3.2.1. Syllable structure

The basic syllable structure in Shiwilu native words is (C)V(C)[3]. According to Valenzuela & Gussenhoven (2013: 98), all consonants except /ʔ/ and /ˀɾ/ can occur in the onset, a distribution that is corroborated in the corpus used for the present study. Even though in Valenzuela & Gussenhoven (2013) the consonant /kʷ/ is not treated as such, but rather as a sequence of consonants, the present work takes the approach of Valenzuela (2012) and Madalengoitia-Barúa (2013[4], 2016), which treats /kʷ/ as a single consonant. CC onsets are found in some loanwords, such as /ˈpwi.ɲu/ 'water jar', borrowed from Quechua (Valenzuela & Gussenhoven 2013: 98). So far, it seems that all the CC onsets coming from loanwords are plosives + liquids/glides. The consonants that can occur in coda position are /k/, /ʔ/, /ˀɾ/, /ɾ/, /n/. Additionally, as mentioned in §3.1.2, /t/ can occur as a coda when the consonant /t͡ʃ/ occurs between /ə/ and another vowel (e.g., /ət.t͡ʃək/ 'k.o. agouti'). The consonants /ʎ/ and /ɲ/ are also geminated when they occur after /ə/ and

[3] Complex onsets and complex codas are also possible due to phonological processes related to lenition and deletion of the mid-central vowel. For example, the word *terapalli* [tər.ˈa.pa.ʎi] 'to plant' is usually realized as *trapalli* [ˈtra.pa.ʎi], changing its syllabic structure.

[4] Madalengoitia-Barúa (2013) does not consider the glottal stop /ʔ/ as a phoneme, but as a prosodic feature of the language. This analysis is abandoned in a later work of the same author (Madalengoitia-Barúa 2018). In the present study, /ʔ/ is considered a phoneme.

before other vowels; thus, in those situations, they can occur as codas as well. According to Valenzuela & Gussenhoven (2013: 99), the complex coda /rn/ is found in words such as /ˈmurn.ka/ 'bubbles' and /ˈsərn.pa/ 'pineapple'; but these may come from an earlier /rən/ sequence.

Accordingly, not all combinations of the four vowels and the possible coda consonants are equally attested or even attested at all in Shiwilu. Table 3.3, adapted from Valenzuela & Gussenhoven (2013: 99), shows the legitimate word-final VC structures in Shiwilu. The symbol '+' indicates that the VC combination is pervasively present in the language, while '-' is used when no cases are attested. Whenever the VC combination is rare, it is explicitly indicated in the table.

Table 3.3. Legitimate word-final VC structures in Shiwilu (adapted from Valenzuela and Gussenhoven 2013: 99)[5]

	k	n	r	ʔr	ʔ
ə	+	+	+	+	-
i	+	+	+	-	+
u	+	+	*rare*	*rare*	+
a	+	+	*rare*	-	+

3.2.2. Stress

The stress pattern in Shiwilu words is largely predictable. There is only stress per word (as also mentioned in Valenzuela & Gussenhoven 2013: 101), and its location is fixed and thus is not used to distinguish different lexemes. Regular stress occurs on the second syllable of the word, as in /a.ˈma.naʔ/ 'jaguar.', /pan.ˈwa.la/ 'tapir', and /aʔ.ˈdaʔ.wi.lək. ʎi/. However, word-final stress is avoided. For this reason, disyllabic words have initial stress, as in /ˈwam.piʔ/ 'owner of the carnival (kind of spirit).', /ˈu.wan/ 'k.o. frog', /ˈa.sək/ 'here', /ˈi.paʔ/ and /ˈəʎ.ʎa/ 'renaco tree (Ficus trigona)'. From these examples we can see that there seems to be no sensitivity to weight in

[5] It is important to notice that the cases presented in this table only involve codas that are not the first half of geminates.

positioning stress, as open syllables and onsetless syllables freely attract stress from heavier syllables.

Stress is to a minor extent sensitive to morphology. The vocative case shifts the stress towards the last syllable, and some affixes attract stress. Valenzuela & Gussenhoven (2013: 102) found the following affixes that change the regular stress patterns: the desiderative prefix /ja/ attracts stress; the locative suffix /k/ (or /kə k/ after stressed syllables) attracts stress when suffixed to words with fewer than three syllables; the 3sg participial suffix /an/ attracts stress when suffixed to a monosyllabic verb; the emphatic affirmative /un.ˈta.na/ is inherently stressed, so every word to which it is attached loses its stress; and the particle /t͡ʃi/, which is used by male speakers after a word to express regret, imposes stress on the preceding syllable.

Additionally, there are some roots with an irregular stress pattern. Some of these words, also mentioned in Valenzuela & Gussenhoven (2013: 102), are /si.ˈmir/ 'Varadero (place name)', /wi.ˈa/ 'squirrel', and /ˈin.ka.tuʔ/ 'four'. It is noteworthy that words with exceptional stress patterns keep them when the locative suffix /k/ ~ /kə k/ is attached to them, such as /si.ˈmir. kə k / 'in Varadero', instead of */si. mir.ˈkə k / (recall that the locative suffix /k/ ~ /kə k/ attracts stress in regular contexts) .

Table 3.4 shows word examples with different syllable structures in Shiwilu, which demonstrate the stress in the expected (peninitial) position of trisyllabic and longer words and the initial syllable of disyllables. As can be seen, syllable weight does not seem to affect stress patterns, as stress appears in a fixed position in Shiwilu (with the exceptions mentioned above).

Table 3.4. Syllable structures and stress patterns in Shiwilu words

Syllable structure	Word examples
CV	/ǰu/ 'k.o. nettle'
CVC	/pɘn/ 'fire'
V.CV	/ˈɘ.ʎa/ 'renaco (k.o. tree)'
V.CVC	/ˈu.wan/ 'k.o. frog'
CV.CV	/ˈpa.wi/ 'k.o. jicara'
CVC.CV	/ˈtun.la/ 'k.o. worm'
CV.CVC	/ˈǰu.kɘɾ/ 'moon'
CVC.CVC	/ˈtun.tun/ 'small drum'
V.CV.CV	/u.ˈki.la/ 'lightning'
V.CV.CVC	/a.ˈmi.kuʔ/ 'ancestors'
CV.CV.CV	/mu.ˈǰi.la/ 'nipple'
CV.CV.CVC	/wa.ˈla.tɘk/ 'k.o. fish'
CVC.CV.CV	/pan.ˈwa.la/ 'tapir'
CVC.CV.CVC	/ ǰun.ˈsa. ǰɘk/ 'shore'

3.2.3. Syllable weight

As mentioned in §2.1, moraic theory (Hyman 1985, Hayes 1989) distinguishes syllables according to the number of moras they contain. Figure 3.2. shows the syllabification configurations in Shiwilu. On the top level, representations for syllables containing the peripheral vowels [a, i, u] are presented (where V stands for any peripheral vowel, i.e., vowel other than /ɘ/), and below it, the representations for syllables containing the mid-central vowel /ɘ/.

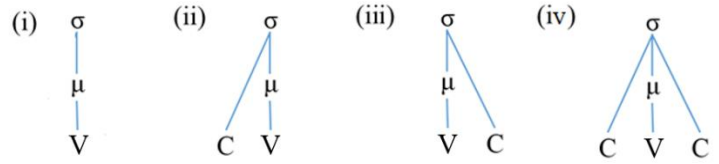
In all syllables, onset consonants are non-moraic in keeping with their lack of a role in predicting phonotactic patterns or weight-driven phenomena in Shiwilu. The only syllable nuclei that are moraic are /a, i, u/, as evidenced by their occurrence in open syllables, in contrast to /ɘ/, which does not occur in open syllables. This asymmetry between peripheral and central vowels falls out from the premise that every well-formed syllable must contain at least one mora. In syllables containing a peripheral vowel, there appears to be no evidence directly bearing on the weight status of coda consonants. Such hypothetical evidence could be a restriction against closed

syllables containing a peripheral vowel nucleus, a pattern that would argue for codas being non-moraic following a peripheral vowel. Alternatively, evidence for closed syllables containing a peripheral vowel behaving heavier than other syllable would suggest that such syllables are bimoraic. In the absence of such evidence (further research is needed to address this issue), closed syllables containing a peripheral vowel are tentatively assumed here to be monomoraic, though nothing crucial hinges on this assumption.

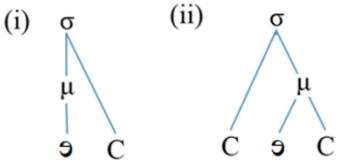
On the other hand, syllables having the mid-central vowel /ə/ as the nucleus have a different moraic configuration. The prohibition against schwa in open syllables in Shiwilu falls out naturally if /ə/ is non-moraic. A following coda consonant, whether underlying or resulting from gemination of the following onset, adds a mora that allows a syllable containing /ə/ to be licensed and thus eligible for stress just like any other vowel. This contrasts with other languages in which non-moraic syllables are allowed to surface but tend to avoid stress due to their non-moraicity (Shih 2018b). It is further assumed that the coda following /ə/ in Shiwilu does not bear the required mora independently but shares it with the mid-central vowel /ə/, thereby allowing stress to be licensed via the nucleus following Shih's account (2018b). This is how closed syllables having the mid-central vowel /ə/ as a nucleus are monomoraic.

Figure 3.2. Shiwilu syllabification constraints and mora bearing of segments

1. /V/ where V = /a, i, u/



2. /ə/



4. Data and methodology

This section explains the origins of the data and the methodology followed for the present study. §4.1 describes the data and how it was managed, and §4.2 explores the methods used for testing the predictions in §5 and §6.

4.1.Data

The data used in the present study consists of a series of narratives recorded in the cities of Iquitos, Jeberos, and Yurimaguas, between July and August of 2019. In total, approximately 57 minutes and 43 seconds of recordings collected from 7 female native speakers of Shiwilu were used in the present research. All were bilingual in Spanish and Shiwilu. The speakers who participated in this research were between 58 and 88 years of age at the time of the recordings. The texts used in this data all come from naturalistic speech, generally folkloric stories, anecdotes, or legends. All the

recordings were made with a Tascam Linear PCM DR-100MKII recorder at a 44.1K sampling rate and 16-bit quantizing rate, with its built-in microphone.

The transcription and translation of the texts were made with the assistance of one of the participants using the ELAN software (Sloetjes and Seibert 2016). After the texts were transcribed, they were segmented by the author (with the assistance of undergraduate researchers) into large prosodic phrases, equivalent to the Intonation Unit (Chafe 1994), words, and individual segments using the software Praat (Boersma & Weenink 2018). The labeled sound files were then run through a customized Praat script to obtain acoustic measurements. From the TextGrids, the duration of each segment was retrieved. The first three formants were calculated over a 25-millisecond window centered around the mindpoint of each vowel. The resulting annotated and segmented files were later exported to a txt. file, and posteriorly processed and statistically analyzed in R (R Development Core Team 2013).

Spurious formant values retrieved by the customized Praat script were manually corrected. In the end, 1655 vowels were manually corrected either for F1, F2, or both. There were also 222 vowels for which the formant values were completely unretrievable, so these were not included in the present analysis. After excluding the non-fixable spurious data and the only male speaker in the corpus for uniformization of the data, the data counted with 6183 individual vowels, distributed among 12 different texts and 7 speakers.

4.2.Methodology

To test the central hypothesis of this thesis, which is that the mid-central vowel /ə/ in Shiwilu is non-moraic, I rely on different tests developed further in §5. The predictions of a non-moraic mid-

central vowel in Shiwilu are that: a. the mid-central vowel /ə/ is shorter than the other vowels; b. the consonant in the onset of a syllable following the mid-central vowel /ə/ (but not other vowels) is geminated due to the non-moraic status of /ə/ coupled with the requirement that every syllable have at least one mora. It is further hypothesized that lengthening of the consonant after /ə/ is limited to open syllables since closed syllables are already moraic and thus in no need of augmentation. To test this, I conducted a study of the effect of the relationship between vowel duration and the duration of the following consonant word medially, the context in which gemination is reported.

To test these hypotheses and answer these questions, I rely on different variables, such as the duration of the vowels, the duration of the following segments, the position of the vowel within the IU, and whether the vowels in question were stressed or not. §5 explain the models applied to test the different hypotheses and answer the relevant questions.

The values of each measure were analyzed using linear regression models, using the packages *dplyr* (Wickham et al. 2021), *car* and *effects* (Fox & Weisberg 2019).

5. Non-moraic mid-central vowel in Shiwilu

This section explores the hypothesis that the mid-central vowel /ə/ is non-moraic in Shiwilu using quantitative methods. We explore the durational properties of this vowel in contrast with the other vowels in Shiwilu (§5.1) and the evidence for gemination of the consonant following the mid-central vowel /ə/ in an otherwise open syllable (§5.2). Model fitting and selection was done as discussed in Gries (2013: Section 5.2).

5.1.Duration evidence

The main claim of the present study is that the mid-central vowel /ə/ in Shiwilu is non-moraic. One of the main characteristics of non-moraic schwas (and, by extension, mid vowels) is that they have an extremely short duration (Crosswhite 1999, Shih 2018b). Valenzuela & Gussenhoven (2013) already indicated that the mid-central vowel /ə/ in Shiwilu is shorter than the others, but the authors did not use quantitative methods in their study. To test whether this was consistent with the present data, a linear model was fit to predict the duration of the different vowels on Shiwilu under different stress and phrasal conditions. For the model, duration (logged to the base of 2 to reduce skewness on the data) served as the dependent variable and the stress conditions (stressed or unstressed) and the relative position within the phrase (word-non-final, word-final but phrase-medial, and phrase-final) as independent variables. Monosyllabic words were excluded for this linear regression and for the other two ran in the present study since stress is considered here as the relative prominence of a syllable with respect to the others within a word, which does not apply in monosyllable cases. Table 5.1 shows the number of tokens analyzed after this subsetting.

Table 5.1. Number of tokens analyzed in the first model

e	a	i	u
902	2459	1716	1004

For the modeling, I used orthogonal contrasts for the elements of the variable Segment (SEGM) to compare, first, the mid-central vowel /ə/ ("e" in the model) against the other vowels, then the vowel /a/ against the other high vowels, and finally /i/ against /u/. The variable SEGM was allowed to interact with both POSinIU and STRESS. The adoption of these independent variables follows from the well-documented tendency for both stress and final position to be associated with increased duration. Given that the study of phrasal prosody in Shiwilu is still in its infancy, a large

phrasal constituent, equivalent to the Intonational Phrase or Intonation Unit (depending on the prosodic framework), was conservatively adopted as the relevant phrase unit.

The model was significant (F=123.6, df_1=15, df_2=6065, p<0.005***), but with overall weak explanatory power (adjusted R^2=0.2322). A single-term deletion test was applied to check whether all the variables and interactions were significant in the model. The interaction SEGM:POSSinIU was significant (p<0.005**), but the interaction SEGM:STRESS (p=0.05287) was not significant. Nonetheless, it is still reported here because of how suggestively close to 0.05 this p-value is. This regression model was the final model used to test whether the duration of the mid-central vowel /ɘ/ was significantly shorter than the others in Shiwilu.

Table 5.2. Single-term deletions of the model testing duration of /ɘ/

	Df	F value	Pr (>F)
SEGM:POSinIU	6	20.3968	< 2e-16 ***
SEGM:STRESS	3	2.5647	0.05287 .

The coefficients of the regression model are shown in Table 5.3.

Table 5.3. Regression coefficients for the linear model of Duration of vowels in function of Stress and POSinIU

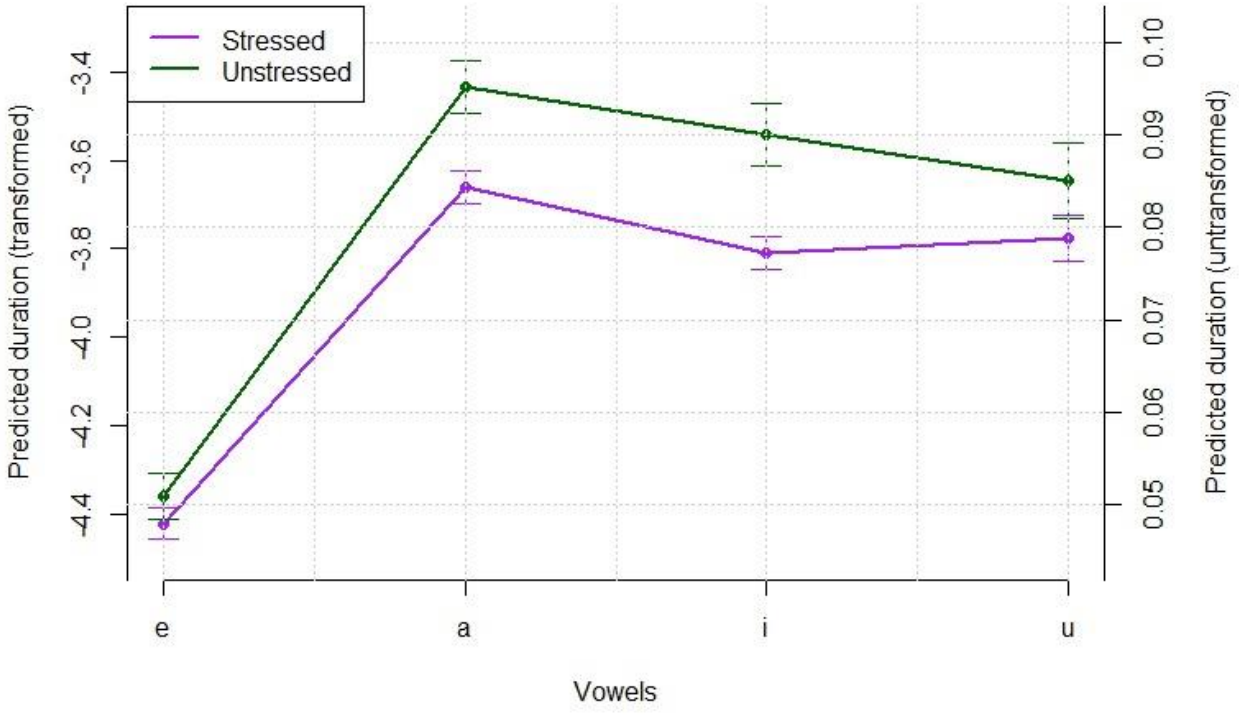
	Estimate	SE	t-value	p-value
(Intercept)	-3.46562	0.02758	-125.650	< 2e-16 ***
SEGMe_vs_rest	-1.22729	0.06525	-18.809	< 2e-16 ***
SEGMa_vs_iu	-0.14256	0.05695	-2.503	0.012335 *
SEGMi_vs_u	0.22391	0.08687	2.577	0.009977 **
POSinIUwordfinal	-0.36502	0.04053	-9.007	< 2e-16 ***
POSinIUwordmedial	-0.41076	0.02974	-13.812	< 2e-16 ***
STRESSY	0.14709	0.01878	7.831	5.66e-15 ***
SEGMe_vs_rest:POSinIUwordfinal	0.32834	0.08965	3.663	0.000252 ***
SEGMa_vs_iu:POSinIUwordfinal	0.25589	0.08585	2.981	0.002888 **
SEGMi_vs_u:POSinIUwordfinal	-0.18209	0.13243	-1.375	0.169188
SEGMe_vs_rest:POSinIUwordmedial	0.57157	0.07244	7.890	3.55e-15 ***
SEGMa_vs_iu:POSinIUwordmedial	0.28855	0.06075	4.750	2.08e-06 ***
SEGMi_vs_u:POSinIUwordmedial	-0.29390	0.09183	-3.201	0.001379 **
SEGMe_vs_rest:STRESSY	**-0.08271**	**0.04989**	**-1.658**	**0.097392 .**
SEGMa_vs_iu:STRESSY	0.01029	0.03757	0.274	0.784072
SEGMi_vs_u:STRESSY	0.11061	0.05340	2.071	0.038376 *

The results of the model show that, overall, the duration of the mid-central vowel /ə/ is significantly shorter than the other vowels (SEGMe_vs_rest $p<0.005$***).

As shown in Figure 5.1 below, stress does not significantly affect the duration of the mid-central vowel /ə/ compared to the other vowels (as reported in Table 5.1.1). Note that the confidence intervals of both stress conditions for this vowel overlap and that the predicted values appear very close to one another. In contrast, the confidence intervals of the two different stress conditions of the peripheral vowels do not overlap and the predicted values for the two stress conditions for these vowels appear more distant one to another than in the mid-central vowel /ə/

case. Moreover, /ə/ persists in being significantly shorter than the other vowels no matter the stress condition.[6] The back-transformed values are shown at the right of the plots.

Figure 5.1. Interaction of Stress and Segment (log. scale) on the Shiwilu vowels

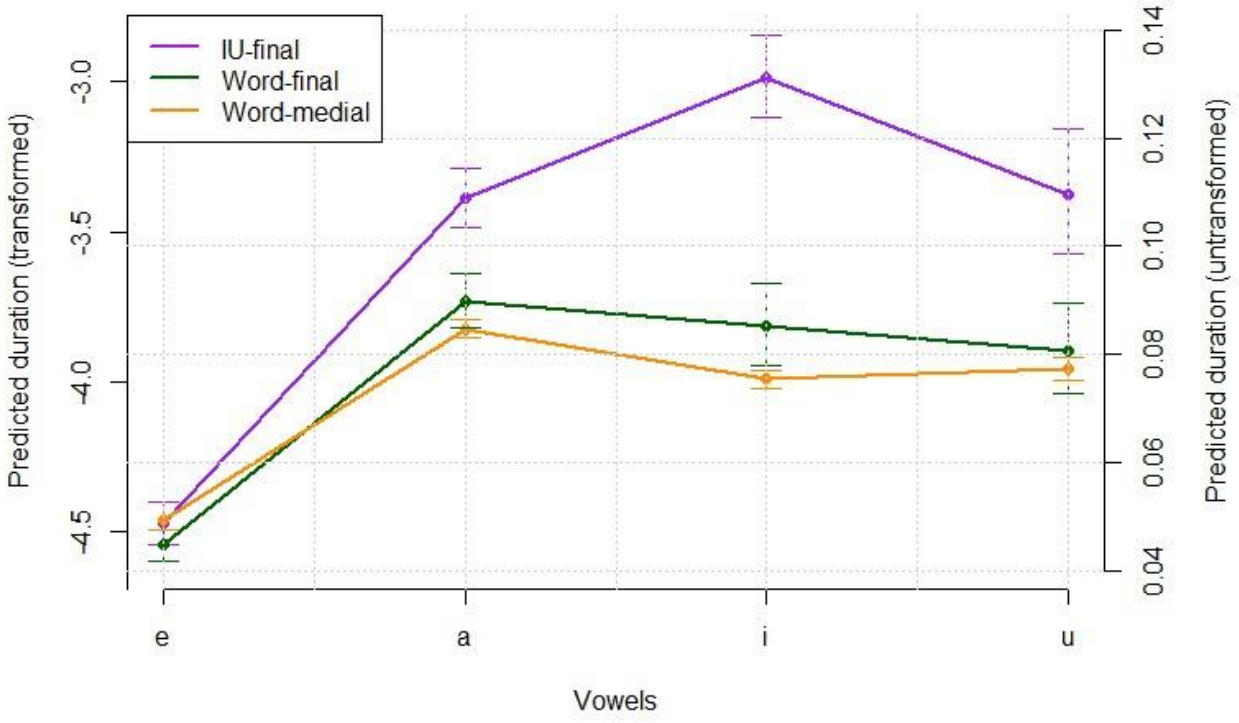


Similarly, Figure 5.2 shows that the duration of the mid-central vowel /ə/ does not significatively change depending on the POSinIU it is, and the tendency of /ə/ to be significantly shorter than the other vowels is evident regardless of position. We can observe this behavior from the overlapping confidence intervals of the three different positions within the word represented by the three different colors in the mid-central vowel /ə/. Note also that the predicted values for this vowel are

[6] The profile of stress between geminates and singletons could cue syllabification. This is something to be investigated in future studies.

very close together in general. It is important to mention that the word-final and phrase-final examples for the mid-central vowel in Shiwilu are necessarily in closed syllables. Nonetheless, the other vowels (a, i, u]) are prone to final lengthening, whereas the mid-central vowel is not. This is consistent with the fact that adding a mora to the mid-central vowel is not available in Shiwilu as strategy for bulking up syllables with this vowel (unlike in Piuma Paiwan [Shih 2018b]). This evidence also offers an explanation for why schwas (the typological equivalent of the mid-central vowel in Shiwilu) are banned in word-final position in many languages (e.g., Javanese [Horne 1974] or Yupik [Reed et al. 1977]).

Figure 5.2. Interaction of POSinIU and Segment (log. scale) on the Shiwilu vowels



5.2.Gemination of following segment

One of the main claims of the present study is that the gemination process affecting the segment after the mid-central vowel /ə/ in Shiwilu (a process also briefly addressed in Valenzuela & Gussenhoven 2013) fulfills the moraic requirement of the syllable. As presented in §3.2, I argue that the mid-central vowel /ə/ is intrinsically non-moraic in Shiwilu and therefore must always be followed by a coda consonant, which provides the mora that satisfies the requirement that every syllable contains at least one mora. In closed syllables, this coda consonant is already present. In open syllables, on the other hand, the coda is provided by a process of gemination applied to the consonant in the onset of the following syllable.

The aim of the present section is to test whether the word-internal geminated segments are indeed longer in duration than their non-geminated counterparts. Recall from previous sections that the possible geminated segments after the mid-central vowel /ə/ are /k/ <k>, /ʎ/ <ll>, /n/ <n>, and /ɲ/ <ñ> (henceforth "gemination consonants"). To test the gemination, a linear model was fit to predict the duration of the next segment of each vowel (logged to the base of 2) given the condition that they were consonants that could geminate (i.e., they occurred word-medially and intervocalically in the syllable onset and belonged to the set of consonants that undergo gemination). Accordingly, the consonants considered for the present model were codas in all cases. Table 5.3 shows the number of tokens analyzed in this model after applying this subsetting conditions.

Table 5.3. Number of tokens analyzed in the second model

e	a	i	u
177	512	394	268

The model was significant (F=15.13, df_1=3, df_2=1270, p<0.005***), but with a very weak explanatory level (adjusted R^2=0.0322). A single-term deletion test was applied to check whether all the variables were significant in the model. This model only used one response (SEGM), which was significant in this model, as presented in Table 5.4.

Table 5.4. Single-term deletions of the model testing duration of next segments

	Df	F value	Pr (>F)
SEGM	3	15.133	1.113e-09***

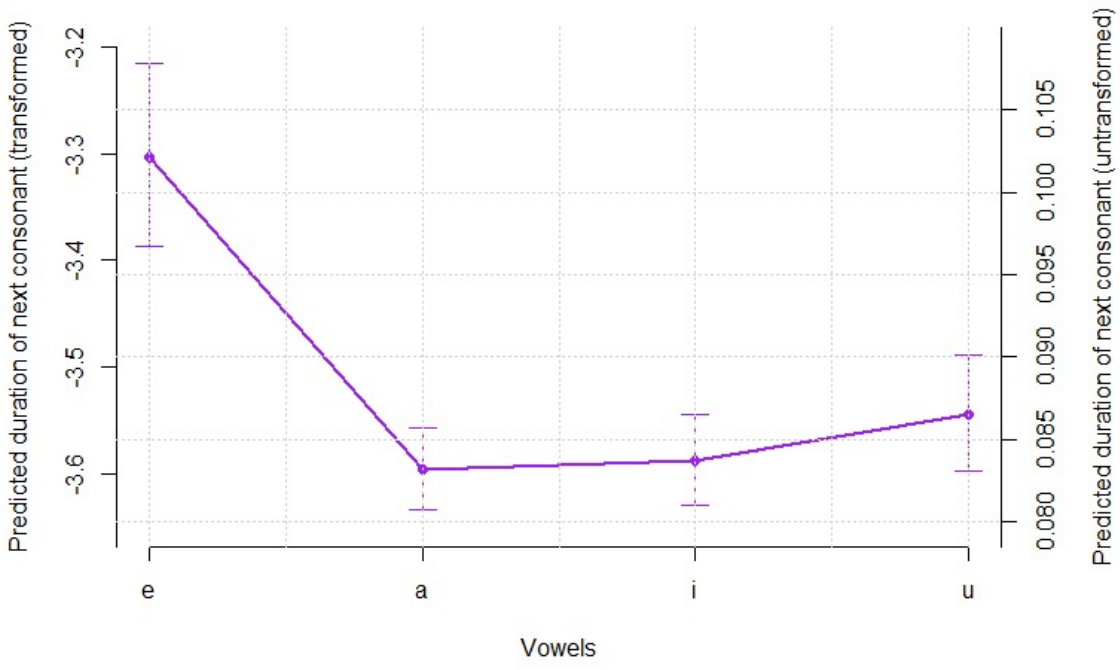
The coefficients of the regression model used to test gemination are shown in Table 5.5.

Table 5.5. Regression coefficients for the linear model of Duration of the next segment of vowels in function of Duration of the vowels

	Estimate	SE	t-value	p-value
(Intercept)	-3.49723	0.01499	-233.327	< 2e-16 ***
SEGMe_vs_rest	0.27353	0.04276	6.397	2.22e-10 ***
SEGMa_vs_iu	-0.03233	0.02929	-1.104	0.270
SEGMi_vs_u	-0.04722	0.03880	-1.217	0.224

As can be observed in Figure 5.3, the results show that the duration of the consonants is significantly longer after the mid-central vowel /ə/ than after any other vowel in Shiwilu (p<0.005***), confirming the gemination of these segments word-medially after the mid-central vowel /ə/.

Figure 5.3. Duration of the gemination segment with each vowel



It is important to notice that although these gemination values fall typologically on the lower side of duration differences between singletons vs. geminates, they are consistent with geminate vs. singleton ratios observed in some other languages. In this specific case, this smaller ratio is also in agreement with the suggestion for monomoraic geminate. For example, Gordon et al. (2000) report several geminate:singleton duration ratios in Chickasaw that fall below the 1.21:1 approximate average ratio observed in the Shiwilu data. It may also be noted that the optional realization of gemination as an epenthetic consonant (see section 3) is consistent with the view that lengthening of the consonant following /ə/ reflects the addition of a mora.

6. Discussion

This thesis has presented evidence in favor of the main hypothesis that the mid-central vowel /ə/ in Shiwilu is underlyingly non-moraic. To support this hypothesis, I presented durational evidence from /ə/ itself (§5.1) as well as evidence regarding the gemination of the following consonant (§5.2). Additionally, I proposed that mora-sharing between the mid-central vowel /ə/ and the coda consonant licenses stress on the syllable containing mid-central vowel /ə/ (§3.2.3).

The typology of schwas (and, by extension, central vowels that behave like them) indicate that they can be divided into three groups prosodically: (i) those that resist stress unless there are no other non-schwa vowels available to stress, (ii) those that accept stress like any other vowel, and (iii) those accepting stress but being subject to repair. Among those systems in group (i), we can find languages such as Armenian, Javanese and K^{w}ak^{w}'ala (Gordon et al. 2012), German (Féry 1995), Indonesian (Cohn 1989 in Gordon et al. 2012), and Girona Catalan (Herrick 2003). In group (ii), by contrast, we can find languages such as British English (Parker 2002), Basemah (McDonell 2008 in Gordon et al. 2012), or Hindi (Dixit 1963, Kelkar 1968, Ohala 1977, 1999 in Gordon et al. 2012). Finally, in group (iii) are languages such as Piuma Paiwan (Shih 2018b), in which the stressed vowel is lengthened, and Shiwilu, in which the following consonant geminates as a syllable-repair strategy so that the syllable with a mid-central vowel is moraic and, consequently, able to bear stress. This typology is summarized in Table 6.1, in which I am using the term *schwa* for an umbrella term that covers central vowels in general.[7]

[7] The tables presented in this section do not intend to be completely comprehensive, but to illustrate the different strategies that different languages may use. For this reason, I only included some languages and left many others aside.

Table 6.1. Typology of languages regarding schwa and stress[8]

Schwa resists stress or has stress restrictions	Schwa accepts stress like any other vowel	Schwa accepts stress but subject to syllabic repair
Armenian (Vaux 1998)*	British English (Parker 2002)	Shiwilu
Javanese (Gordon 2002, 2006)*	Basemah (McDonnell 2008)*	Piuma Paiwan (Shih 2018b)
American English (Lehiste & Peterson 1959)*	Hindi (Dixit 1963, Kelkar 1968, Ohala 1977, 1999)*	
Girona Catalan (Herrick 2003)		
Kwakw'ala (Boas 1947, Bach 1975, Wilson 1986, Shaw 2009)*		
German (Féry 1995)		
Indonesian (Cohn 1989)		

Additionally, different languages may vary their treatment towards schwas regarding their occurrence in different positions within the word. Table 6.2. lists some languages that allow and that do not allow schwas (or any central vowel in their inventory) word-finally.

Table 6.2. Examples of languages that allow and do not allow schwas (or central vowels) word-finally

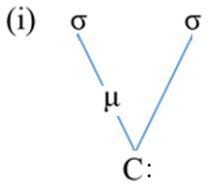
Schwas allowed word-finally	Schwas not allowed word-finally
German (Wiese 1986, Féry 1995)	Shiwilu
Bari Italian (Grice et al. 2018)	Gujarati (Shih 2018b)
Catalan (Recasens & Espinosa 2006)	Piuma Paiwan (Shih 2018b)
Standard French (Hutin et al. 2020)	Yami (Chun-Jan Young, p.c.)
American English (Flemming & Johnson 2007)	Indonesian (Cohn 1989)
Dutch (Kager & Zonneveld 1986)	Javanese (Gordon 2002, 2006)
Kakataibo (Zariquiey 2018)	Yupik (Jacobson 1979)

Consonant gemination also provided crucial evidence that the mid-central vowel in Shiwilu is non-moraic (§5.2). According to Hayes (1989), what differentiates geminates from singletons is that the former assumes the presence of a mora in its input, while the latter does not. Accordingly, the

[8] Most of this information was retrieved from Gordon et al. (2012). All the sources with an asterisk (*) are originally mentioned in that paper.

most commonly assumed structure for output geminates is as shown in Figure 6.1., where C: denotes a geminate.

Figure 6.1. Flopped structure of geminates word-medially (adapted from Topintzi 2008: 148)



A geminate is, then, split in half: one half functions as the coda of the first syllable, and the other works as the onset of the second syllable. Given this situation, the first half can contribute to the weight of the first syllable. Recall that in Shiwilu gemination only occurs word medially, a restriction that can be linked to the fact that geminates cannot cross word boundaries in Shiwilu.

Gemination has been previously attested as a strategy for turning stressed monomoraic syllables into bimoraic ones (Hayes 1989, 1995). Nonetheless, the Shiwilu case is apparently unique in employing gemination to turn a non-moraic syllable into a monomoraic one. As stated in the introduction, this thesis contributes to a better understanding of the mora-increasing-related strategies typologically, especially for a language with a small-vowel inventory. Table 6.3 presents the different outcomes of gemination as a metrical mora-increasing strategy used by different languages. In most of the languages, gemination serves to turn a monomoraic stressed syllable into a bimoraic one, a phenomenon that is especially common in iambic stress languages, which include all of the languages in table 6.3. except Piuma Paiwan.

Table 6.3. Examples of languages using gemination as metrical mora-increasing strategy[9]

	non-moraic → monomoraic	monomoraic → bimoraic
Consonant gemination	Shiwilu	Munsee/Unami Menomini Seward Peninsula Inupiaq Central Alaskan Yupik Pacific Yupik
Vowel gemination		Piuma Paiwan (Shih 2018b) Hixkaryana Macushi Surinam Carib Menomini Potawatomi Cayuga Onondaga Seneca St. Lawrence Yupik (Jacobson 1979) Central Alaskan Yupik Pacific Yupik Kashaya Maida Sierra Miwok

Finally, it is important to emphasize once again that the corpus used in the present study comes from naturalistic data in contrast to previous research on the phonetic manifestations of moraic structure and syllable weight (e.g., Hubbard 1994, Broselow et al. 1997, Gordon 2002). Naturalistic data are not directly elicited by the researcher but rather observed in real and non-controlled interactions. Although the kind of hypotheses tested in the present study tends to be investigated using more experimentally controlled data, or laboratory-based, there are several disadvantages with them. Primarily, we can mention that lab-based experiments may result in studies whose results depend on some specific conditions or measures taken during the experiment and that any variation in those conditions can cause the effects observed to drastically change (Sagi 2019: 1620). Harmegnies & Poch-Olivé (1992), for example, found that some vowel quality

[9] All the languages in the third column (monomoraic →bimoraic) that do not include a reference were taken from Hayes (1995). For a summary, see Hayes (1995: 83).

significatively change from laboratory against spontaneous speech in Spanish. Additionally, after a short time of adjustment, subjects tend to forget that they are being recorded (Kasper 2000), so narratives are closer to what we could find in an uncontrolled and natural environment. Thus, using naturalistic data for the present study was motivated by these considerations. Admittedly, naturalistic data have some drawbacks, such as the asymmetry of data obtained from one speaker to another or, especially important for the present study, differences in the frequency of the vowels. Nonetheless, the results of the present study show that patterns can be reliably extracted even from data that is not carefully controlled.

As mentioned before, Shiwilu is a seriously endangered language, which calls for special attention. In this context, it is not appropriate to limit the record to only data pertinent for a specific study or to issues of current theoretical interest (Mithun 2001: 53). The narratives utilized as the corpus of the present study will also contribute to future descriptions of other aspects of the language and help preserve the language for the speakers and their descendants.

References

Bach, Emmon. 1975. Long Vowels and Stress in Kwakiutl. Texas Linguistic Forum 2, 9-19.

Bendor-Samuel, John. 1961. The Verbal Piece in Jebero. (Linguistic Circle of New York Monograph, 4.) New York: Linguistic Circle of New York.

Boas, Franz. 1947. Kwakiutl Grammar with a Glossary of the Suffixes. Edited by Helene Boas Yampolsky with the collaboration of Zellig S. Harris. Transactions of the American Philosophical Society 37:3. 199/202-377

Boersma, Paul & David Weenink. 2018. Praat: doing phonetics by computer [Computer program]. Version 6.0.3.7, retrieved March 2018 from <http://www.praat.org>

Broselow, Ellen, Su-I Chen & Marie Huffman. 1997. Syllable weight: convergence of phonology and phonetics. *Phonology* 14. 47–82.

Chafe, Wallace L. 1994. Discourse, consciousness, and time: The flow and displacement of conscious experience in speaking and writing. Chicago: University of Chicago Press.

Cohn, Abigail. 1989. Stress in Indonesian and bracketing paradoxes. Natural Language and Linguistic Theory 7:167-216.

Crosswhite, Katherine. 1999. *Vowel reduction in Optimality Theory.* PhD dissertation, University of California, Los Angeles.

de Lacy, Paul. 2002. *The formal expression of markedness*. PhD dissertation, University of Massachusetts, Amherst.

Dixit, R. P. 1963. The Segmental Phonemes of Contemporary Hindi. MA thesis, University of Texas at Austin

Féry, Caroline .1995. Alignment, Syllable and Metrical Structure in German. *SfS-Report* 02-95 (Habilitation). University Tübingen, Tübingen.

Flemming, Edward & Stephanie Johnson (2007). Rosa's roses: reduced vowels in American English. *Journal of the International Phonetic Association* 37, 83–96.

Fox, John. 2003. Effect Displays in R for Generalised Linear Models. Journal of Statistical Software, 8(15), 1-27. URL: <https://www.jstatsoft.org/article/view/v008i15>.

Fox, John & Sanford Weisberg. 2019. An {R} Companion to Applied Regression, Third Edition. Thousand Oaks CA: Sage.

Golato, A. 2005. Compliments and Compliment Responses: Grammatical Structure and Sequential Organization. Amsterdam/Philadelphia: John Benjamins.Gordon, Matthew Kelly. 2006. *Syllable weight: phonetics, phonology, typology* (Studies in Linguistics). New York: Routledge.

Golato, Andrea. 2017. Naturally occurring data. In Barron, Anne, Yueguo Gu and Gerard Steen (eds.) The Roudledge Handbook of Pragmatics (Routledge Handbooks Online). Adingdon: Routledge, p. 21-26.

Gordon, Matthew. 2002. A phonetically-driven account of syllable weight. Language 78, 51-80

Gordon, Matthew. 2006. Syllable Weight: Phonetics, Phonology, Typology. New York: Routledge

Gordon, Matthew. 2016. Phonological typology (Oxford Linguistics). First edition. Oxford, United Kingdom: Oxford University Press.

Gordon, Matthew, Pamela Munro & Peter Ladefoged. 2000. Some Phonetic Structures of Chickasaw. *Anthropological Linguistics*, *42*(3), 366-400.

Gordon, Matthew, Edita Ghushchyan, Bradley McDonnell, Daisy Rosenblum & Patricia Shaw. 2012. Sonority and central vowels: A cross-linguistic phonetic study. In Steve Parker (ed.), The sonority controversy, 219–256. Berlin: De Gruyter.

Grice, M., Savino, M., Roettger T. B. 2018. Word final schwa is driven by intonation – the case of Bari Italian. JASA 143:4, 2474-2486.

Gries, S. T. 2013. Statistics for Linguists with R: A Practical Introduction. 2nd edition. Berlin: Mouton de Gruyter.

Hall, Nancy. 2011. Vowel Epenthesis: Vowel Epenthesis. In Marc van Oostendorp, Colin J. Ewen, Elizabeth Hume & Keren Rice (eds.), The Blackwell Companion to Phonology, 1–21. Oxford, UK: John Wiley & Sons, Ltd.

Harmegnies, Bernard & Dolors Poch-Olivé. 1992. A study of style-induced vowel variability: Laboratory versus spontaneous speech in Spanish. Speech Communication 11 (1992) 429-437.

Hayes, Bruce. 1989. Compensatory lengthening in moraic phonology. *LI* 20. 253–306.

Herrick, Dylan. 2003. An Acoustic Analysis of Phonological Vowel Reduction in Six Varieties of Catalan. PhD dissertation, University of California, Santa Cruz.

Hint, Mati. 1973. Eesti Keele Sõnafonoloogia I. Talinn, Estonia: Eeste NSV Teaduste Akadeemia.

Horne, Elinor Clark. 1974. Javanese–English Dictionary. New Haven: Yale University Press.

Hubbard, Kathleen. 1995. Toward a theory of phonological and phonetic timing: evidence from Bantu. In Bruce Connell & Amalia Arvaniti (eds.) *Paper in Laboratory Phonology IV*. Cambridge: Cambridge University Press. 168–187.

Hutin, M., Jatteau, A., Vasilescu, I., Lamel, L.&Adda-Decker,M. 2020. Le schwa final en français standard est-il un lubrifiant phonétique? Actes du CongrèsMondial de Lignuistique française, CMLF2020.

Hyman, Larry. 1985. *A theory of phonological weight*. Dordrecht: Foris.

Jacobson, Steven A. 1979. A grammatical sketch of Siberian Yupik Eskimo as spoken on St. Lawrence Island, Alaska. Alaska Native Language Center: University of Alaska. Fairbanks, Alaska.

Kager, René. 1989. *A metrical theory of stress and destressing in English and Dutch*. Dordrecht: Foris Publication.

Kager, R. & Zonneveld, W. 1986. Schwas, syllables, and extrametricality in Dutch. The Linguistic Review 5, 197-221.

Kelkar, Ashok R. 1968. Studies in Hindi-Urdu I: Introduction and Word Phonology. Poona: Deccan College

Kenstowicz, Michael. 1997. Quality-sensitive stress. *Rivista di Linguistica* 9. 157–187.

Labov, W. 1972. Sociolinguistic Patterns. Philadelphia: University of Pennsylvania Press

Lehiste, Ilse. 1970. Suprasegmentals. Cambridge, Mass.: MIT Press

Lehiste, Ilse. & Gordon E. Peterson. 1959. Vowel amplitude and phonemic stress in American English. Journal of the Acoustical Society of America 31, 428-435

Liljencrants, Johan & Björn Lindblom. 1972. Numerical simulation of vowel quality systems: The role of perceptual contrast. *Language* 48. 839–862.

Lin, Yen-Hwei. 1998. On minor syllables. In Osamu Fujimura, Brian D. Joseph & Bohumil Palek (eds) *Proceedings of LP'98: Item order in language and speech*. Prague: The Karolinum Press. 163–183.

Lindblom, Björn. 1963. Spectrographic study of vowel reduction. *Journal of the Acoustical Society of America* 35. 1773–1781.

Madalengoitia Barúa, María Gracia. 2013. Bosquejo fonológico de la lengua jebero (shiwilu). B.A. thesis. Lima: Pontificia Universidad Católica del Perú.

Madalengoitia Barúa, María Gracia. 2018. Prosodia y fonación no modal de vocales en shiwilu (jebero). Master's tesis. Lima: Pontificia Universidad Católica del Perú.

Matteson, Esther. 1965. *The Piro (Arawakan) language*. University Publications in Linguistics 42. Berkeley: University of California Press.

McDonnell, Bradley. 2008. A Conservative Vowel Phoneme Inventory of Sumatra: The Case of Besemah. Oceanic Linguistics 47(2), 409–432.

Mithun, Marianne. 2001. Who shapes the record: the speaker and the linguist. Linguistic Fieldwork, ed. Paul Newman and Martha Ratliff, pp. 34–54. Cambridge: Cambridge University Press

Ohala, Manjari. 1977. Stress in Hindi. In Larry Hyman (ed.), Studies in stress and accent. [Southern California Occasional Papers in Linguistics 4], pp. 327-338. Los Angeles: USC Department of Linguistics.

Ohala, Manjari. 1999. Handbook of the International Phonetic Association. Cambridge: Cambridge University Press, pp. 100–103.

Oostendrop, Marc van. 1995. Vowel quality and syllable projection. Ph.D. dissertation, University of Tilburg.

Parker, Stephen. 2002. Quantifying the Sonority Hierarchy. Doctoral Dissertation. University of Massachusetts Amherst.

Piggott, G. L. 1995. Epenthesis and syllable weight. Natural Language and Linguistic Theory 13: 283-326.

Potter J. 2002. Two kinds of natural. Discourse Studies 4(4): 539–542.

R Core Team. 2017. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/

Recasens, D., & Espinosa, A. 2006. Dispersion and variability of Catalan vowels. Speech Communication, 48, 645–666.

Reed, Irene, Miyaoka, Osahito, Jacobson, Steven, Afcan, Paschal, and Krauss, Michael. 1977. Yup'ik Eskimo Grammar. Fairbanks, AK: Alaska Native Language Center.

Sagi, Eyal. 2019. Taming big data: Applying the experimental method to naturalistic data sets. Behavior Research Methods (2019) 51:1619-1635.

Shaw, Patricia A. 2009. Default-to-Opposite Stress in Kʷak'ʷala: Quantity Sensitivities in a Default-to-Right System. Paper presented at SSILA, University of California at Berkeley

Shih, Shu-hao. 2018a. On the existence of sonority-driven stress in Gujarati. *Phonology* 35: 327–364.

Shih, Shu-hao. 2018b. *Non-Moraic Schwa: Phonology and Phonetics*. Ph.D. dissertation, Rutgers University.

Silverman, Daniel. 2011. Schwa. In Marc van Oostendorp, Colin J. Ewen, Elizabeth Hume & Keren Rice (eds.), The Blackwell Companion to Phonology. Wiley-Blackwell.

Sloetjes, Han, and Olaf Seibert. 2016. "Measuring by Marking: the Multimedia Annotation Tool ELAN." In Measuring Behavior 2016, 10th International Conference on Methods and Techniques in Behavioral Research, edited by A. Spink, G. Riedel, L. Zhou, L. Teekens, R. Albatal, and C. Gurrin, 492–95.

Topintzi, Nina. 2008. On the existence of moraic onset geminates. NLLT 26. 147-184

Valenzuela, Pilar. Forthcoming. "The Kawapanan Family". In Patience Epps and Lev Michael (eds.), *Handbook of Amazonian Languages*. Berlin: Mouton de Gruyter.

Valenzuela, Pilar. 2014. *Kirka' Llawer'lla'la' Ñak*, Diccionario Shiwilu-Castellano y Castellano-Shiwilu. Lima: Federación de Comunidades Nativas de Jeberos.

Valenzuela, Pilar M. & Carlos Gussenhoven. 2013. Shiwilu (Jebero). Journal of the International Phonetic Association, 43 (1): 97-106, doi:10.1017/S0025100312000370

Vaux, Bert. 1998, The Phonology of Armenian, Clarendon Press, Oxford.

Wickham, Hadley, Romain François, Lionel Henry and Kirill Müller. 2021. dplyr: A Grammar of Data Manipulation. R package version 1.0.5. URL: <https://CRAN.R-project.org/package=dplyr>

Wiese, R. 1986. Schwa and the structure of words in German. In: Linguistics 24: 697-74.

Wilson, Stephen A. 1986. Metrical structure in Wakashan phonology. Proceedings of Berkeley Linguistics Society 12, 283-291.

Zariquiey, Roberto. 2018. A grammar of Kakataibo, volume 75 of Mouton Grammar Library. Berlin: Mouton de Gruyter.

Zec, Draga. 2007. The syllable. In Paul de Lacy (ed.) *The Cambridge handbook of phonology*. Cambridge University Press. 161–194.