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Phonetics and Phonology of Gua

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Phonetics and Phonology of Gua

A dissertation submitted in partial satisfaction of the
requirements for the degree of Doctor of Philosophy

in

Linguistics

by

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2021

The dissertation of Michael Obiri-Yeboah is approved, and it is acceptable in quality and form for publication on microfilm and electronically.

University of California San Diego

2021

DEDICATION

I dedicate this dissertation to the memory of my grandparents, the late Mr. Samuel Obiri Yeboah and Mrs. Comfort Obiri Yeboah for their training and upbringing. They also granted me the opportunity to speak Gua as a native speaker from my childhood.

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LIST OF ABBREVIATIONS

1	First Person
2	Second Person
3	Third Person
AM	Associated Motion
ATR	Advanced Tongue Root
COMPL	Completive marker
CV	Consonant-Vowel
DET	Determiner
DIM	Diminutive
FUT	Future
H	High tone
HAB	Habitual aspect marker
L	Low tone
NEG	Negative marker
PERF	Perfective aspect marker
PL	Plural marker
PROG	Progressive aspect marker
PST	Past Tense marker
SG	Singular marker
SUBJ	Subject marker
OBJ	Object marker

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My journey to the PhD level has received massive support from various groups and individuals to whom I owe a great deal, and I am very much grateful. This support ranges from professors, colleagues, research consultants and assistants, to family, friends and community support. Although none of the support provided is little or unimportant, there is the need to appreciate some specific groups and individuals.

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Chapter 2 in part has been submitted for publication in the material as it will appear in *Indiana Working Papers on Speech Sound Articulation* as Myers, Samantha, Michael Obiri-Yeboah, Kenneth de Jong and Kelly Berkson (to appear). Tongue root contrasts in Gua: evidence from articulatory imaging. *Indiana Working Papers on Speech Sound Articulation*. The dissertation author is a co-author of this paper.

Chapters 3 and 4 in part are reprint of the material as it appears *in Natural Language and Linguistic Theory* as Obiri-Yeboah, Michael and Sharon Rose. 2021. Vowel harmony and phonological phrasing in Gua. *Natural Language and Linguistic Theory*, 1-35. The dissertation author is a co-author of this paper.

Chapter 7 in part is reprint of the material as it appears in the *Proceedings of the 30th West African Languages Congress* as Obiri-Yeboah, Michael. 2020. *Tone Melody and TMA Marking in Gua. In F. Ahoua & B. Elugbe (eds.) Language typology and language documentation in West Africa: proceedings of the 27th West African Linguistics Congress (WALS). Paris: L'Harmattan.*

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Obiri-Yeboah, Michael. 2020. *Tone Melody and TMA Marking in Gua. In F. Ahoua & B. Elugbe (eds.) Language typology and language documentation in West Africa: proceedings of the 27th West African Linguistics Congress (WALS). Paris: L'Harmattan.*

Myers, Samantha, Michael Obiri-Yeboah, Kenneth De Jong & Kelly Berkson. to appear. Tongue root contrasts in Gua: evidence from articulatory imaging. *Indiana Working Papers on Speech Sound Articulation*.

ABSTRACT OF THE DISSERTATION

Phonetics and Phonology of Gua

by

Michael Obiri-Yeboah

Doctor of Philosophy in Linguistics

University of California San Diego, 2021

Professor Sharon Rose, Chair

This dissertation documents and analyzes phonetic and phonological features of Gua, an under-documented, understudied and nearly-endangered Guang language, spoken in the Eastern Region of Ghana. The language has two dialects, Anum and Boso. The data for this dissertation is from the Boso dialect spoken in the Boso community.

The dissertation focuses on the properties of the sound system which includes the segmental inventory, tone, and processes such as vowel harmony, hiatus resolution, consonant assimilation and nasalization, and their interactions with other areas of the grammar.

Chapter 1 provides a general introduction to Gua including a sociolinguistic survey. It also situates the scope and the relevance of the study. Chapter 2 presents the vowel inventory in the language. It discusses the different properties of the vowels including oral and nasal vowels, Advanced Tongue Root (ATR) distinctions, vowel length and vowel sequences. Acoustic measurements are provided to show the positions of oral and nasal vowels in the F1/F2 vowel space. The chapter also presents the syllable structure which consists of open syllables, no complex onsets or codas, and only nasal consonants as possible codas. Nasals may also serve as syllabic consonants.

Chapter 3 presents the basic patterns of word-internal ATR vowel harmony and directionality which is robustly regressive within words, roots, and across words. Chapter 4 presents a description of cross-word harmony and demonstrates how the process is sensitive to both prosodic phrasal units as well as syntactic structure.

Chapter 5 describes and analyzes consonants. Gua has voicing contrasts among stops and affricates at six places of articulation, including labio-velar stops. It also has a series of nasal consonants. The chapter presents consonant interactions that involve nasals and stops in the verbal prefix complex. These processes include nasal place assimilation, nasal assimilation and stop deletion.

In Chapter 6, two processes are introduced that affect vowel realization: nasalization and vowel hiatus. Gua has a series of nasal vowels and also shows tautosyllabic nasalization of vowels triggered by either onsets or codas. This process interacts with ATR harmony, both within and across words. The chapter shows how nasal vowels are fully participatory in vowel harmony, and even though Gua lacks phonemic mid +ATR nasal vowels /ẽ, õ/, like many West African languages (Hyman 1972, Rolle 2013), these vowels can be created as allophones via the interaction of nasalization and/or ATR vowel harmony. The second section discusses the resolution of vowel hiatus (Casali 1997/2011) across morpheme and word boundaries, showing all combinations of sequences of oral vowels. The vowel hiatus resolution patterns interact with ATR harmony, leading to opacity on the surface.

Chapter 7 is dedicated to the discussion of tone and tone processes. Gua is a two tone language with downstep. It also has both lexical and grammatical tone. Lexical tone distributions are tightly bound to word class in nouns, adjectives and postpositions. In verbs, tone is grammatical and there are no lexical distinctions among verb roots. Tense, mood and aspect correlate with one of three tone melodies that extend across the root. Monomoraic roots cannot host a contour tone, and how the tone melody reduces depends on the presence of a prefix. In addition, some verbal prefixes show tone polarity effects. Subject markers alternate tone based on the tone of the following tone-bearing unit. TAM prefixes display opposite tone to the following tone-bearing unit, also creating a tone polarity effect.

The dissertation contributes to the description and analysis of the grammar of Guang languages. It also contributes to the typological study of phonologies of the world's languages.

CHAPTER ONE

INTRODUCTION

1.0 General Introduction to Gua and its classification

Minority languages have contributed greatly to linguistic typology and theory. For instance, Leben (1973) and Goldsmith (1976) are two classic studies of African languages that gave rise to autosegmental phonology which assumes that suprasegmental representations such as tone are independent of host segments. Fieldwork conducted on minority African languages has furthered our understanding of vowel harmony, tone, and other grammatical structures, thereby improving linguistic knowledge. It has also helped such languages and their communities gain recognition. This dissertation continues this tradition; it documents and analyzes phonetic and phonological features of Gua, an under-documented, understudied and nearly-endangered Guang language, spoken in the Eastern Region of Ghana.

Some languages have lost fluent speakers before they have been adequately documented. Any time a language dies – loses its speakers –, there is loss of cultural knowledge and identity, as well as an understanding of language structures. According to the UNESCO (2021), "The extinction of a language results in the irrecoverable loss of unique cultural knowledge embodied in it for centuries, including historical, spiritual and ecological knowledge that may be essential for the survival of not only its speakers, but also countless others." Field linguists have worked on documenting many languages, but more are still dying or sleeping – without speakers or documentary records – due to a variety of factors which impact intergenerational transmission, such as inter-ethnic marriages, lack of societal prestige, use of dominant languages in education, among others. It is estimated that half of the over 6,000 languages currently in use will die by the end of the century if steps are not taken (UNESCO). This calls for action with all the urgency it demands. This urgency has occasioned this dissertation which seeks to document, describe and analyze the phonological patterns of the Boso variety of Gua. As a threatened and nearly-endangered language, Gua is struggling for its survival.

The Guang languages classified as part of the Tano branch of Kwa languages. They are broadly divided into South and North Guang with Gua falling under the South Guang branch. The South Guang languages are grouped further into Hill and Coastal Guang. Previous scholars proposed slightly different divisions based on the available information. The map below is from Painter (1967) which represents the language family of Guan. It is one of the first proposed groupings of the Guang[1] languages, and proposed four main branches. The two dialects of Gua, Anum and Boso, are shown here under Anum. This tree has been adopted and modified from Painter (1967b:6).

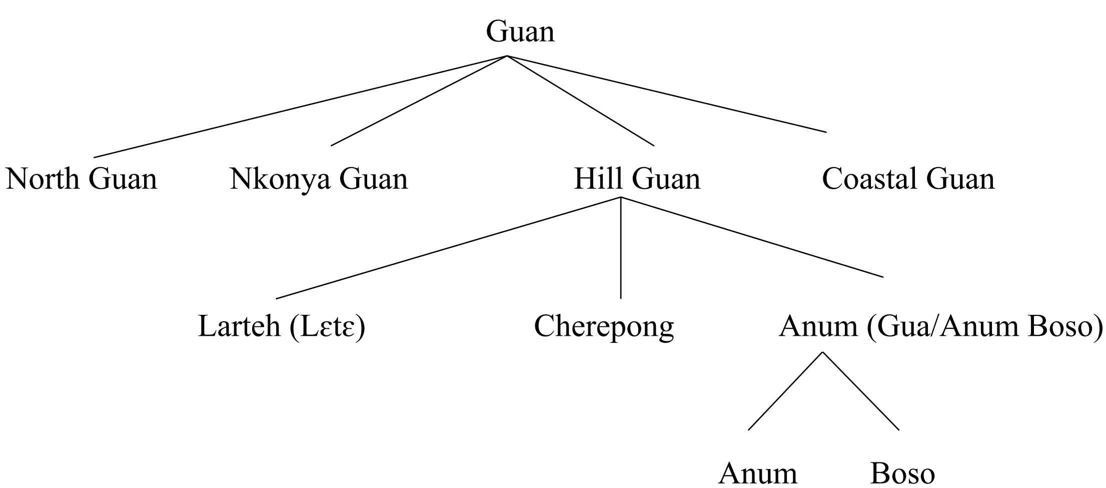

Figure 1.1: Gua Language Family Tree

[1] Some scholars write Guan as Guang so I'll use them interchangeably in this dissertation.

Aside from this tree, Snider (1990) also provides a language taxonomy that categorizes all the Guang languages. Snider's classification shows a detailed version of the Guang language groupings with subdivisions among both the north and south languages. The taxonomy below is cited from Tideman (2019). Unlike Painter's classification, Snider groups Gua more closely with Cherepong as North Hill Guang, joining with Larteh to form Hill Guang.

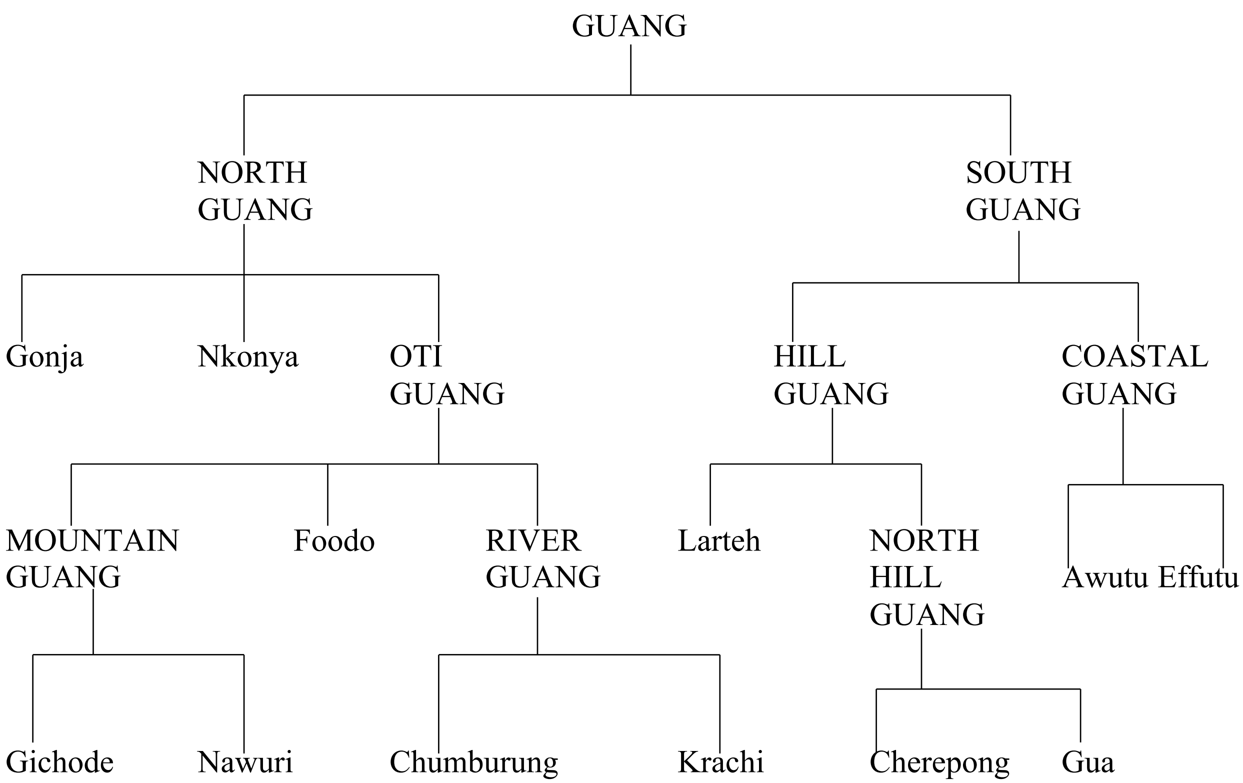

Figure 1.2: Snider's taxonomy of Guang languages

Tideman (2019) also presents a broader version of the taxonomy of the Guang languages based on available data. She presents the following subgroupings based on data from Glottalog (Hammerström et al 2019).

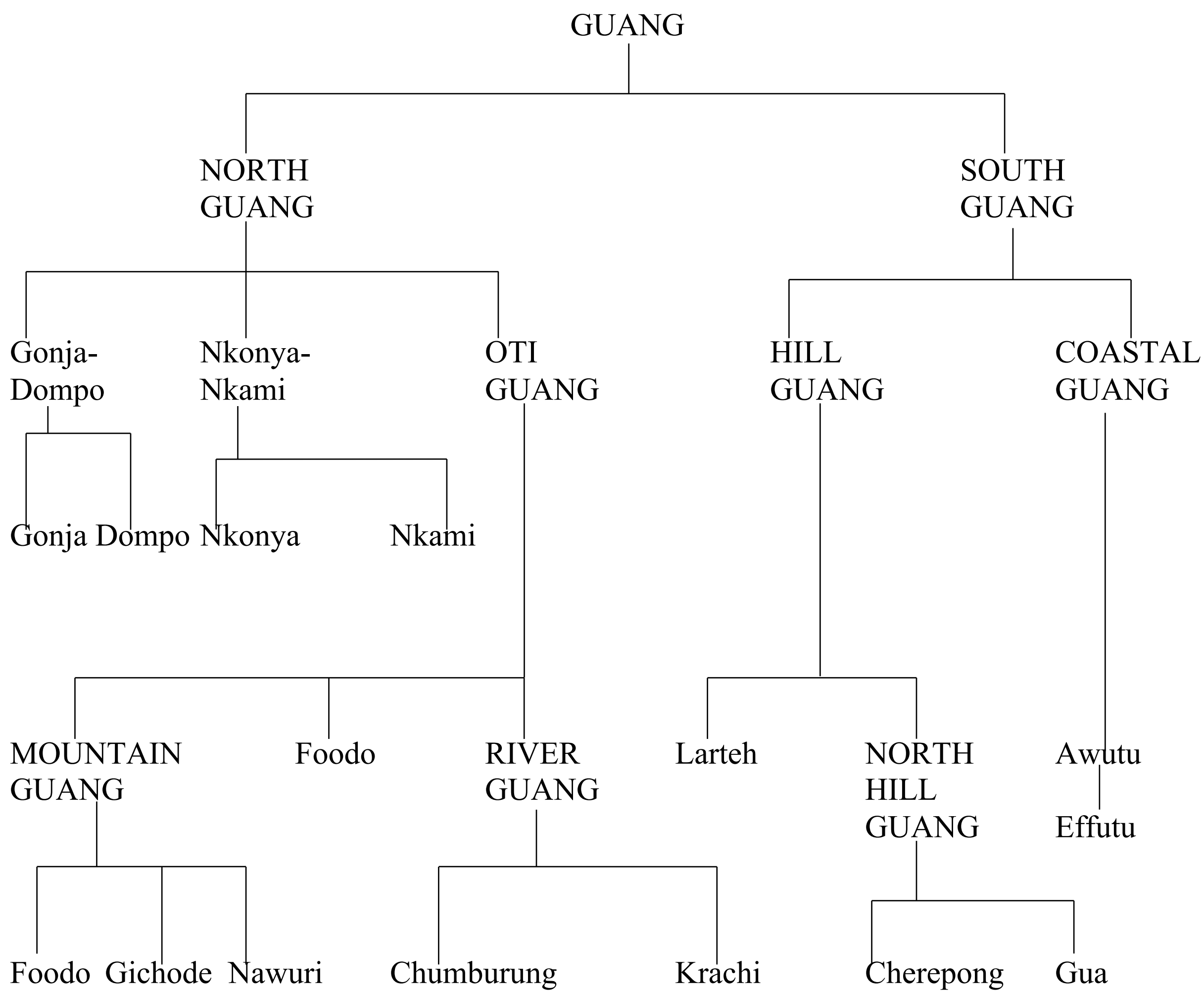

Figure 1.3: Guang Subgroupings from Glottolog and cited in Tideman 2019

The map below is the language map of Ghana with Gua represented in number 52, as provided by Ethnologue (Lewis et al 2013).

Figure 1.4: Language Map of Ghana from Lewis et al. (2013) with Gua in number 52.

1.1 Sociolinguistic survey and status of Gua

It is estimated that there are about 17,600 speakers of Gua according to the United Nations Statistics Division (UNSD, 2013). Although UNSD (2013) reports a relatively high number of speakers of Gua, it is not clear how many of these speakers are competent and fluent in the use of the language. Tompkins et al (2002) estimate a population of speakers of 30,000 – 25,000 for Anum and 5,000 Boso respectively through a sociolinguistic survey. They interviewed 20 speakers and conducted tests to test their Twi comprehension and the use of Gua and Twi in different domains. Akan is a cover term of all dialects of Akan people of Ghana which include Twi, Fante, among others. Whenever Akan is used in the dissertation, it refers to the Twi dialect of Akan. In 2018, I conducted a sociolinguistic survey in Boso which indicates that there have been significant changes in competence and use of the language among younger people in the area since the 1995 survey reported in Tompkins et al (2002).

I interviewed twenty-four people for my survey. The interviews were conducted in Gua since both the researcher and the participants were all speakers of the language. Out of the 24 participants, 6 of them were elderly of sixty years and over, 6 were older adults between 40 to 59 years, 6 were young adults from 30 years to 39 years and 6 young people from 18+ to 29 years. There are more participants under 40 than over 40. The table below shows the distribution of the speakers.

Table 1.1: Participants details by gender, age and languages spoken.

Participants	Males	Females
Age	18+ to 29 3 30 to 39 3 40 to 59 3 60+ 3	18+ to 29 3 30 to 39 3 40 to 59 3 60+ 3

Some of the participants who were interviewed in Boso included pastors, an assemblyman (representative of the people at the district level), two chiefs, two teachers, and other people of different professions. Seven main questions relating to the subject were asked as follows:

1) What languages do you speak?

2) What language do you speak at home?

3) How did you learn the language(s)?

4) What language do you use in conversation with family and friends?

5) How do you see the future of Gua language?

6) What language do your children and grandchildren speak (or will speak if you do not have children or grandchildren yet)?

7) What could be done to safeguard the future of Gua?

The results of the survey are presented in the table below based on the questions asked. Three of the questions asked were open-ended so the participants gave their views which are captured in prose after the tables below.

Table 1.2 Languages spoken

Languages spoken	18-29	30-39	40-59	60+
Gua only	0	0	0	0
Akan and Gua	0	0	0	0
English, Akan and Gua	6	5	4	6
Ewe, English, Akan and Gua	0	1	2	0

This table shows the inhabitants in Boso are all bilingual or multilingual. The question did not ask about fluency or language dominance. Dominance was observed indirectly during my interviews, and can also be reflected by language usage.

Table 1.3 Languages used in the home.

Languages spoken at home	18-29	30-39	40-59	60+
Gua only	0	0	0	6
Mostly Gua, some Akan, no English	0	2	4	0
Mostly Akan, some Gua, no English	0	4	2	0
Mostly Akan, some Gua, some English	6	0	0	0

The responses to question 2 about language used in the home illustrate that only those older than 60 use Gua in the home to the exclusion of other languages. Younger participants reported that they are compelled to use Gua with older people in the home but their preference would be to communicate in Akan. This is also reflected in their patterns of usage with Akan dominating. There are also some mixed marriages where Akan is the language of communication. English is also used in the home, although no distinction was made for school English compared to pidgin English or codeswitching practices.

Table 1.4 Where languages learned

Where languages learned	18-29	30-39	40-59	60+
Gua at home	6	6	6	6
Gua at school	0	0	0	0
Gua in community	6	6	6	6
Akan at home	6	6	0	0
Akan at school	6	6	6	6
Akan at community	6	6	0	0
English at school	6	6	6	6
Ewe with friends/community	0	1	2	0

Table 1.4 reflects that Gua is learned in the home and the larger community, English is learned at school, but Akan is learned in all locations for the younger people. This shows the pervasiveness of Akan in the Boso area compared to Gua.

Table 1.5: Language used with friends.

Language used with friends	18-29	30-39	40-59	60+
Gua only	0	0	0	0
Mostly Gua, some Akan, no English	0	2	4	6
Mostly Akan, some Gua, no English	0	4	2	0
Mostly Akan, some Gua, some English	6	0	0	0
Ewe in addition to Akan/Gwa	0	1	2	0

The language repertoire is broader with friends, as it includes the use of Ewe in addition to the standard repertoires, but only for three people. This is because Ewe is a dominant local language in the area. The breakdown by age group for these five questions shows a strong decline in Gua usage and Akan preference among younger Gua participants.

Of the question about the language their grandchildren speak or will speak, more than half of the participants admitted they either speak Akan (=Twi) or will speak Twi (referring to those who are yet to have grandchildren), one of the major languages of Ghana. For most of the participants, when it comes to language of choice for communication in their homes or environment, Twi will be the preferred one. In fact, there was a waiting area where the participants stayed before they came for the recording, and at one point when three young adults came for the recording, I observed that they were seriously engaged in conversations in Twi even when they were aware that they were there to be interviewed about Gua usage. Of the six young people I interviewed, only two of them could speak Gua fluently, according to my estimation. The others complained about how their Gua has been diluted by Twi. In the views of the participants, the current status is that Gua has lost most of its domain of usage to Twi. This indicates that the language will survive with only aged speakers due to lack of transmission of the language to the younger generation by some members of the community. I did not interview children, but some of the adults I interviewed reported that some of their children do not understand the language. Others feared that their grandchildren will completely lose the language if their children speak Akan instead. This is quite different than the 1995 survey of Tompkins et al (2002) who report high levels of bilingualism with Twi, but a strong use of Gua in the home and in community activities.

Regarding the question on how the participants see the future of Gua language, they all responded that if the current trend, with a lack of language transmission from one generation to the other, is not checked, the language will likely disappear after some time. Although all the participants agreed to this, of the two chiefs that I interviewed, one of them agreed to that the language could disappear after some time, the other thought that will not be the case. My future interactions with both of them revealed that the chief who thought the language will not disappear was actually referencing the culture rather than the language. The transmission of the culture is also endangered but the specific culture that relates to royalty is highly upheld. There is an intentional means of transmitting the cultural practices of the royalty to the next generation. Other aspects of the culture in the community are, however, as threatened as the language.

The final question pertained to what could be done to safeguard the future of Gua. All the participants agreed that speakers will need to communicate in the language irrespective of the number of languages they speak. They were of the view that teaching and learning materials should be provided for learning Gua. They also agreed that the language should be used in schools, the community and other events that bring the entire community together. The participants also wanted the language to be used in churches and other religious environments. The chiefs and elders beyond age 60 also wanted avenues where both the language and the culture of the community will be properly transmitted to the younger generation.

Gua's survival cannot be guaranteed after a generation or two and it runs the risk of disappearing. Akan has taken over most domains of communication, and there is a lack of transmission from adults to the younger generation. All Gua speakers are at least bilingual with Akan, but Akan is used in the schools, and for most events where people meet for communication, events which used to be Gua-dominated. Gua speakers have over the years migrated to urban centers for economic reasons and formal education, and they typically stop speaking their language in the new area (Dakubu and Emberson 1989); this phenomenon is now occurring in Boso, the heart of the Gua area. Gua is likely to suffer in the same way as other Guang languages if it dies without documentation or without any trace of its contribution to linguistic knowledge and cultural heritage. For example, Mpre and Nterato, are two Guang languages that are extinct, with no documentation of the language (cf. Dakubu 1988, Blench and Dendo 2007), and cultural heritage. The status of Gua requires urgent steps for the documentation and the description of the language. The focus of the dissertation will be on the general sound system of the language relating to both segmental and suprasegmental features. Future work should include a full grammar and dictionary.

1.2 Previous studies

There have been few previous studies of Gua. Painter (1967) worked on the distribution of Guang languages, while Painter (1971) presented a short description of the vowel harmony in the Anum variety. Obeng (1995) also wrote on vowel harmony in Gwa Nmle which mainly focused on the Anum dialect. Ofori (2014) is a grammar of the Anum dialect of Gua which contains aspects of its phonology, morphology and syntax. Tideman (2019) surveys vowel phenomena in Guang languages in general, which includes Gua, although the data are drawn from my own and other sources.

My MA thesis (Obiri-Yeboah 2013) was the first to discuss various aspects of Gua phonology. My more recent descriptive work is more detailed and includes a presentation of the verb tone melodies (Obiri-Yeboah 2020), and vowel harmony and the syntax-phonology interface (Obiri-Yeboah and Rose, 2021). The latter two studies are incorporated into the dissertation, the tone in chapter 7 and the vowel harmony in chapters 3 and 4.

1.3 Ethnography of Gua and Boso

The dissertation focuses on the Boso dialect spoken in the town of Boso and surrounding areas. Therefore, it is important to present some information about the community and its link with the language. Ampene (2003:6) notes that "The 'aboriginal inhabitants' of Ghana called themselves GUAN, and speak a language of the same name". There are various Guan varieties as identified by the speakers and previous linguists. The speakers of the Boso dialect call the language Gua [gwà]. The 'Hill Guang' people – Okere, Larteh, Anum, Boso – call themselves GWA-EBI, the people of Guang descent. Guang largely refers to the language and the people who reached Ghana first before any other ethnic group (Ampene 2003). Gua is spoken in other towns and villages in Ghana especially in the eastern region including Anu(m), Boso, Tosen, Dodi, Nanyɔ, Nkwakubew, Anum Apapam, Asamankese Anum, and partially at Asikuma and Sankɔre. In this study, I will restrict myself to the Boso dialect of Gua which is spoken in areas such as Boso (where the data were collected), Tosen, Dodi and Nanyɔ.

Boso is located in the Asuogyaman District in the Eastern Region of Ghana. It serves as the seat or head of the Gwa-Boso Traditional Council with the Paramount Chief living in Boso with Dodi, Nanyɔ, Tosen and Boso itself serving as the traditional jurisdiction of the council. The map below shows where Gua is spoken in the Asuogyaman District of Ghana.

Figure 1.5: Ghana Map with the red arrow pointing to where Boso is located in the Eastern region of Ghana where Gua is spoken. Adapted map from One Stop Map[2].

[2] http://onestopmap.com

Boso is a highly religious pluralistic society. There are three main religious practices in the area: Christianity, Islam and African traditional religions. Christianity is the majority but the religious groups co-exist in harmony and peace without any chaos or rancor.

"Odweegyi", the main festival celebrated by the people, is one unifying factor in the area. The festival brings family members and friends home for a reunion. Odweegyi comes from two Gua words. *Odʑwe* 'a type of yam' and *gyi* 'eat or celebrate'. It is celebrated in the month of September to mark a successful end of year and a beginning of a new one. It is during the celebration that the ban of eating of odʑwe is lifted to allow for the harvesting of the new yam.

Farming is the main source of income for many people in the area. The farmers cultivate oil palm, maize, cassava and yam. These activities are mostly done by men with some women getting involved. Women are engaged in trading the foodstuffs produced by the farmers. Palm oil production has also become another major source of income for women in the area lately.

Boso has some schools that provides for education of children. These include Boso Presbyterian Primary and Junior High School and the Anglican Primary and Junior High schools. There is Boso Senior High and Technical School, the main high school that admits most students from the area. Although school is viewed favorably in the area, there is still a relatively high level of illiteracy. Lewis et al 2013 reports that the literacy rate in the L2 of the area (Akan) has been pegged at 5-15%.

1.4 Statement of the problem

Gua, like most other Guang languages, does not have a large extant description of the linguistic patterns in the language. As an under-documented, threatened and nearly-endangered language, the first step towards the documentation and the description of the language is its sound system. Although there have been some mention of aspects of the phonological system by Painter

1967 and Obiri-Yeboah 2013, these are not in-depth. This has necessitated a broader description and analysis of the patterns in the sound system.

1.5 Scope of the Dissertation

The dissertation focuses on the segmental inventory, tone, and processes such as vowel harmony, hiatus resolution, consonant assimilation and nasalization. Chapter 2 presents the vowel inventory in the language. It presents the different properties of the vowels including oral and nasal vowels, Advanced Tongue Root (ATR) distinctions, vowel length and vowel sequences. Acoustic measurements are provided to show the positions of oral vowels in the F1/F2 vowel space. The chapter also presents the syllable structure. Gua has open syllables, no complex onsets and only nasal consonants as possible codas. Nasals can also be syllabic consonants.

Chapter 3 presents the basic patterns of word-internal ATR vowel harmony. As Casali (2003) notes about ATR harmony in African languages, “Many African languages, especially in the Niger-Congo and Nilo-Saharan families, have vowel contrasts commonly described in terms of a phonological feature [ATR] (Advanced Tongue Root). It is extremely common for languages with an [ATR] contrast to display some form of assimilation or harmony involving [ATR].” Gua shows a robust regressive directionality pattern of ATR harmony within words, roots, and across words. ATR harmony applies iteratively within words and non-iteratively across words affecting the final vowel of the preceding word. Chapter 4 presents a description of cross-word harmony and demonstrates how the process is sensitive to both prosodic phrasal units as well as syntactic structure. Cross-word vowel harmony operates within prosodic domains of two or three words, and is sensitive to the subject-verb phrase boundary. A description of the facts is provided here – a formal analysis is outlined in Obiri-Yeboah & Rose (2021).

Regarding consonants, as described and analyzed in chapter 5, Gua has voicing contrasts among stops and affricates at six places of articulation, including labio-velar stops. It also has a series of nasal consonants. There are also allophonic alternations that affect fricatives and liquids. Finally, the chapter presents consonant interactions that involve nasals and stops in the verbal prefix complex. These processes include nasal place assimilation, nasal assimilation and stop deletion.

In chapter 6, two processes are introduced that affect vowel realization: nasalization and vowel hiatus. Gua has a series of nasal vowels and also shows tautosyllabic nasalization of vowels triggered by either onsets or codas. This process interacts with ATR harmony, both within and across words. The chapter shows how nasal vowels are fully participatory in vowel harmony, and even though Gua lacks phonemic mid +ATR nasal vowels /ẽ, õ/, like many West African languages (Hyman 1972, Rolle 2013), these vowels can be created as allophones via the interaction of nasalization and/or ATR vowel harmony. The second section discusses the resolution of vowel hiatus (Casali 1997/2011) across morpheme and word boundaries, showing all combinations of sequences of oral vowels. The vowel hiatus resolution patterns interact with ATR harmony, leading to opacity on the surface in two ways: an [+ATR] surface vowel wherein the following [+ATR] trigger has been deleted, or a surface sequence of [-ATR][+ATR] that fails to show vowel harmony because the target of non-iterative harmony has been deleted. This indicates that ATR harmony applies before the application of vowel hiatus.

Chapter 7 is dedicated to the discussion of tone and tone processes. Gua is a two tone language with downstep. It also has both lexical and grammatical tone. Lexical tone distributions are tightly bound to word class in nouns, adjectives and postpositions. In verbs, tone is grammatical and there are no lexical distinctions among verb roots. Tense, mood and aspect correlate with one of three tone melodies that extend across the root. Monomoraic roots cannot host a contour tone, and how the tone melody reduces depends on the presence of a prefix. In addition, some verbal prefixes show tone polarity effects. Subject markers alternate tone based on the tone of the following tone-bearing unit. TAM prefixes display opposite tone to the following tone-bearing unit, also creating a tone polarity effect. Aspects of these patterns were analyzed in Obiri-Yeboah (2020)

Chapter 8 discusses the findings of the dissertation and the typological and theoretical implications of the data for phonological interactions with other aspects of grammar including phonetics, morphology and syntax.

1.6 Significance of the dissertation

There are two important factors that makes this study useful for linguistic inquiry and knowledge. These are: (1) documenting and describing a number of phonological phenomena in Gua, and (2) providing a theoretically-motivated analysis of the data collected that advances our understanding of the broader interaction of phonology and its interfaces.

Documentation and description of specific phonological phenomena will support the long-term goal of writing a grammar of Gua and will aid in further development of the language. This is especially important because there is no existing documentation or description of the Gua language, and successive generations of the Gua community are now speaking more Akan and less Gua. A description of Gua will help in the development of an orthography for the language which will go a long way to encourage teaching and learning of the language.

Secondly, analyses offered of some of the described phenomena shows the contribution of Gua to larger theoretical and typological discussions, specifically regarding the mechanisms by which phonology interacts with other modules of grammar, namely morphology and syntax. These include the robust case of regressive directionality that applies within words, roots and across words, cross-word vowel harmony that operates within phonological phrases but not across them and also non-iterative, the interaction of harmony with nasal vowels and hiatus resolution, and grammatical tone with reference to tense-aspect-mood marking. Others include binarity phrasing in ATR vowel harmony, which is a first reported case in a harmony system, and ternarity which appears to be unacceptable in other languages but acceptable in Gua. In addition, the discussing on tone provides further understanding of grammatical tone across languages where the same tone melodies on verbs are deployed to mark tones in other prefixes.

In general, the dissertation provides a detailed description and analysis of several phonetic and phonological phenomena in the sound system of Gua, as well as a discussion of their implications for linguistic theory and typology.

1.7 Methods of data collection and analysis

The data for this study is based on the Boso dialect drawn from fieldwork conducted in Boso in the summers of 2017, 2018, 2019 and 2020. The data was obtained through structured and informal interviews with native Gua speakers conducted in Gua, as I am a community member and native speaker of Gua. This method helped me to get controlled data to sort out grammatical details. In addition, naturally occurring speech from cultural events and programs in the community were recorded. Naturally occurring speech involves people talking freely about specific issues in the language. This is a useful tool to collect data on informal language, cultural information and communication practices. The data collected for this dissertation is saved on OneDrive on the University of San Diego virtual data saving tool. In future, this data together with other data from my language documentation project will be archived with the Firebird Foundation and The Archive of Languages and Oral Resources of Africa (ALORA), free archives that will help keep the data for future use.

All the sessions were recorded using both audio and video recorders. Where acoustic measures are involved, Praat scripts from Styler (2021) were used to extract values from annotated vowels. Otherwise, values like VOT were measured by hand since they are easily identifiable in the spectrogram and waveform.

1.7 Conclusion of the chapter

The chapter has introduced Gua and the Boso community where the Boso dialect of Gua is spoken. It discusses the various issues that the dissertation covers from general introduction through sociolinguistics survey, ethnographic details of Gua and Boso, statement of the problem, significance of the study, scope of the study and methods of data collection. It also provides a brief overview of each of the chapters.

CHAPTER TWO

VOWEL SYSTEM AND SYLLABLE STRUCTURE

2.0 Introduction

Gua has a large vowel inventory that includes both oral and nasal vowels, as well as long vowels and vowel sequences. In addition, the Advanced Tongue Root (ATR) distinction is important for vowel harmony. Within words, all vowels occur in word initial, medial and final positions except /u/ and /ʊ/ which occurs in word medial and final positions only. This chapter discusses the various vowels and their distribution in Gua. Gua favors open syllables with no complex onsets and limited nasal codas. Details of the syllable types are also discussed here.

2.1 Vowel Systems

In this section, I present the vowels that exist in Gua. The section presents oral and nasal vowels, vowel length and their acoustic vowel space. ATR distinctions and the status of vowel sequences are also discussed.

2.1.2 Oral Vowels

Gua has nine phonemic oral vowels /i, e, ɛ, a, o, ɔ, ʊ, ɪ, u/ with a tenth allophonic vowel [ɜ], which is an +ATR alternate of /a/. The following examples in (1) illustrate minimal and near-minimal pairs that establish the oral vowel phonemes[3] in Gua.

[3] The vowels transcribed here are not standard IPA transcriptions for ATR which have [̘] diacritic under +ATR vowels and [̙] under -ATR vowels. These diacritics are too small to be clearly visible under the vowels.

(1)	/i/	bì	‘pluck!’	fì	‘drink (a soup)!’
	/ɪ/	fì	‘sell!’	tɕì	‘see/watch!’
	/e/	tè	‘weed (along a path)!’	dè	‘grow!’
	/ɛ/	kɛ̀	‘teach/show!’	dɛ̀	‘inside’
	/a/	kà	‘hear/listen!’	tà	‘patch!’
	/ɔ/	sɔ̀	‘buy/collect!’	dɔ̀	‘weed!’
	/o/	k͡pò	‘close (from work)!’	dó	‘here’
	/ʊ/	lʊ̀	‘weave!’	tʊ́	‘gourd’
	/u/	sù	‘spit!’	tù	‘throw!’

All the examples in (1) are monosyllabic words, and most of them constitute the imperative form of the verb, which has low tone. In cases where low tone verbs are absent or difficult to find in the language for minimal pairs, nouns or postpositions with high tones have been cited. It is important to note that [ɜ] is not part of the examples because it only occurs before +ATR vowels. Therefore, it is not found in monosyllabic words. Gua oral vowels are shown in the vowel chart below with their phonological classification. Back vowels are round while front and central vowels are unrounded.

		Front	Central	Back
High	+ATR	i		u
	-ATR	ɪ		ʊ
Mid	+ATR	e		o
	-ATR	ɛ		ɔ
Low	+ATR		[ɜ]	
	-ATR		a	

Figure 2.1: Oral Vowel Chart

The images below show vowel charts involving F1/F2 of two speakers of Gua. They were created using Visible Vowels web-based software[4]. The first figure, 2.2 represents my speech as a native speaker of Gua producing multiple repetitions of a single word for each vowel. The one in figure 2.3 is a female speaker in Boso named here as EO, who produced two repetitions of several different words for each vowel. The images are on slightly different scales representing the range of the values from both speakers. The F1 axis is larger for EO than for MOY which is a possible reason for differences in position of vowels.

[4] https://www.visiblevowels.org/#formants

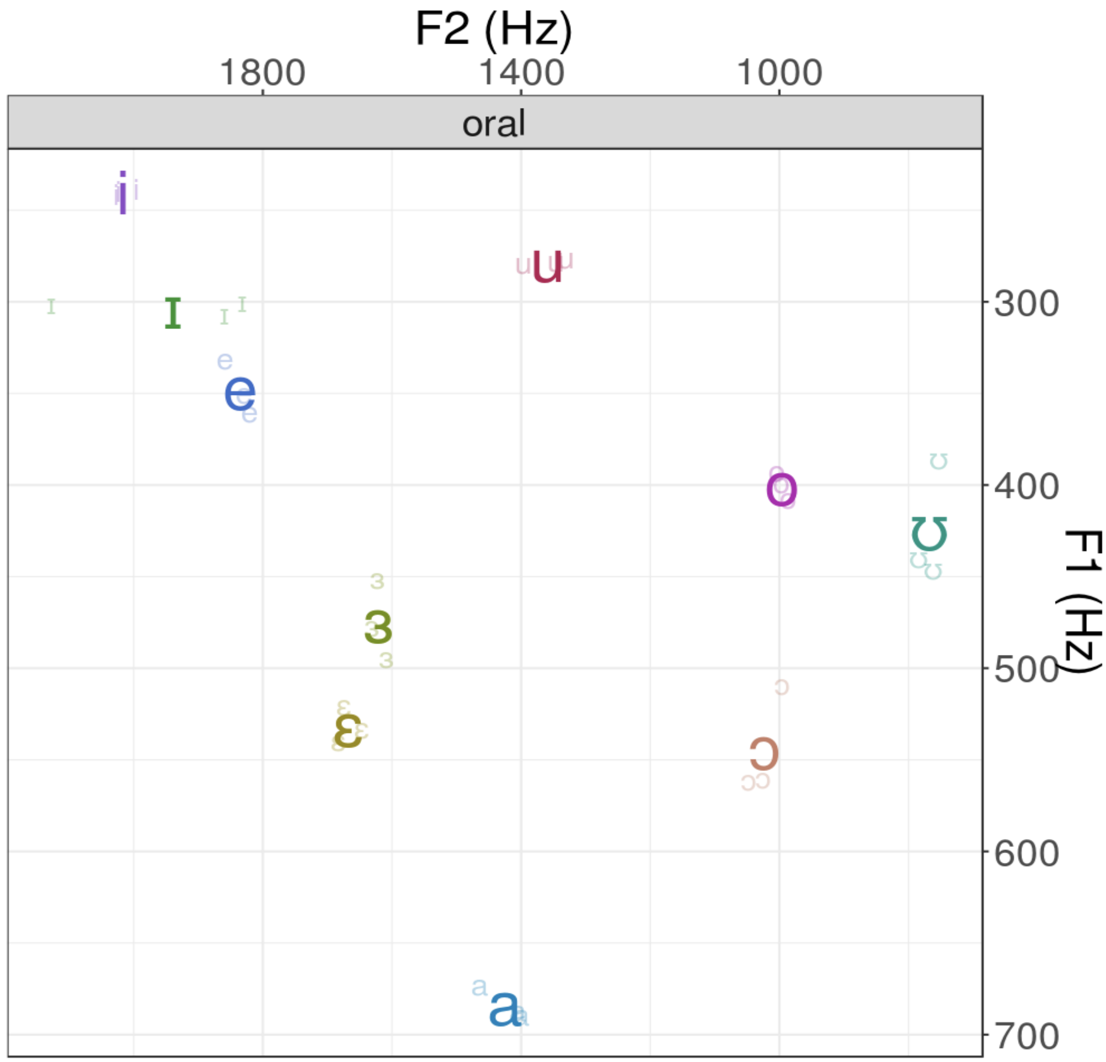

Figure 2.2: Gua oral vowels produced by MOY.

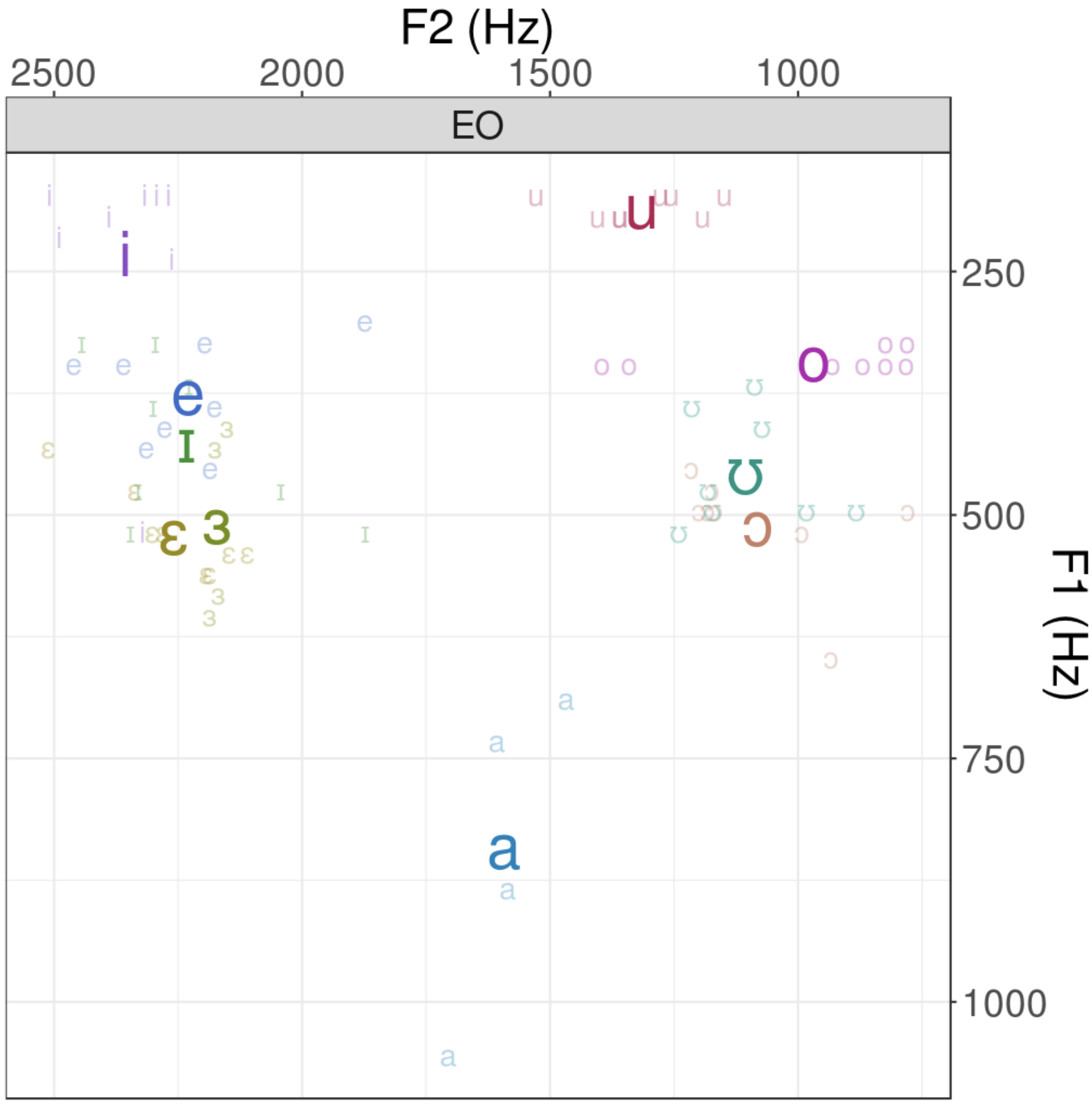

Figure 2.3: Gua Oral Vowels produced by EO

From the two figures, we observe that the back vowels in figure 2.3 are centralized, and the /o/ vowel has lower F1 than the /ʊ/ vowel. However, in the case of EO, both the mid vowels /e/ and /o/ have much lower F1 than the high vowels /ɪ/ and /ʊ/. These patterns are similar to what Kirkham and Nance (2017) found in Akan.

2.1.3 Nasal Vowels

Apart from the oral vowels, Gua has seven phonemic nasal vowels. The examples in (2) below illustrate the differences between the oral and the nasal vowels in Gua.

(2)	**Oral**		**Nasal**		
	/i/ tì	‘close/cover’	/ĩ/	tĩ́	‘short/summary’
	/ɪ/ àtɕí	‘woman’	/ĩ/	átɕĩ̂	‘sponge’
	/ɛ/ kɛ̀	‘to teach/show’	/ɛ̃/	kɛ̃̀	‘spread (mat), drive!’
	/a/ tɕà	‘dance!’	/ã/	tɕã̀	‘to lit (matches)/change!’
	/ɔ/ kɔ̀	‘defecate!’	/ɔ̃/	kɔ̃̀	‘fight!’
	/a/ àkʊ́	‘one’	/ʊ̃/	ákʊ̃̂	‘honey’
	/u/ sù	‘spit!’	/ũ/	sũ̀	‘cry!’

The vowel chart for nasal vowels is given below. There are three allophonic nasal vowels which will be presented shortly.

		Front	Central	Back
High	+ATR	ĩ		ũ
	-ATR	ɪ̃		ʊ̃
Mid	+ATR	[ẽ]		[õ]
	-ATR	ɛ̃		ɔ̃
Low	+ATR		[ɜ̃]	
	-ATR		ã	

Figure 2.4: Nasal Vowel Chart for Gua

Although most of the nasal vowels illustrated are found in monosyllabic words, the same distinctions can also be found in bisyllabic words as well, but in final position. However, there are no nasal vowels in word initial position, so patterns like ṽCv and ṽNṽ are not found in the language, where C = oral consonant and N = nasal consonant. We will see shortly that CṽNṽ is possible.

(3)	a.	k͡pìtɛ́	'separate a fight!'	sìsɛ̃́	'human being'
	b.	àtɕí	'woman'	átɕĩ̂	'sponge'
	c.	àkʊ́	'one'	ákʊ̃̂	'honey'
	d.	òsí	'cola nut'	òsĩ́	'horn'
	e.	ɔ̀sɔ́	'buying/purchasing'	ɔ̀sɔ̃́	'burning'
	f.	ɜ̀tɕú	'soup'	òsṹ	'crying'
	g.	ɛ̀dɛ̀	'something'	ɛ́sɛ̃̂	'people'

Gua lacks phonemic nasal vowels /ẽ/ and /õ/. This is a common pattern in West African languages (Rolle 2013). Several other Guang languages are also reported to lack these phonemic nasal vowels as well (Nkonya, Asante 2009; Nkami, Akanlig-Pare & Asante 2016). The same is also true of Akan (Dolphyne 1988/2006). Although the phonemic nasal vowels /ẽ, õ/ are missing in Gua these vowels can be created as allophones from three possible sources. They could be 1) the allophonic +ATR counterparts of /ɛ̃/ and /ɔ̃/ due to vowel harmony, 2) the result of oral /e/ and /o/ being nasalized due to proximity to a nasal consonant, and 3) the result of both ATR vowel harmony and nasality applying simultaneously to /ɛ/ and /ɔ/. Details of how vowel nasalization creates nasalized vowels including the allophonic versions of /ẽ, õ/ are discussed in section 2.1.4. The interaction between ATR harmony and vowel nasality is discussed in chapter 6 of this dissertation.

The presence of nasal vowels in Gua may be attributed to the deletion of a word final nasal consonant. Painter (1967) notes that the South Guang languages have lost the final nasal consonants of Proto-Guang and replaced them with nasal vowels, but their North Guang counterparts still have the word final nasal consonants. Indeed, the only nasal consonant found in the final position of native Gua words is /m/ in words like ɜ̀*nṹm̀* ‘elder’ and *ɜ́nṹm̀* ‘name of a town and other dialect of Gua’ or *kpɔ̃́m̀* ‘an ideophone for a noise made when an object bursts’. In fact, Gua speakers often do not produce the final nasal consonant in *ɜ̀nṹm̀* and simply make the preceding vowel nasal as [ɜ́nũ̂]. Although nasal consonants do not occur in word final positions except /m/ in few words, all nasal consonants occur in word initial and medial positions. Further analysis of the word medial nasal consonants is provided in section 2.3 below.

2.1.4 Vowel Nasalization

Gua has phonemically nasal vowels, but there are also cases where oral vowels are nasalized when they occur after nasal consonants in tautosyllabic contexts. The examples in (4) illustrate progressive nasalization for phonemic vowels while those in (5) provide examples of allophonic nasalized vowels, versions of the phonemic ones that are not found in the phonemic inventory of the language. In these cases, they occur preceding another +ATR vowel as a result of vowel harmony. As the examples show, all the nasal consonants can trigger nasalization. There are no cases where oral vowels /e/ and /o/ occur after nasal consonants so cases like *ɲe or *ɲo are not attested[5]. I have assumed that the underlying form of words like [nã] is /na/, but it is actually not possible to determine if [nã] is underlying /nã/ or /na/ in monomorphemic words. The first case

[5] These restrictions may be responsible for the case where pre-nasal CṼNṼ is the only context where nasal vowels are allowed word-medially due to a historical process of regressive nasalization from any nasal consonant, which has since been curtailed to tautosyllabicity.

would have an inherently nasal vowel, and the second case would involve nasalization of the vowel by the nasal consonant. However, for the forms in (5), as these vowel qualities are not phonemic nasal vowels.

(4)	a.	[ĩ]	ɲĩ̀	'harvest (palm fruit)!'
	b.	[ĩ]	mĩ̀	'swallow!'
	c.	[ɛ̃]	nɛ̃̀	'give!'
	d.	[ã]	nã̀	'walk!'
	e.	[ʊ̃]	mʊ̃́	'him/her'
	f.	[ũ]	ŋṹ	'head'
	g.	[ɔ̃]	nɔ̃́	'farm'
	h.	[ɛ̃]	ŋ͡mʷɛ̃́	'life'

(5)	a.	[õ]	ɲõ̀kúrùbí	'a type of meal'
	b.	[ẽ]	ɜ̀ɲẽ́tì	'morning'
	c.	[ɜ̃]	nɜ̃́mĩ̂	'toe'

In example (6), we see that phonemic nasal consonants trigger progressive vowel nasalization irrespective of whether the vowels are short, long or vowel sequences in Gua. Most nasal long vowels are found among ideophones.

(6)	a.	nṵ̃̀ṵ̃́	'drink!'
	b.	ɲã́ã̀	'ideophone for a very slow movement/passage'
	c.	mʊ̃̀ĩ́	'get full (from eating)!'

d.	ŋã̀ṍ	‘an ideophone for a fearful object or character’

The examples in (7) show oral vowels occurring before nasal consonant onsets. These vowels are not nasalized, although the vowel following the nasal consonants are.

(7)	a.	/i/	ɜ́k͡pìnĩ̂:	‘okro/okra’
	b.	/ɪ/	k͡pìnɛ̃́	‘hit/clash/knock!’
	c.	/ɛ/	dʑɛ́ŋ͡mɛ̃̀	‘past/historical past’
	d.	/a/	dámɪ̃̀	‘draft’ or ádàmɪ̃́ ‘heart’
	e.	/u/	sùmɛ̃́	‘send!’
	f.	/ʊ/	bʊ́nɔ̃̀	‘an egg’

But, there are other cases where vowels occurring before onset nasal consonants are nasal, as in (8). We conclude that such cases are vowels that are phonemically nasal. The examples show that unlike the cases in (7) where there was no nasality in the vowels in the first syllables, those in (8) have nasality. Because of the contrast between (7) and (8), nasality cannot be due to nasalization from the nasal consonant, but must be inherent to the vowel. However, the only time phonemically nasal vowels occur in the initial syllable is when they precede a nasal consonant – CṼCV is not a possible structure, where C = an oral consonant. And yet, the contrasts show that their presence is not directly due to nasalization from the following nasal as part of the synchronic phonology.

(8)	a.	sʊ̃́nɔ̃̂	‘seven’
	b.	tɪ̃́mɪ̃́	‘short’

c. dĩ̀mɛ̃́ ‘bite continuously’

d. fĩ̀nɛ̃́ ‘smell’

Aside from progressive vowel nasalization in the same syllable, anticipatory nasalization occurs when the nasal consonant is in a coda, in the same syllable as the vowel.

(9) a. sĩ̀ǹtĩ́ ‘hit foot against a stone!’

b. fĩ̀ǹtĩ́ ‘jump!’

c. kɛ̃̀ɲ̀tɕĩ̂ː ‘plate/bowl’

d. kɔ̃́ŋ͡ḿkpɔ́ ‘goitre’

e. sʊ̃́ńsʊ̃́ ‘heaven/atmosphere’

f. dʊ̃́ńdʊ̃́ ‘very heavy’

g. àdã́ńdà ‘jaw’

Like their progressive counterparts, anticipatory vowel nasalization also creates the allophonic versions of the missing nasal vowels in Gua as illustrated in (10). These vowels are +ATR due to regressive +ATR vowel harmony within the word, which will be discussed further in chapter 3. As mentioned above, the only words in the language that have a word-final nasal coda involve an [ũm] sequence, so these vowels will only occur preceding nasal codas word-internally (although see chapter 6 for examples of cross-word resyllabification of nasals).

(10) a. [ẽ] tẽ́ńté ‘long/tall’

b. [õ] ɜ̀dʑõ̀ŋ̀kú ‘hip’

c. [ɜ̃] dɜ̃̀ɲ̀tɕĩ́ ‘turn!’

In summary, the distribution of nasal vowels and nasalized vowels in monosyllabic and bisyllabic words is shown below. Trisyllabic words also exist and the nasals are distributed in a similar manner. The table shows that nasal vowels occur in CṼ, (C)VCṼ, CṼNṼ contexts but not in *(C)ṼCV and *ṼNṼ. Nasalized vowels also occur before and after nasal consonants in tautosyllabic contexts which include NṼ, CṼNṼ, (C)VNṼ, NṼCV, NṼNṼ, V.CṼN, CṼN.CṼ and CṼN.CV contexts. Nasal vowels are bolded

Table 2.1: Distributions of nasal and nasalized vowels in Gua.

Nasal vowels		Nasalized vowels	
C**Ṽ**.	k**ɔ̃̀**	NṼ	nã̀
(C)VC**Ṽ**	ɔ̀s**ɔ̃́**, dʑɔ̀w**ɛ̃́**	(C)VNṼ	sùmɛ̃́, àŋmʷã́, ɔ̀nã́
*(C)ṼCV	---	NṼCV	mã̀sí
C**Ṽ**NṼ	s**ṹ**nɔ̃̀	NṼNṼ	nɜ̃́mĩ̂
*ṼNṼ	---	V.NṼN	ɜ̀nṹm̀
CṼN.C**Ṽ**	sɔ̃́ńs**ɔ̃́**	CṼN.CV	tɛ̃́ńté

2.1.5 Vowel Length

Gua also shows a distinction between long and short vowels with oral vowel distinctions illustrated in (11) and their nasal counterparts presented in (12). It appears that the long nasal vowels only occur in ideophones since all the cases found so far point to this.

(11)		**Short vowels**		**Long vowels**	
	a.	ɜ̀bòbí	‘a bird’	ɜ́tòhîː	‘he-goat’
	b.	tù	‘throw!’	tûː	‘an ideophone for emphasis’
	c.	k͡pʊ́	‘a sea’	k͡pʊ̌ː	‘to leave something unwillingly’
	d.	sì	‘shave/have a hair cut!’	dǐː	‘sleep!’
	e.	kpò	‘close (from work)!’	k͡pǒː	‘sound for hitting objects with palm’
	f.	kpɔ̀	‘walk out or get out!’	kpɔ̌ː	‘scald!’
	g.	ésê	‘case/an issue	ètêːmĩ́	‘money’
	e.	ɛ́bɛ̀	‘You(pl) come’	ɛ̂ːbɛ́	‘It has come’
	f.	dá	‘there’	dâː	‘everyday’
	k.	kpɜ̀tìrí	‘slip (on slippery ground)!’	dɜ̂ːbí	‘no’

(12)	a.	dĩ̀	‘bite!’	dĩ̂ː	‘of a very quiet place’
	b.	sũ̀	‘cry!’	hũ̌ː	‘a car engine sound when in motion’
	c.	sɔ̃̀	‘burn!’	gɔ̃̂ː	‘very bright fire or light’

Although all oral vowels show length distinctions, the same is not true for the nasal vowels. Nasal /ĩ: ʊ̃: ɛ̃: ã:/ are not readily available. Since nasal long vowels are restricted to ideophones, this is not surprising.

In longer words, long vowels occur in all positions. The examples in (13a-b) and (13c-d) illustrate long vowels in word initial-syllable and word final positions.

(13)	a.	k͡pô:mò	'big'
	b.	dû:dùbí	'tiny'
	c.	ɜ̀túrû:	'a gun'
	d.	ɜ́tòhî:	'he.goat'

2.1.6 ATR Vowels

Gua shows a tongue root (Advanced Tongue Root or ATR) distinction for its vowels. The short oral vowels in Gua can be grouped into two sets (14).

(14)	**–ATR**		**+ATR**	
	ɪ	ʊ	i	u
	ɛ	ɔ	e	o
	a		[ɜ]	

Segmental minimal pairs are presented in (15) that show the ATR contrast (tones may differ on the examples). In (15), the examples to the left represent the -ATR forms while those on the right are the +ATR forms. (15i) and (15j) are examples of only /a/ because there is no phonemic +ATR counterpart. The tenth allophonic vowel [ɜ] cannot occur alone in a root. The [ɜ] vowel will be discussed later.

(15)	**–ATR**		**+ATR**	
	/ɪ/		/i/	
a.	fɪ̀	'sell!'	fì	'drink (soup)!'
b.	sɪ́	'sand/soil'	sì	'pound!'
	/ɛ/		/e/	
c.	lɛ̀	'choke/hang!'	lé	'song'
d.	sɛ̀	'fetch!'	sé	'pain'
	/ʊ/		/u/	
e.	tʊ́	'gourd/calabash'	tù	'throw!'
f.	bʊ́	'vagina'	bù	'calculate!'
	/ɔ/		/o/	
g.	dɔ̀	'weed/climb!'	dó	'here'
h.	hɔ̀	'water!'	hò	'marry!'

/a/

i. dá 'there'

j kà 'hear/listen!'

Myers et al (to appear) has provided ultrasound imaging of the articulatory production of Gua ATR vowels, with the current author as the research subject. The pictures are ultrasound imaging tracings which show that there is the advancement of the tongue root in +ATR vowels compared to their -ATR counterparts. The tongue root is at the bottom left while the tongue tip is at the right side. Figure 2.5 shows a tracing that indicates ATR distinctions between /i/ and /ɪ/ in word final positions. The figure shows that there is advancement of the tongue root for the +ATR /i/ vowel compared to the -ATR /ɪ/ vowel.

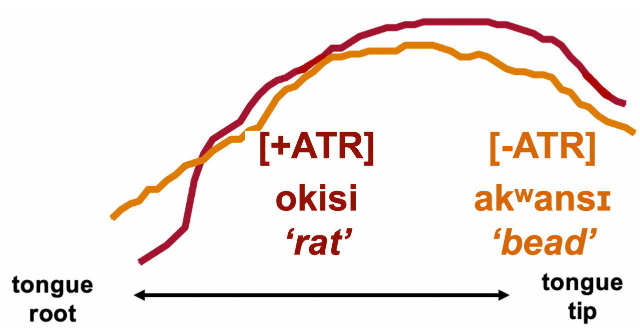

Figure 2.5: Midsagittal trace overlay of the high front vowels. Traces are taken from the midpoint of the final vowel in each word

In figure 2.6, the tracing shows ATR distinctions between /e/ and /ɛ/ in word final position. The figure shows that there is advancement of the tongue root for the +ATR /e/ vowel compared to the -ATR /ɛ/ vowel.

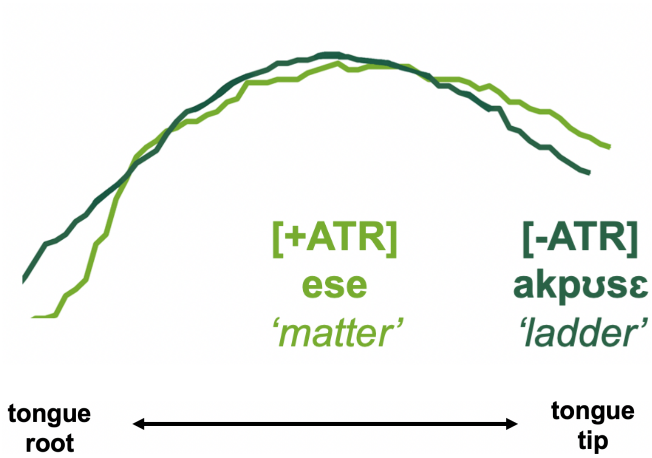

Figure 2.6: Midsagittal trace overlay of the front mid vowels. Traces are taken from the midpoint of the final vowel in each word

The final tracing in figure 2.7 shows ATR distinctions between [ɜ] and /a/ in word initial position. There was the need to use word initial vowels unlike those in figures 4 and 5 because the [ɜ] vowel only occurs preceding +ATR vowels, hence does not occur in word-final position. The tracings show that, like the other higher phonemic vowels, the allophonic +ATR vowel [ɜ] has an advanced tongue root compared to the -ATR vowel /a/.

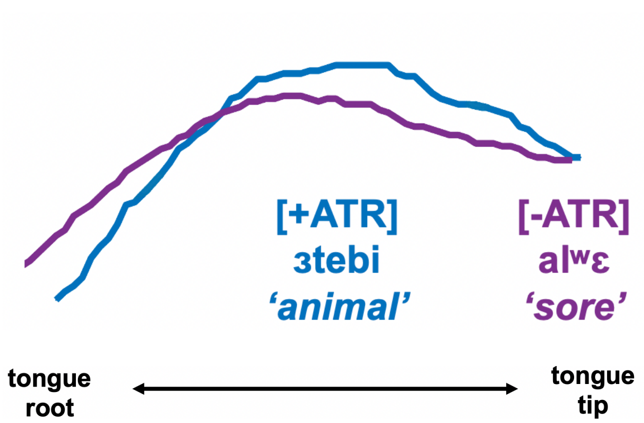

Figure 2.7: Midsagittal trace overlay of the low vowels. Traces are taken from the midpoint of the initial vowel in each word

These patterns show that all the +ATR vowels have tongue root advancement. There were no tracings for /u/ and /ʊ/ since the ultrasound equipment could not get proper images from the back of the tongue.

ATR distinctions are also observed in nasal vowels as well (16). However, as noted above, the phonemes /ẽ/, /õ/ and /ɜ̃/ are missing although they can be produced as allophones via harmony, nasalization or both.

(16)

–ATR			**+ATR**		
ɪ̃		ʊ̃	ĩ		ũ
ɛ̃		ɔ̃	[ẽ]		[õ]
	ã			[ɜ̃]	

All the phonemic -ATR oral vowels have nasal counterparts but the phonemic +ATR oral forms have nasal vowels for the high vowels only. All other cases of nasality with low and mid +ATR nasal vowels are derived (See section 2.1.4).

2.1.7 Vowel sequences

Gua also has a number of vowel sequences, which only appear in the final syllable of words. The examples in (17) show vowel sequences that end in unrounded vowels while those in (18) end with round vowels.

(17) a. bìé 'bath'

b. kpàí 'a storage material for smoked fish'

c. téì 'food'

d. sɛ̀í 'spoil!

e. fùí 'open!'

f. bùá 'answer!'

g. pȉã́ 'push!'

h. sĩ́ɛ̃̀ 'six'

i. ɜ́sìá 'in-law'

j. kpȕã́ 'add/include something to make a whole!'

(18) a. gɔ́ʊ̀ cemetery

b. kpɔ̀ʊ́ 'scald!'

Examples (17) and (18) show that all the individual sounds that form these sequences bear their own tones. This suggests that the high vocoids [u] and [i] in sequences such as [ua] or [ia] cannot be part of the preceding consonant as a palatalized or labialized consonant or a glide, but are in the syllable nucleus. Words such as *bùá* ‘answer!’ and *fũ̀ĩ́* ‘open!’ can be contrasted with *gʷà*[6] ‘run!’ and *tɕʷí* ‘eight’ which bear a single tone. Imperatives have a LH tone pattern if there are two tone-bearing units, but a L pattern if there is a single tone-bearing unit (see chapter 7). Therefore, the [w] in gwà must be part of the onset, whereas the [u] in bùá is part of the nucleus of the syllable. Vowel sequences like *bùá* ‘answer!’ are allowed in roots. However, such sequences are changed when they arise across morpheme and word boundaries, via glide formation (see chapter 6). Furthermore, forms like *fũ̀ĩ́* ‘open!’ shared nasality of the two vowels. This is not something that is required for different vowels across words.

Gua allows for different kinds of vowel height combinations: high-low, high-mid (rising sonority) low-high, mid-high (falling sonority) and even high-high (equal sonority). But there are no mid-low or low-mid combinations. These vowel combinations are actually a more restricted subset of the non-adjacent vowel combinations attested in bisyllabic roots. This is illustrated in the following table, which shows the possible bisyllabic short oral vowel combinations – a C is shown between the vowels. A full discussion of vowel distribution in bisyllabic roots is found in chapter 3. Setting aside nasality, the combinations in boxes are the vowel sequences. Note that [ia] is shown bolded without an intervening C as this vowel sequence occurs in a restricted fashion.

[6] The name of the language Gua has been written and transcribed variously as either Gua or Gwa. The actual form of the verb gwà ‘run’ and the name of the language is [gwà] with a labialized velar consonant, not a vowel sequence.

Table 2.2 Possible vowel sequences in bisyllabic/monosyllabic roots

V1/V2	i/ɪ	u/ʊ	e/ɛ	o/ɔ	ɜ/a
i/ɪ	iCi ɪCɪ		iCe ɪCɛ		**ia** ɪCa
u/ʊ	uCi ʊCɪ	uCu ʊCʊ	uCe uCɛ ʊCɛ	uCo uCɔ ʊCɔ	uCa ʊCa
e/ɛ	eCi ɛCɪ		eCe ɛCɛ		
o/ɔ	oCi ɔCɪ	oCu ɔCʊ	oCe ɔCɛ	oCo ɔCɔ	ɔCa
ɜ/a	ɜCi aCɪ	ɜCu aCʊ	ɜCe aCɛ	ɜCo aCɔ	aCa

First, apart from the ia and ua (and nasal versions of these) combinations, the vowel sequences have to share ATR. This is similar to what is found in bisyllabic roots, where matching ATR is required, except for when non-high -ATR vowels can follow the high +ATR [u] – *súmâ̂* 'a god' is an attested word, for example. However, there are no [ɜi] type sequences, even though there are [aɪ]. This is unlike bisyllabic roots. Second, consider the high vocoids in the vowel sequences. The front vocoid [i] can precede front and low vowels, but not the back round vowels. This is also similar to its distribution in bisyllabic roots. In the case of /u/, it can precede [i] and [a], whereas in bisyllabic roots, it can precede [e] and [o] as well. High vocoids can follow non-high vowels. We find aɪ but not *aʊ; the latter is attested in bisyllables: ánɔ̂̂ as well as ɛɪ, ei, but not these vowels followed by a round vowel, which again, is like bisyllables. Finally, we find only one round vowel sequence: ɔʊ, despite various combinations with an initial mid round vowel with bisyllables. All these sequences are attested in bisyllabic forms, but a much smaller subset. This actually suggests that the vowel sequences may have developed from bisyllabic roots via reduction/lenition and eventual loss of an intervening consonant with certain words. This would explain why they are a proper subset of the bisyllabic combinations. This distributional data, combined with the tone bearing capacity, suggests that these are vowel sequences rather than diphthongs. A diphthong is a single segment with two articulatory targets. As we will see in chapter

4, cross-word vowel harmony affects only the final vowel of the vowel sequences, also supporting a sequence analysis rather than a diphthong analysis. As to whether the vowel sequences are also bisyllabic, there is no empirical evidence that can determine this. Tone patterns (chapter 7) are assigned based on moras rather than syllables.

The discussion of the vowels has shown that there are both phonemic oral and nasal vowels. These vowels display ATR and length distinctions. There are also vowel sequences in Gua. Gua has some phonotactic restrictions in its vowel system. Vowel sequences can only appear word-finally, high round vowels do not appear word-initially, and nasal long vowels occur primarily in ideophones. The Gua vowel system is similar to the general inventories reported in other related Guang languages (See Nkonya, Asante 2009, Nkami, Akanlig-Pare & Asante 2016, Lɛtɛ Akrofi Ansah 2009).

2.2 Syllable Structure

Gua syllables are fairly simple, with a preference for open syllables with simple onsets. Only one kind of complex onset is attested, and one type of coda. Syllables types are CV, CVV, V, VV, N, CVN, where VV indicates a long vowel or vowel sequence. There is also a possible CRV syllable, where R = liquid consonant. Syllables with vowel sequences cannot occur at the beginning of word although long vowels can. Syllables with VV that end in nasal consonants do not exist in the language.

2.2.1 CV/CVV Syllables

CV is a basic syllable type in Gua. Most words in the language have CV structure. The examples below in (19) are monosyllabic words that illustrate CV syllable types.

(19)	a.	bì	'pluck!'
	b.	fì	'sell!'
	c.	té	'an oath'
	d.	sɔ̀	'buy/collect/receive!'
	e.	ɲɛ̃́	'a name'
	f.	ŋṹ	'a head'
	g.	lé	' a song'
	h.	wɔ̀	'pound!'

Aside from monosyllabic CV words, both bisyllabic (20a-b) and trisyllabic (20c-d) words also illustrate the occurrence of the CV syllable type in Gua.

(20)	a.	bò.lí	'break!'
	b.	sɔ̀.k^wí	'seize!'
	c.	bò.kí.tì	'bucket'
	d.	bò.ké.té	'a type of measuring container'

The CV syllable is the most basic syllable cross-linguistically. Jacobson (1962:526) notes that "There are languages lacking syllables with initial vowels and/or syllables with final consonants, but there are no languages devoid of syllables with initial consonants or syllables with final vowels.” This assertion is also corroborated by Blevins (1996) noting that all languages have the CV syllable type.

2.2.2 CVV Syllables

There are also CVV syllables that are analyzed in this dissertation as vowel sequences. Some of the examples of CVV syllables are cited in example (21).

(21) a. téì ‘food’

b. fũ̀ĩ́ ‘open!’

c. fã̀ĩ́ ‘stop!’

d. kpàí ‘a storage material for smoked fish’

e. kpúì ‘water storage equipment’

f. sã̀ĩ́ ‘untie!’

g. dǐː ‘sleep!’

h. dâː ‘everyday’

i. k͡pǒː ‘a sound made when an object is hit with another object’

j. ɲǎː ‘slow movement’

2.2.3 V/VV Syllables

The V syllable alone can constitute grammatical or function words. The only two examples that show grammatical functions are illustrated in (22).

(22) a. à ‘determiner/question marker’

b. ɛ̀ ‘focus marker’

V syllables are also attested in word initial position. The examples in (23) all begin with [a], or [ɜ] via vowel harmony. This vowel is a singular prefix in nominals.

(23)	a.	à.dà.mɪ̃́	'heart'
	b.	à.k͡pà.kʊ́	'he.goat'
	c.	á.mɪ̃̂	'stomach'
	d.	ɜ̀.tè.bí	'an animal'
	e.	ɔ̀.tɑ̃́.nɪ̃̀	'nursing mother'
	f.	ò.sé	'earthenware'
	g.	è.tê:.mɪ̃́	'money'
	i.	í.kʷâ	'neck'
	j.	í.fî	'a rope'
	k.	ɛ́.sɛ̃̂	'people'
	l.	ɛ̀.tɕí	'women'

There are other cases where we have VV syllables represented here with long vowel diacritic. The examples in (24) show cases where an aspect prefix ɛ̌:-/ɛ̂:- illustrate VV syllables. Vowel sequences are not allowed in this position.

(24)	a.	ɛ̌:.kpɔ̀.lì	'..is cleaning'
	b.	ê:.bó.lì	'..has broken'
	c.	ɛ̌:.kpɔ̀.tɔ̀	'..is grinding'
	d.	â:.kpɔ́.lì	's/he has cleaned'

2.2.4 N Syllable

Syllabic nasal consonants in Gua also serve as a single syllable in the language. They occur in word initial positions and share the same place of articulation as the next consonant. In these examples, the nasal is a plural noun class marker. It is a tone-bearing unit, and can have different tone from the following vowel. All NC word-initial sequences are multimorphemic words in Gua.

(25)	a.	ǹ.dà.mĩ́	'heart'
	b.	ŋ͡m.k͡pà.kʊ́	'he.goat'
	c.	ḿ.mĩ̂	'stomach'
	d.	ǹ.tè.bí	'an animal'
	e.	ǹ.tɛ̃́	'alcohol'
	f.	ǹ.tɕú	'water'

2.2.5 CRV Syllable?

There is a particular syllable type CRV (either CrV or ClV) that appears to be derived from a bisyllabic word CVCV. This happens when V_1 is deleted from the first CV structure to create CrV or ClV ([r] and [l] are allophonic free variants intervocalically – see chapter 5). Examples of this syllable type are illustrated in (26):

(26)	a.	wʊ̀.rɛ́	→	wrɛ́	'wear!'
	b.	bʊ̀.lí	→	blí	'beat!'
	c.	jì.rɛ́	→	jrɛ́	'hide!'
	d.	sì.lí	→	slí	'fear!'
	e.	bì.lí	→	blí	'collect'

f.	bì.rí	→	brí	'talk/speak'
g.	kìrí	→	krí	'bind!'

The V_1 that gets deleted is a high vowel, but the second vowel can either be a high or a mid vowel. Given that this sequence is derived optionally in rapid speech, it is not clear it is syllabified as a complex onset and is not part of the basic syllable inventory of the language (yet). This phenomenon is a common feature in other West African languages such as Akan (Dolphyne 1988/2006), Fongbe (Lefebvre and Brousseau 2011) and some Kru languages (Bing, 1987; Marchese, 1979, 1988; Corbett, 1991, Sande 2015,2019).

2.2.6 CGV/VG Syllables?

Vowel hiatus resolution between high vowels and non-high vowels can result in a consonant-glide-vowel sequence. Although labialized consonants are phonemic in the language, palatalized consonants are not. It appears as if consonant-glide (CG) sequences are derived only. Some examples are given below:

(27)	a.	bɔ̀lí ɛ́dɛ̂	→	bɔ̀ljɛ́dɛ̂	'python thing'
	b.	wʊ̀sʊ́ ɛ́bî	→	wʊ̀swɛ́bî	'shake palm tree'

These sequences are similar to the Cr or Cl sequences in that they are derived by a change to a high vowel.

2.2.7 CVN - Syllable Structure

The final syllable type is CVN. When this syllable occurs in word final position, it is mostly observed in borrowed words except for a few cases as explained earlier in section 2.1.4. Some examples of this syllable type are the following in (28):

(28)	a.	ɔ̀.hʊ́.nám̀	'(human) body'
	b.	ò.ʥɜ́ḿ.pím̀	'elephantiasis'
	c.	nɜ́ŋ͡m.k͡pô:mȉ	'ankle'
	d.	ɜ́dʑòŋ̀.kú	'hip'
	e.	ɜ̀.nű̃m̀	'elder'

Examples (28b-d) have an N.C sequence and (28e) has a final CVN where the N has been syllabified as a coda in the syllable. There are a number of arguments that point to the N being in a coda rather than in an onset as a prenasalized obstruent or syllabic nasal in these cases.

Riehl's (2009) analysis of cross-linguistic NC patterns distinguishes either prenasalized or clusters cross-linguistically. It is not immediately clear if homorganic medial nasal consonants (N) in NC sequences in Gua are syllabified as coda-onset or as prenasalized stop. Different analyses have been proposed for similar NC sequences in Bantu including a consonant cluster analysis (Downing 2005) or a single segment account (Morrison 2009). In this section, I argue that the nasal in NC sequences in Gua is a coda based on nasalization, tone distribution, word-final nasals and the distribution of long vowels.

First, as pointed out in section 2.1.4, vowels are not nasalized before nasal onsets. However, it is possible to have a nasal vowel preceding a nasal consonant, but the contrast shows that these are inherently nasal, not nasalized before a nasal consonant.

(29)		Nasal		Oral	
	a.	kpɔ̃̀nĩ́	‘break part of a whole’	sɔ̀nĩ́	‘ceive’
	b.	sṹnɔ̃̀	‘seven’	sùmɛ̃́	‘send!

Vowels preceding an NC are always nasal, unlike vowels before an onset nasal (28). Likewise, vowels following an NC are oral (29a,b), unlike those in example (28). Therefore, the cases in (29) are vowels nasalized by the following nasal consonant.

(30)	a.	tɛ̃́ńté	‘long/tall’
	b.	ʒ́dʑõ̀ŋ̀kú	‘hip’
	c.	fĩ̀ǹtĩ́	‘jump!’
	d.	dʒ̃̀ɲ̀tɕĩ́	‘turn’

It must be noted that the final vowel can either be an oral or nasal final vowel and that it has no effect on the nasalization process of the nasal vowel before an NC sequence. This suggests that nasalization occurs within the same syllable and that N in the NC sequence is a coda. Nasalization occurs within the syllable only, onsets nasalize progressively (28) and codas nasalize regressively (29). Therefore, these appear to be coda nasals.

Second, the N in an NC sequence in word-medial position bears the same tone as the preceding vowel as shown in (30) and reproduced in (31) suggesting that within a medial VC rhyme, tone must be identical. However, in word final position, the tone differs as the final nasal consonant bears a low tone (31c). This does not mean that different tone equals different syllabification, but the restriction for the word-internal nasals does point to coda status. In the case of (31), the verbs in (31d-e) show that CVN has all low in the imperative forms while those in the past forms have all high.

(31)	a.	tɛ̃́ńté	'long/tall'		
	b.	ɜ́dʑɔ̃̀ŋ̀kú	'hip'		
	c.	ɜ̀nʊ̃́m̀	'elder'		
	d.	fĩ̀ǹtĩ́	'jump!'	fĩ́ńtĩ̀	'jumped'
	e.	dɜ̃̀ɲ̀tɕĩ́	'turn'	dɜ̃́ɲ́tɕĩ̀	'turned'

When a word beginning with an NC follows a vowel-final word, regressive nasality affects the final vowel of the first word, and furthermore, the nasal changes its tone to that of the preceding vowel (32a-c). This does not occur with initial NV sequences (32d-f). These facts suggest that N in NC is re-syllabified as coda of the preceding word.

(32) a. wʊ́ + ǹtèbí → [wʊ̃́ń.tè.bí]

Your things/animals

b. àtɕí + ǹtɛ̃́ → [à.tɕĩ́ń.tɛ̃́]

'A woman's (alcoholic) drink'

c. ɜ̀lèbí + ǹtɛ̃́ → [ɜ̀.lè.bĩ́ń.tɛ̃́]

'A child's (alcoholic) drink'

d. wʊ́ + nɛ̃̀nɛ̃́ → [wʊ́.nɛ̃̀.nɛ̃́]

Your grandmother

e. kʊ̀sʊ́ + ɲɜ̃̀kɛ̃́ → [kʊ̀.sʊ́.ɲɜ̃̀.kɛ̃́]

'get-up and dress (sore)!'

f. sòbí + nɛ̃̀ɲɛ̃́ → [sò.bí.nɛ̃̀.ɲɛ̃́]

'pull grandfather!'

Aspects of these analyses have received similar descriptions in Akan (Dolphyne 1988/2006), Nkami (Asante 2016) and Lɛtɛ (Akrofi Ansah 2009), but the case presented here shows several pieces of evidence to suggest that the N in word-internal NC sequence is indeed a coda.

Finally, nasal consonant onsets can occur after long vowels (33a), but NC sequences are barred after them (33b).

(33) a. k͡pôːmò 'big'

b. *k͡pôːmbó

Gua has both light and heavy syllables, namely CV and CVV. The absence of *VVNC suggests that Gua syllables are maximally bimoraic and that the nasal coda in CVN is also moraic. It also implies that such NC cases are N+C and not prenasalized NC.

This section has argued that the N in NC sequence in Gua is a coda. It is the first analysis that provides a comprehensive account of NC sequences in a Guang language.

2.3 Conclusion

This chapter has discussed the vowel system of Gua and basic syllable structure. There are oral and nasal phonemic vowels in Gua. These vowels show length and ATR distinctions. There are also vowel sequences which occur in the final syllable. All vowels can begin words except /u/ and /ʊ/ irrespective of their nasality status. Nasalization also occurs in Gua and is triggered by a nasal consonant in the same syllable.

In terms of syllables, Gua has a composite syllable template (C)V(V)(N). There is also a surface CRV syllable that is the result of loss of a high vowel between the first two consonants of a word if the second one is a liquid. I have also argued that N in word medial NC sequences is a coda with evidence from nasalization, tonal marking, cross-word nasalization and the distributions of long vowels. However, in initial position, NC clusters are syllabified with the N as a syllabic nasal.

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CHAPTER THREE

VOWEL HARMONY: DIRECTIONALITY

3.0 Introduction

Many languages of the world are reported to have ATR vowel harmony, especially within the Nilo-Saharan and Niger-Congo phyla (Casali 2008). Rolle et al (2019) notes that out of the 681 languages in the Areal Linguistic Features of Africa (ALFA database) found in the Macro-Sudan Belt, 358 exhibit ATR vowel harmony. Patterns of ATR vowel harmony across languages can be classified as unidirectional (regressive or progressive) and/or bidirectional. But it can be difficult to separate directionality from stem control and the morphological structure of the language. For example, if a language has suffixes only and progressive vowel harmony, then one cannot tell whether harmony is progressive due to a directionality specification or whether it is progressive because the root or stem is the source of the harmony and spreads to the suffixes. Nevertheless, there appear to be several languages showing regressive directionality (Casali 2008, Hyman 2002, Ribeiro 2002, Mahanta 2007 and Linebaugh 2015) while progressive directionality is more limited and only occurs in specific morphological environments (e.g. Kinande – Mutaka 1995; Tutrugbu - McCollum & Essegbey 2020; Tafi - Bobuafor 2013). In this chapter, I provide a detailed account of the regressive directionality pattern of Gua ATR harmony, and situate it within the typology of harmony directionality, taking into account morphological structure. I argue that Gua presents one of the best and clearest case for regressive directionality at all levels: within words, roots and across word boundaries. I end the chapter with a typological overview of directionality in ATR systems and show how Gua fits within these systems.

The rest of the chapter is organized as follows: Gua ATR harmony is discussed in section 3.1, directionality within roots and words is discussed in section 3.2, section 3.3 presents a typology of directionality patterns across ATR systems and section 3.4 concludes the chapter.

Because cross-word ATR harmony in Gua is governed by rhythmic principles and syntactic structure, and so requires a lengthy description, this will be addressed separately in chapter 4.

3.1 Gua Vowel Harmony

As indicated in chapter 2, Gua has nine phonemic oral vowels with a tenth vowel [ɜ], which is an +ATR allophone of /a/. The oral vowels in Gua can be grouped into two sets (1) according to their ATR feature. All of these vowels also show length contrasts.

(1)

–ATR			**+ATR**		
ɪ		ʊ	i		u
ɛ		ɔ	e		o
	a			[ɜ]	

Nasal vowels also show ATR distinctions, as in (2). However, among +ATR nasal vowels, only /ĩ/ and /ũ/ are phonemic. The others are allophonic and generated through vowel harmony. Most of these vowels show length contrasts.

(2)

–ATR			**+ATR**		
ɪ̃		ʊ̃	ĩ		ũ
ɛ̃		ɔ̃	[ẽ]		[õ]
	ã			[ɜ̃]	

3.2 Gua Vowel Harmony: Directionality

In this section, I will show that Gua exhibits regressive directionality. It differs from some related Guang languages such as Nkami (Asante 2016) in having an allophonic vowel [ɜ], a fact which helps determine that regressive directionality also operates within the root, not just within the larger word domain.[7]

3.2.1 Regressive Directionality within words

Regressive directionality of ATR harmony is observed within polymorphemic words. Prefixes alternate for ATR and the root is causing this alternation. Example (3) shows that the verbal noun prefix ɔ̀- occurs before -ATR verb roots and ò- occurs before +ATR verb roots.

(3)

	-ATR		**+ATR**	
a.	ɔ̀-kpʊ́tɛ̀	'separation'	ò-sóbì	'pulling'
b.	ɔ̀-kpítì	'plucking'	ò-kpítè	'cleansing/cleaning'
c.	ɔ̀-tánɪ̃̀	'rearing'	ò-bíè	'bathing'
d.	ɔ̀-fɪ̃́ńtɪ̃̀	'jumping'	ò-bólì	'breaking/cracking'

Gua has noun class prefixes and they undergo harmony. Although Gua does not have a comprehensive noun class system like some Niger-Congo languages, the available ones do

[7] Although Asante (2016) reports no allophonic vowel, Tideman (2019) analyzed /a/ vowels preceding +ATR vowels in Nkami and reports that they are, in fact, acoustically distinct from /a/ preceding -ATR vowels, suggesting Nkami may have a +ATR allophonic version of /a/.

undergo harmony. Examples (4a-b) shows that a- alternates with ɜ- depending on the ATR value of the stem in singular nouns, and (4c-d) shows that the prefix ɛ- alternates with e- in plural nouns based on the ATR value of the stem.

(4)

	-ATR		+ATR	
a.	à-tɕí	'woman'	ɜ́-bî	'child'
b.	á-nɛ̂̂	'grandchild'	ɜ́-nî	'mother'
c.	ɛ̀-tɕí	'women'	é-bì	'children'
d.	ɛ́-nɛ̂̂	'grandchildren'	é-nî̂	'mothers'

In addition, tense, aspect and mood (TAM) prefixes on verbs harmonize. These prefixes include the future marker bɛ̀-/bè, the progressive marker ɛ̌ː-/ěː- with rising tone and the perfective marker ɛ̂ː-/êː- with falling tone. In the examples below in (5), the prefix harmonizes with the ATR value of the root.

(5) **-ATR** **+ATR**

	-ATR			+ATR		
a.	kòfí	bɛ̀-fítɛ̀	ǹtèbí	kòfí	bè-bólì	kókósì
	kofi	FUT-dry	clothes	kofi	FUT-break	a coconut
	'Kofi will dry clothes'			'Kofi will break coconuts'		

-ATR **+ATR**

b. kòfí ɛ̆ː-bɔ̀tɛ̀ ɛ́dídɛ̀ kòfí ĕː-sòbì ífì

kofi PROG-remove mat kofi PROG-pull rope

'Kofi is removing a mat' 'Kofi is pulling a rope'

-ATR **+ATR**

c. kòfí ɛ̂ː-bɔ́tɛ̀ ɛ́dídɛ̀ kòfí êː-sóbì ífì

kofi PERF-remove mat kofi PERF-pull rope

'Kofi has removed a mat' 'Kofi has pulled a rope'

Also, the negative marker bɛ́-/bé- appears as a prefix before the verb root and it undergoes harmony.

(6) **-ATR** **+ATR**

a. kòfí bɛ́-fitɛ̀ ǹtèbí kòfí bé-bòlì kókósì

kofi NEG-dry clothes kofi NEG-break a coconut

'Kofi does not dry clothes' 'Kofi does not break/crack coconuts'

-ATR **+ATR**

b. kòfí bɛ́-bɔ̀tɛ̀ ɛ́dídɛ̀ kòfí bé-sòbì ífì

kofi NEG-remove mat kofi NEG-pull rope

'Kofi does not remove a mat' 'Kofi does not pull a rope'

Singular pronouns indicating subjects are prefixed to verb stems, and they undergo harmony as well. Singular pronouns are *mí-* 'I', *wʊ́-* 'You', *á-* 'he/she/it' and *mɔ̀* 'her/him'. Since these pronouns can occur by themselves as objects and are always [-ATR] in that position as shown in example (8)[8], I assume that the underlying form of these prefixes is -ATR, and I will show shortly that only the [+ATR] feature spreads[9]. Subject pronoun prefixes always harmonize and never trigger harmony within a word. These are illustrated in the examples in (7) below. The example in (7d) also illustrates that the harmony process also affects all vowels in preceding prefixes.

(7)	**-ATR root with singular pronoun**		**+ATR root with singular pronoun**	
a.	mɪ̃́-k͡pɔ̀lì	'I clean'	mɪ̃́-bòlì	'I break/crack'
b.	wʊ́-k͡pɔ̀lì	'You clean'	wú-bòlì	'You break/crack'
c.	á-k͡pɔ̀lì	'He/she cleans'	ɜ́-bòlì	'He/she breaks/cracks'
d.	wʊ́-bɛ̀-k͡pɔ́lì	'You will clean'	wú-bè-bólì	'You will break/crack'

(8) **-ATR Object Pronouns**

a. kòfí sóbì mɪ̃̀

kofi pull.pst 1SG.OBJ.

'Kofi pulled me'

[8] The pronouns have low tones when they occur in object positions.

[9] Another possibility is that the prefix is unspecified for ATR and all 0 values are filled in for default -ATR after harmony.

b.	kòfí	sóbì	wʊ̀
	kofi	pull.pst	2SG.OBJ.
	'Kofi pulled you'		
c.	kòfí	sóbì	mɔ̏
	kofi	pull.pst	3SG.OBJ.
	'Kofi pulled him/her'		

The 1st and 2nd person singular subject pronouns have allomorphs which occur in the past tense as well as in some other TAM forms. The first person is a nasal that shares the same place of articulation with the following consonant, while the second person is a vowel prefix ɔ̀-/ò- depending on the ATR value of the root. The third person does not differ from the forms in (8) and shows the same alternation between à- and ɜ̀-. These prefixes have low tones in the past tense as in (9). See chapter 7 for an explanation of the tone alternations.

(9)	**-ATR root with singular pronoun + PST**		**+ATR root with singular pronoun + PST**	
a.	m̀-k͡pɔ́lì	'I clean'	m̀-bólì	'I broke/cracked'
b.	ɔ̀- k͡pɔ́lì	'You cleaned'	ò-bólì	'You broke/cracked'
c.	à-k͡pɔ́lì	'He/she cleaned'	ɜ̀-bólì	'He/she broke/cracked'

Unlike prefixes, suffixes are not targets of harmony within words, but +ATR suffixes are triggers. The diminutive +ATR suffix ***-bí*** triggers regressive harmony. When it is attached to a -ATR stem, it causes the stem to change from -ATR to +ATR to harmonize with the suffix as shown in (10). The example in (10b) shows that the suffix can affect both the root and a preceding prefix.

(10)	**-ATR root**		**-ATR root with -bí → +ATR**	
a.	ɔ̀bá	'hand'	bɜ́-bí	'finger' (hand-DIM)[10]
b.	á-tɕɛ̂̃	'sponge (for bathing)'	ɜ́-tɕɪ̃́-bí	'small sponge (for washing dishes)'
c.	ɛ́dɛ̂	'thing'	édé-bí	'small/unimportant thing'

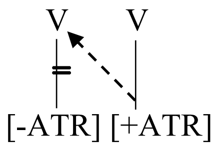
On the other hand, in (11), the suffix *-hɔ̃̀*[11]*/-hɔ̀* is not affected by the [+ATR] vowels in the root, and the root does not change to [-ATR] in agreement with the suffix. This indicates that the active harmonic feature is +ATR and harmony is strictly regressive within words.

(11)	**-ATR root with -hɔ̃̀/-hɔ̀**		**+ATR root with -hɔ̃̀/hɔ̀**	
a.	àdá-hɔ̃̀	'master'	ɜ̀bìélì-hɔ̀	'blacksmith'
b	àbɔ̀ɔ́-hɔ̀	'messenger'	ɜ̀sítìí-hɔ̀	'deaf person'

Gua has many prefixes but there are not many suffixes. The two suffixes provided here are both nominal ones, and the *-bi* might have derived from a separate word meaning 'child' that formed a compound. There are no verbal suffixes or sequences of suffixes. However, the behavior of the suffixes is enough to determine that suffixes trigger harmony if +ATR, but do not participate in harmony if -ATR. This shows that ATR harmony in Gua is regressive within words and that the dominant feature spreading is +ATR. ATR harmony can be represented as follows:

[10] The initial vowels in ɔ̀bá 'hand' deletes when the diminutive suffix is added to derive bɜ́bí.
[11] The nasalization property of the suffix appears to be lexicalized per word.

(12)



This section has shown that pronominal, deverbal and TAM prefixes undergo harmony within words. While suffixes do not undergo harmony, +ATR suffixes trigger regressive harmony on roots.

3.2.2 Compounds

There are very few compounds in Gua, but harmony does operate within them. The compounds appear to be combinations of a noun and a postposition, possibly derived from another noun. In most cases, they consist of -ATR postpositions occurring after +ATR nouns. In this case, no harmony is observed across the boundary of the two words in either direction (13a,b). However, when the second half of the compound is +ATR, regressive harmony is extended onto the first half as in (13c).

(13)	a. sóbì	+	àsí	→	sóbjàsí
	cooking stove		under		kitchen
	b. m̀bú	+	àmɛ́	→	m̀bwàmɛ́
	houses		back/behind		faeces
	c. àɲɛ́	+	ɜ̀nű́m̀	→	ɜ̀ɲénúm̀
	male		elder	→	elderly man

ATR harmony within compounds is also in accordance with regressive directionality, and it also shows that harmony is triggered by the +ATR feature value (13c), but not by the -ATR feature value (13a-b).

3.2.3 Numerals

Numerals in Gua behave like compounds with respect to ATR harmony. Harmony applies in compounds when the right configuration for regressive directionality is met. In example (14), we have numerals starting from one[12].

(14)	a.	àkʊ́	‘one’	f.	sɪ̃́ɛ̃̀	‘six’
	b.	ɲɔ̃́	‘two’	g.	súnɔ̃̂[13]	‘seven’
	c.	sã́	‘three’	h.	tɕʷí	‘eight’
	d.	nɛ̃́	‘four’	i.	k͡pʊ́nɔ̃̂	‘nine’
	e.	nĩ́	‘five’			

[12] There is no numeral zero. Phrases are used to capture the idea of zero or nothing.
[13] This word shows a +ATR -ATR sequence word-internally, which appears to violate vowel harmony. In fact, it is more evidence for regressive directionality. These kinds of words will be addressed in the next section.

The numeral system is decimal. There is a base for 10, and numerals from 11 through 19 add the numbers from 1 to 9 to the base 10 as shown in (15). In (15) all the examples involve +ATR words followed by either -ATR or +ATR words and so therefore, there is no harmony.

(15)	a.	ídû	→	ídû	'ten'
	b.	ídû + àkʊ́	→	ídwàkʊ́	'eleven'
	c.	ídû + ɲɔ̃́	→	ídúɲɔ̃́	'twelve'
	d.	ídû + sã́	→	ídúsã́	'thirteen'
	e.	ídû + nɛ̃́	→	ídúnɛ̃́	'fourteen'
	f.	ídû + nĩ́	→	ídúnĩ́	'fifteen'
	g.	ídû + sĩ́ɛ̃̀	→	ídúsĩ́ɛ̃̀	'sixteen'
	h.	ídû + súnɔ̃̀	→	ídúsúnɔ̃̀	'seventeen'
	i.	ídû + tɕʷí	→	ídútɕʷí	'eighteen'
	j.	ídû + k͡pʊ́nɔ̃̀	→	ídúk͡pʊ́nɔ̃̀	'nineteen'

From 20 to 29, there is a base for 20, *òdòɲɔ̃́*, which appears to contain a base *òdò* and the word for 2 *ɲɔ̃́*. However, the word for 10 is *ídû*, so one would expect 20 (10 x 2) to be *ídúɲɔ̃́*, but instead the base has round mid vowels. Note that there is no harmony between the two halves as *òdò* is +ATR and *ɲɔ̃́* is -ATR. The digits are added to the base twenty to continue the counting within the twenties as shown in (16). With these examples, there is ATR harmony of the final vowel of the base in (16f-i) because the numeral is +ATR.

(16)	a.	òdòɲɔ̃́	→	òdòɲɔ̃́	‘twenty’
	b.	òdòɲɔ̃́ + àkʊ́	→	òdòɲʷàkʊ́	‘twenty-one’
	c.	òdòɲɔ̃́ + ɲɔ̃́	→	òdòɲɔ̃́ɲɔ̃́	‘twenty-two’
	d.	òdòɲɔ̃́ + sã́	→	òdòɲɔ̃́sã́	‘twenty-three’
	e.	òdòɲɔ̃́ + nɛ̃́	→	òdòɲɔ̃́nɛ̃́	‘twenty-four’
	f.	òdòɲɔ̃́ + nĩ́	→	òdòɲṍnĩ́	‘twenty-five’
	g.	òdòɲɔ̃́ + sĩ́ɛ̃̀	→	òdòɲṍsĩ́ɛ̃̀	‘twenty-six’
	h.	òdòɲɔ̃́ + súnɔ̃̂	→	òdòɲṍsúnɔ̃̂	‘twenty-seven’
	i.	òdòɲɔ̃́ + tɕʷí	→	òdòɲṍtɕʷí	‘twenty-eight’
	j.	òdòɲɔ̃́ + k͡pʊ́nɔ̃̂	→	òdòɲɔ̃́k͡pʊ́nɔ̃̂	‘twenty-nine’

The numerals following twenty use *ɛ̀dʊ́ɛ̀* as the base and then the digit is added to the base for the value in tens. The three ‘ten’ bases may be related as they all consist of a VdV pattern, but only *ídù* has the meaning ‘ten’ alone. So, thirty has the base *ɛ̀dʊ́ɛ̀sã́*, forty has *ɛ̀dʊ́ɛ̀nɛ̃́* and fifty has *èdúènĩ́* and so on through ninety which has *ɛ̀dʊ́ɛ̀k͡pʊ́nɔ̃̀*. When the second part of the numeral has +ATR vowels the -ATR vowels in the base become +ATR. Like the relationship between the base and the digits regarding harmony in (16), the bases after thirty also show evidence of regressive directionality as illustrated in (17b-c).

(17)	a.	ɛ̀dʊ́ɛ̀- + nɛ́	→	ɛ̀dʊ́ɛ̀nɛ́	‘forty’
	b.	ɛ̀dʊ́ɛ̀- + ní	→	èdúèní	‘fifty’
	c.	ɛ̀dʊ́ɛ̀- + tɕʷí	→	èdúètɕʷí	‘eighty’
	d.	ɛ̀dʊ́ɛ̀- + kpʊ́nɔ̃̂	→	ɛ̀dʊ́ɛ̀kpʊ́nɔ̃̂	‘ninety’

For the hundreds, there is the base *ɔ̀lɔ̀fɛ́* for one hundred then the multiples of that by digits give the multiples of hundreds: two hundred, *ɔ̀lɔ̀fɛ́ ɲɔ́* ‘two hundred’, *ɔ̀lɔ̀fɛ́ sã́* ‘three hundred’, among others. In the same manner, when digits with +ATR vowels are added to the base, they trigger harmony on all the vowels in the base (18b-d).

(18)	a. ɔ̀lɔ̀fɛ́	→	ɔ̀lɔ̀fɛ́	‘hundred’
	b. ɔ̀lɔ̀fɛ́ + ní	→	òlòfé-ní	‘five hundred’
	c. ɔ̀lɔ̀fɛ́ + sĩ́ɛ̃̀	→	òlòfé-sĩ́ɛ̃̀	‘six hundred’
	d. ɔ̀lɔ̀fɛ́ + tɕʷí	→	òlòfé-tɕʷí	‘eight hundred’

To form numerals after a hundred, the conjunction *nɪ̀* is used to add the digit to the hundreds (19). The examples in (19) show the conjunction undergoes harmony before the +ATR whole words, but harmony does not extend further than the conjunction. This pattern indicates that these are phrases rather than compound numerals. I will show in chapter 4 that vowel harmony across words is non-iterative. It affects only the last vowel of the word preceding the trigger.

(19) a. ɔ̀lɔ̀fɛ́ àkʊ́ nɪ̀ àkʊ́ 'one hundred and one'

b. ɔ̀lɔ̀fɛ́ àkʊ́ nɪ̀ ɲɔ́ 'one hundred and two'

c. ɔ̀lɔ̀fɛ́ àkʊ́ nɪ̀ sã́ 'one hundred and three'

d. ɔ̀lɔ̀fɛ́ àkʊ́ nɪ̀ nɛ̃́ 'one hundred and four'

e. ɔ̀lɔ̀fɛ́ àkʊ́ nɪ̀ nɪ̃́ 'one hundred and five'

f. ɔ̀lɔ̀fɛ́ àkʊ́ nɪ̀ sɪ̃́ɛ̃̀ 'one hundred and six'

From thousand, there is the base *ɜ́k͡pê* 'thousand' that also multiplies by the whole numbers from one to nine to show the multiples of thousand. Beyond one thousand, all other multiples have the ɜ́- replaced with the labiovelar nasal consonant ŋ͡m-. This may be a case of noun class changing from singular noun to plural nouns. Examples in (20) illustrate cases with multiples of one thousand in Gua, and as expected, there is no harmony as 'thousand' has +ATR vowels.

(20) a. ɔ́k͡pê 'thousand'

b. ŋ͡ḿk͡pé ɲɔ́ 'two thousand'

c. ŋ͡ḿk͡pé sã́ 'three thousand'

d. ŋ͡ḿk͡pé nɛ̃́ 'four thousand'

e. ŋ͡ḿk͡pé nĩ́ 'five thousand'

A close look at the numeral system indicates that most numerals behave like compounds, and +ATR does apply regressively from the rightmost numeral or word to the preceding one. This supports the regressive nature of the harmony process within morphologically complex words. The exception is when the conjunction nì 'and' is added and phrasal numerals result. In that case, phrasal vowel harmony applies, which is also regressive, but non-iterative.

3.2.4 Vowel Combinations in Roots

Harmony in Gua is also observed in the distribution of vowels in monomorphemic roots. The vowels in roots are generally either all -ATR or all +ATR. This is illustrated in bisyllabic monomorphemic words in Gua, as in (21).

	–ATR		+ATR	
(21)	a. sɔ̀kʷí	‘collect/cease!’	sòbí	‘pull!’
	b. k͡pɪ̀tɛ́	‘separate!’	kpìté	‘clean!’
	c. sɔ̀tɛ́	‘catch (a falling object)!’	òsé	‘earthenware’
	d. fɔ̀tɕí	‘sweep!’	kùrí	‘dig (a hole)!’

Table 3.1 below shows the distribution of all attested vowel combinations within bisyllabic roots (C)VCV in Gua, with an example word for each combination. Blanks indicate no attestations. The distribution shows that Gua displays ATR vowel harmony in roots. Exceptions to this pattern, the three words in the upper right-hand corner of the table, are always a +ATR vowel followed by a non-high -ATR vowel and never the reverse. These are patterned exceptions and will be discussed shortly.

Table 3.1: Distribution of vowels in bisyllabic roots.

V1/V2	i	u	e	o	ɜ	ɪ	ʊ	ɛ	ɔ	a
i	bìrí		k͡pìté							
u	kúrî	kútù	wùlé	hùló				sùmɛ́	súnɔ̂	sùmá
e	ébî		ésê							
o	bòlí	òsú	òsé	òkó						
ɜ	ɜ́jî	ɜ̀bú	ɜ́k͡pê	ɜ̀ló						
ɪ						kɪ̀rɪ́		fɪtɛ́		ɪ́kʷâ
ʊ						fʊ̀tɕɪ́	kʊ̀tʊ́	k͡pʊ̀tɛ́	k͡pʊ́tɔ̀	k͡pʊ̀tá
ɛ						kɛ̀lɪ́		ɛ̀dɛ̀		
ɔ						k͡pɔ̀lɪ́	ɔ̀tɕʊ́	sɔ̀tɛ́	ɔ̀kɔ́	ɔ̀bá
a						áfɪ̀	ánʊ̂	àdɛ́	átɕɔ̂	ámâ

There are some gaps in the forms that agree for ATR: [i u], [e u], [i o], [e o], [ɪ ʊ], [ɪ ɔ], [ɛ ʊ], [ɛ ɔ], and [a ɔ]. All of these involve a round vowel as the second vowel. If we compare these with the attested forms with a round vowel in the second position, it can be observed that the first vowel is always either another round vowel or the low vowel [a] or [ɜ]. It appears that the gaps indicate a rounding agreement within the root for high and mid vowels, with the second vowel as the trigger. There is no active rounding harmony affecting prefixes, however, only this static distribution within roots.[14]

Table 3.1 also demonstrates that [ɜ] can only occur before +ATR vowels. This means that, [ɜ] has a restricted distribution. The distributions are: (i) [ɜ] never occurs in monosyllabic roots (as noted in (Table 3.1)), and there are *no* bisyllabic roots with only [ɜ], (ii) it does not occur word-finally in roots (note absence in V2 [ɜ] column from the table) and (iii) it occurs in the initial position of bisyllabic roots only if the second vowel is +ATR /i u e o/ (see V1 [ɜ] row). Further examples of the occurrence of the /ɜ/ vowel in roots as compared to the distribution of /a/ are illustrated in the examples in (22) below.

(22)	**–ATR**			**+ATR**	
	a.	ásî	‘father'	ɜ́sî	‘waist’
	b.	áfȉ	‘axe’	ɜ́fȉ	‘year’
	c.	àk͡pɛ́	‘path/road’	ɜ́k͡pê	‘thousand’

In trisyllabic roots, [ɜ] occurs in initial or medial (C_C) positions before a +ATR vowel.

(23)	a. ɜ́k͡pɜ́bì	‘servant/slave’	ɜ́ɲétì	‘morning’
	b. ɜ́g͡bélì	‘cassava’	òdɜ́ńtɕȉ	‘turning’

[14] Related Guang languages do show rounding harmony. See Tideman (2019) for an overview.

Prefixal alternations already established that [ɜ] alternates with [a] via vowel harmony in the regressive direction, and we have argued based on the distribution of +ATR and -ATR vowels in affixes that harmony is regressive and +ATR dominant. The distributions in bisyllabic and trisyllabic words further support this analysis and provide evidence that [ɜ] is an allophone of /a/, only occurring due to vowel harmony.[15] This explains why [ɜ] never occurs alone in roots and always occurs to the left of a +ATR vowel, never to its right.

(24) / á b ù / ---> [ɜ́bù]

[-ATR] [+ATR] 'house'

Example (24) indicates the spreading of the +ATR value regressively from /u/ to /a/. It shows that [+ATR] spreads from V2 to /a/, creating [ɜ].

If [ɜ] can only be derived via regressive harmony and –ATR is not a spreading feature value, this predicts that words with a +ATR vowel followed by [a] should be attested in Gua. As predicted, Table 1 shows examples of such words. Indeed, the fact that [a] can follow [+ATR] is part of a general pattern that [-ATR] can follow [+ATR] vowels in Gua roots as illustrated in example (25).

[15] The low vowel /a/ is reported to have different allophonic realizations in many Guang languages. For instance, it is realized as [ə] in Lɛtɛ (Akrofi Ansah 2009), and [ɜ] in Nkonya (Peacock 2007). However, Nkami does not show this allophonic realization since in all words, it consistently appears as [a] (Akanlig-Pare and Asante 2016), although see Tideman (2019) for a different analysis. As for other Kwa languages, Akan also has [æ] as a variant of the low vowel /a/ (Dolphyne 1988, 2006) or sometimes transcribed as [ɜ] (Casali 2012).

(25) a. sùmã́ ‘a god’

b. kùmã́ ‘small/junior/young’

c. sùmɛ̃́ ‘send!’

d. súnɔ̃̂ ‘seven’

The examples in (25) have mid and low vowels /ɛ ɔ a/ occurring in the final position after the high back vowel /u/ in words[16]. So far, there are no cases where these vowels occur after other +ATR vowels.

The examples in (26) show words ending in vowel sequences, and interestingly, they also show disharmony involving an initial high vowel with a final [a] in (26 a-g) and [ɛ] in (26 h & i). This phenomenon is also found in related Guang languages. A similar situation is reported in in Lɛtɛ (Akrofi Ansah 2009) and Akanlig-Pare & Asante (2016) alludes to a similar pattern in Nkami. The CVCV roots in (25) appear to have a similar pattern as the forms with the vowel sequences in (26) which occur in the final positions of the roots. There are no attested cases of CiCa or CiCɛ, but the combinations ia and iɛ can appear in the vowel sequences.

(26) a. ɜ́dùá ‘pawpaw’

b. gùá ‘run!’

c. sùá ‘difference’

d. ɜ́sìá ‘in-law’

e. ɜ́bìá ‘thigh’

f. sìá ‘leave (some behind)!’

g. bìá ‘break!’

h. èbĩ́ɛ̃̀ ‘lice’

i. sĩ́ɛ̃̀ ‘six’

[16] Words like òdòɲɔ̃́ ‘twenty’ are multimorphemic.

Essentially, disharmonic roots are only allowed if there is a mismatch in height of a particular type. High [ɪ ʊ] cannot occur word-finally following [+ATR] vowels. [-ATR] vowels in disharmonic forms must always be non-high and must appear after the back high [+ATR] vowel, except in vowel sequences where they can appear after both high [+ATR] vowels.

In summary, ATR harmony in Gua roots is purely regressive for the following reasons. First, [ɜ] is unattested in the final position of roots as illustrated in examples (25) and (26). Second, there are a handful of roots that do not conform to strict ATR harmony within roots. All of them involve [-ATR] non-high vowels in V2 in word-final position, preceded by [+ATR] vowels in V1. If harmony is regressive, this means that these roots in (25) and (26), although disharmonic, provide additional evidence that harmony is regressive and [+ATR] dominant. They cannot be repaired by progressive [+ATR] harmony, nor by regressive [-ATR] harmony. Combined with the affixes, compounds and numeral data, ATR harmony in Gua words is consistently regressive, regardless of internal morphological structure.

3.3 Typology of Directionality and Gua ATR Harmony

Cross-linguistic studies of vowel harmony have identified directionality as a key parameter. Vowel harmony directionality involves three possible directions of operations: regressive, progressive and bidirectional. However, directionality is often intertwined with the morphological structure of languages so it can be hard to ascertain if a language has purely regressive or progressive harmony, or is combined with stem control in which the root or stem is the source of the harmony and affects affixes in either direction.

Hyman (2002) and Linebaugh (2015) present overviews of directionality in harmony. Hyman (2002) lays out the argument that regressive directionality is the default harmonic pattern if morphological root control is not at play. He supports this with data from Punu. He also sketches out how this would need to be surveyed in combination with morphological structure to determine if directionality as a parameter can be independently identified. In addition to the main directionality pattern, he also discusses differences in the behavior of neutral vowels in the two directions, with data from some Congolese Bantu languages, including Kinande. Linebaugh (2015) surveys 71 ATR harmony languages for directionality, although he does not provide details on what those languages are. However, he identifies four languages with purely regressive harmony distinct from morphological stem-control: Karajá, Dilo, Mayogo and Kalabari Ijo. He also discusses the issue of neutral vowels showing different behavior in the two directions. In some languages like Turkana (Dimmendaal 1983, Noske 1990), the low vowel /a/ is opaque in the regressive direction, while in others like Alur (Kutsch Lojenga 1986), it is opaque in the progressive direction. In this section, I lay out typological patterns concerning the directional behavior of both roots and affixes in ATR vowel harmony, separating out directionality that mirrors the morphological structure from systems in which directionality can be independent. Since Gua is of the latter type, it is important to do this to see how it fits within the general typology of ATR systems.

3.3.1 Stem control and directionality

Root control or stem control directionality relates to cases where roots trigger harmony onto affixes, and the reverse is not a possibility. All three possible sources of directionality, regressive, progressive and bidirectionality, are empirically attested under stem control, but there is a tight connection between directionality and the morphological structure, whereby directionality can be construed as an epiphenomenon of the morphology (Bakovic 2000).

Yoruba, a Benue-Congo language spoken in Nigeria shows regressive directionality where roots trigger harmony onto prefixes. Yoruba has only prefixes. The examples in (27) from Bakovic (2003) cited from (Bamgbose 1966, Archangeli & Pulleyblank 1989, 1994) show that in (27a, c) the root has +ATR vowels and they trigger regressive +ATR vowel harmony onto the prefixes resulting in +ATR vowels. On the other hand, the prefixes in (27b, d) are -ATR because the roots have -ATR vowels. Therefore, if harmony is viewed iteratively, this means that the prefix closest to the root receives harmony from the root and then passes that value on to the prefix to its left.

(27)	a.	ɛ + we	→	ewe	'lip'
	b.	ɛ + gɛ	→	ɛgɛ	'cassava'
	c.	ɔ + gɛ + de	→	ogede	'incantation'
	d.	ɔ + gɛ + dɛ	→	ɔgɛdɛ	'banana/plantain'

Conversely, in Tangale, a Western Chadic language (Kidda 1985, van der Hulst & van de Weijer 1995, Bakovic 2003) where there are only suffixes, there is no regressive harmony from the root. Rather, there is progressive harmony in which suffixes agree with the root for ATR as shown in (28). The examples in (28) show the opposite pattern of directionality from the Yoruba case in (27). The affixes in (28 a, c) are +ATR because the root has +ATR vowels while those in (28b, d) are -ATR form because the root has -ATR vowels.

(28)	a.	tug + ɔ	→	tugo
		pound + NOM		'pounding'

b.	wʊd + ɔ	→	wʊdɔ
	farm + NOM		'farming'
c.	ɗob + ʊm + gʊ	→	ɗobumgu
	call + 1PL + PERF.PL		'called us'
d.	tɛŋl + ʊn + gɔ	→	tɛŋlʊngɔ
	mislead + 1SG + PERF.SG		'misled me'

The final directionality expected under stem control is bidirectionality which affects languages with prefixes and suffixes. Degema, an Edoid language of Nigeria (Fulop et al 1998, Kari 2007) shows bidirectionality in the application of ATR vowel harmony in words where prefixes (29) and suffixes (30) share the same ATR vowels as their roots. The examples in (29b,d) show that the roots with +ATR vowels have +ATR prefixes while those in (29a,c) have -ATR vowels like their roots. The cases presented in (30) show similar pattern regarding suffixes so the suffixes in (30a,c) have +ATR vowels like their roots while those in (30b,d) have -ATR vowels.

(29)	a.	mará	'yawn (v)'	→	ɪ-mára	'yawn (n)'
	b.	siré	'run (v)'	→	i-síré	'run (n)'
	c.	tɛβtέβ	'be short'	→	ɛ-tɛβtέβ	'ones that are short'
	d.	godó	'be long'	→	e-godó	'ones that are long'

(30)	a.	dúw	'be soft'	→	duw-esé	'cause to be soft'
	b.	sín	'climb'	→	sɪn-ɛsέ	'cause to climb'
	c.	gbé	'go (finally)'	→	gbe-βiríj	'go many times'
	d.	tʊ́	'be burnt'	→	tʊ-βɪríj	'be burnt many times'

In (31) below, bidirectionality is observed in the affixes that surround the root. Kari (2007) refers to these affixes as a circumfix. Crucially, all the vowels in the affixes where there are +ATR vowels in the root are +ATR (31a,c) and they are -ATR when the root has -ATR vowels (31b,d).

(31)	a.	ɓól	'hold'	→	u-ɓól-ə́m	'holding'
	b.	gɛ́n	'look'	→	ʊ-gɛ́n-ám	'looking'
	c.	ɗű̃m	'create'	→	o-ɗű̃m-ə́m	'creator'
	d.	hɔ́r	'sharpen'	→	ɔ-hɔ́r-ám	'sharpener'

When directionality is directly attributed to stem control only, languages with prefixes only will have regressive directionality, those with suffixes only will show progressive directionality while those with prefixes, suffixes and/or circumfix will have bidirectionality if the process is controlled by the root. These patterns have been summarized in table (2), where P stands for prefix, S for suffix and R for root. When n/a is indicated, it means the configuration (such as a sequence of prefixes) is not attested in the language. A question mark means the source did not provide such information.

Table 3.2: Directionality patterns in stem control systems

Language example	P ← P	P ← R	R ← S	S ← S	P → P	P → R	R → S	S → S
Yoruba	yes	yes	n/a	n/a	no	no	n/a	n/a
Tangale	n/a	n/a	no	no	n/a	n/a	yes	yes
Degema	?	yes	no	?	?	no	yes	?

3.3.2 Dominant-recessive and directionality

Dominant-recessive harmony systems are those in which harmony is controlled by both affixes and roots. In these systems, there is evidence for a combination of stem control (which can be bidirectional or unidirectional depending on the morphology) and uni- or bidirectionality stemming from the suffix. Although dominant systems are often assumed to have a single dominant feature (van der Hulst 2016), some systems like Turkana (cf. Dimmendaal 1983, Noske 2000) and Bondo-so (Hantgan & Davis 2012) do not – suffix-triggered harmony can be either -ATR or +ATR. This section provides an overview of the directionality patterns.

There are languages with prefixes and suffixes where the root triggers bidirectional harmony on prefixes and suffixes, and suffixes also trigger bidirectional harmony on other suffixes and roots. A system where prefixes trigger harmony in this manner is not currently attested. Turkana (Dimmendaal 1983, Noske 2000) and Diola-Fogny (Ringen 1979) are two languages that demonstrate the bidirectional pattern. Turkana, a Nilotic language spoken in Kenya, has ATR harmony that extends from roots and suffixes in a bidirectional fashion (Dimmendaal 1983, Noske 2000). Examples in (32) and (33) exhibit bidirectional harmony where both prefixes and suffixes agree with the ATR value of the roots. The /a/ vowel can undergo harmony (to [o] in these examples), but does not do so when in a prefix.

		+ATR		-ATR	
(32)	a.	ŋi-risy-o	‘leopard, PL.’	ŋɪ-lʊkʊj-a	‘wild cat, PL.’
	b.	ŋi-kory-o	‘giraffe, PL.’	ŋɪ-kɔrɪ-a	‘ratel, PL.’
	c.	ŋi-bur-in	‘drum, PL.’	ŋa-kʊñ-ɪn	‘knee, pl.’
	d.	ŋi-re:t-in	‘face, PL.’	ŋa-tɛkɛr-ɪn	‘kind of gourd, PL.’

(33)	a.	a-lim-un	'to tell'	a-k-ılıp-ʊn	'to pray this way'
	b.	a-gol-un	'to close in'	a-dɔk-ʊn	'to climb down'

Some +ATR suffixes also trigger bidirectional harmony, affecting roots and prefixes and other suffixes. The examples below from Turkana are from Noske (2000). The example in (34) shows how the habitual suffix -e:n triggers regressive +ATR harmony on the preceding root and prefix as well as onto the following suffix. Turkana also has -ATR dominant suffixes, but they do not spread bidirectionally like their +ATR counterparts (34).

		-ATR		**+ATR**	
(34)	a.	a-kı-dɔk	'to climb'	e-dok-e:n-e	's/he always climbs'
	b.	a-k-ımʊj	'to eat'	a-k-imuj-e:n	'to eat regularly'
	c.	a-dɛm-ar	'to take away'	e-dem-e:n-e	's/he always takes'

The patterns in Turkana show that bidirectional ATR harmony is triggered by the dominant feature in both roots and suffixes.

A similar system to Turkana is one in which there is bidirectionality of the harmony process from root onto both prefixes and suffixes, but unidirectionality from the suffixes. Toposa a Teso-Turkan Eastern Nilotic language has a dominant ATR harmony system (Schroder and Schroder 1987). In this language, root control harmony is bidirectional, but suffix triggered harmony is only regressive. The examples in (35) shows that the root triggers regressive harmony onto the prefixes (35a,b) and progressive harmony onto the ventive suffix -ʊn (35c,d). Suffixes that trigger regressive harmony are also in (35e). Note that some prefixes that indicate person on verbs, including ɛ-, do not change their ATR forms, and /a/ is opaque in the language, hence its inability to undergo harmony in (35d).

(35)	a.	kɪ-gɪr	'write!'
	b.	ki-lim	'learn!'
	c.	nya-dɔk-ʊn	'to climb down (vent)'
	d.	nya-dol-un	'to arrive (vent)'
	e.	ɛ-dok-un-i	'he climbs down (vent)!'

The reverse of the Turkana-style cases whereby both roots and prefixes trigger bidirectional harmony is currently not attested, and neither is the reverse of the Toposa system where prefixes trigger harmony progressively, but suffixes do not[17]. There are a couple of cases that show bidirectionality, but are more limited in their scope, with harmony only between root and suffix. I do not present detailed data here, but will describe the systems. Komo [xom], a Koman language spoken in Ethiopia has regressive harmony with +ATR as the dominant feature that spreads from the first suffix onto the root (Otero 2015). The process is non-iterative, so if the root has two vowels, only the second one will be affected. There are no prefixes and +ATR suffixes do not trigger harmony progressively onto other suffixes that follow them. In addition to this pattern, -ATR high vowels in the root trigger harmony progressively onto suffixes with high vowels. -ATR high vowel suffix can also trigger progressive harmony onto a following suffix. Both directions show non-iterativity in the harmony process.

[17]Tunen, Budu and Tuki languages have progressive cases where numeral stems can be affected by a class prefix and demonstratives (Boyd 2015). In Kinande, the Class 4 +ATR prefix affects a high vowel in a numeral root. However, these cases occur as part of a general system that is bidirectional, and they are very limited in application.

Lango, a Nilotic language spoken in Uganda which has both prefixes and suffixes, shows regressive directionality between suffixes onto the root and vice versa but prefixes are unaffected by the harmony process (Noonan (1992)[18]. Lango has regressive harmony triggered by +ATR vowels in suffixes onto the final vowel of the root (Woock & Noonan 1979, Noonan 1992, Smolensky 2006, Kaplan 2008). Just as +ATR vowels in suffixes trigger regressive harmony on the roots, roots also trigger +ATR progressive harmony onto suffixes. This suggests that the dominant feature of the harmony process in Lango is +ATR. Harmony in the progressive direction can affect more than one vowel, albeit in the same suffix, but regressive harmony is non-iterative. The Lango pattern is +ATR dominant progressive and regressive harmony, but it is confined to operate within the domain of the root + suffixes. Even if harmony is non-iterative in the regressive direction, the root could condition harmony onto a prefix, but it does not.

To sum up, we have considered four cases that involve instances where the dominant feature triggers harmony from the root to affixes and from the affixes. to another root. These have been summarized in the table below. The most permissive systems are those such as Turkana. Restrictions involve disallowing progressive harmony from suffixes (Toposa) or limiting harmony to apply only between roots and suffixes, as in Komo (lacks prefixes) and Lango (prefixes excluded).

[18]However, Okello (1975) states that the a- prefix can undergo harmony for some speakers *ǎ-bìtò* versus *ə̌-bìtò* '(that) he lured', and this is confirmed by Noonan as well.

Table 3.3: Dominant-recessive systems with progressive and regressive directionality with affixes.

Language example	P ← P	P ← R	R ← S	S ← S	P → P	P → R	R → S	S → S
Turkana	?	yes	yes	yes	no	no	yes	yes
Toposa	?	yes	yes	yes	?	no	yes	no
Komo	n/a	n/a	yes	n/a	n/a	n/a	yes	yes
Lango	n/a	no	yes	n/a	n/a	no	yes	n/a

As previous authors have suggested (cf. Hyman 2002, Linebaugh 2015), regressive directionality in harmony appears to be more common than progressive. But it is important to separate out stem control from directionality in making this assessment. For ATR systems, when this is done, we can see that the only cases of progressive directionality are those which coincide with the morphology. The only time there is progressive directionality from suffixes is when there is bidirectional stem control in general, as discussed here. In these cases, when the suffixes are added, they form part of the new stem, and so can then trigger harmony onto another suffix when one is added. The Turkana-like systems do not show evidence for a directionality parameter independent of morphology, but the more restrictive systems such as Toposa appear to favor regressive directionality by limiting suffix-controlled harmony to apply in one direction.

3.3.3 Pure Regressive Directionality

So far, the patterns discussed do not represent the patterns in Gua. Gua has regressive directionality triggered by both suffixes and roots onto roots and prefixes. There are a few other languages that also appear to exhibit regressive directionality like Gua which are discussed herewith.

Bongo, a Central Sudanic (Nilo-Saharan) language of South Sudan (Kilpatrick 2005) has +ATR vowels that trigger regressive harmony from roots onto prefixes and from the first suffix onto roots and prefixes. Example (36a-b) illustrates the diminutive prefix alternating its ATR value depending on the ATR feature of the root vowels. (36 c-i) also show harmony within roots based on ATR.

(36) **Bongo vowel harmony**

a.	gì-kúŋgú	'baby baboon'
b.	gì-má	'small child'
c.	pìlɛ̀gʊ̀	'species of bird'
d.	bʊ̀ɗɔ̃	'husband'
e.	tárà	'lip'
h.	kébì	'rope'
i.	bírù	'bat'

In (37), we observe that suffixes also trigger regressive harmony onto the root. In (37a-c), there are ATR alternations in the root triggered by the +ATR possessive suffix /-í/. In (37 a,c) the /a/ vowel becomes /ɨ/ when it occurs before the +ATR suffix that follows it.

(37) **Bongo vowel harmony**

a.	mbágá	+ -í	→	mbɨ̀gɨ̀-í
	mother	your		'Your mother'

b.	bʊ̀ɗɔ̃	+ -í	→	bùɗõ̀-í
	husband	your		'your husband'
c.	tárà	+ -í	→	tɨ́rɨ̀-í
	lip	your		'your lip'

Although +ATR suffixes trigger harmony onto roots, there are cases where -ATR vowels in suffixes do not change their form whether they occur after words with +ATR vowels (38). In (38c) the -ma 'my' suffix with an /a/ vowel does not change its ATR value to [ɨ] even though it occurs after +ATR vowels.

(38) **Bongo vowel harmony**

a.	bʊ̀dɔ̀	+ -má	→	bʊ̀dɔ̀má
	husband	my		'my husband'
b.	tárà	+ -má	→	táràmá
	lip	my		'my lip'
c.	gbógbó	+ -má	→	gbógbómá
	windpipe	my		'my windpipe'

In Bongo the harmony process is regressive only, whether it is triggered by roots or suffixes. There is no evidence that a second suffix triggers the harmony process through other suffixes to roots and prefixes, but the presence of harmony from roots to prefixes and suffixes to roots confirms that harmony applies regressively.

The directionality process in Gua appears to be the same as what is observed in Bongo since roots and suffixes trigger regressive harmony in the language. But it's not clear if Bongo has root internal regressive harmony, and there is no data on multiple prefixes to see if prefixes can condition harmony on another prefix as in Gua.

Apart from Gua and Bongo, several other African languages show regressive directionality within roots and words. Linebaugh (2015) identifies three other African languages with regressive ATR harmony from both roots and suffixes: Dilo (Jones 1987), Mayogo (McCord 1989) and Kalabari (Jenewari 1978/1989, Akinlabi 1994, 1997). The Mayogo (McCord 1989) system shows another good case of regressive +ATR harmony, as it can be triggered by roots and by affixes and also applies within compounds. In (39), there are vowel alternation in the prefixes attached to the roots. The singular prefix is -ATR [ɛ] in (39a,c) but +ATR [e] in (39b,d). Harmony in words is presented in (39) where there are -ATR vowels in (39e), and +ATR vowels in (39f). Harmony is triggered by the rightmost +ATR word. In (39h), the 3PL affix -úò triggers +ATR harmony leftwards when it is a suffix but not rightwards in (39g) when it is a prefix in the verb.

Mayogo vowel harmony

		-ATR		**+ATR**	
(39)	a.	ɛ̀-kpí 'day'	b.	è-bi	'vine'
	c.	ɛ̀-ndʊ́ 'rubber	d.	è-dú	'hole'
	e.	/ɓʊ́[19]-kpí-pɛ/	→	ɓʊ́-kpí-pɛ	'on the day of the month'
	f.	/ɓʊ́-kpí-kùlù/	→	bú-kpí-kùlù	'on the day of the work'
	g.	/úò-dʒɛ́-ní/	→	úò-dʒɛ́-ní	'they understand us'
	h.	/ní-dʒɛ̄-úò/	→	ní-dʒē-úò	'we understand them'

[19] McCord uses [ω] to represent [ʊ] in contemporary transcription. I have replaced it with [ʊ] for consistency.

The patterns in Mayogo show that both roots and suffixes can trigger regressive harmony. However, when the same suffixes occur as prefixes, they do not trigger progressive harmony (39g) which confirms the point that the harmony process in the language is purely regressive.

There are some reported cases of regressive directionality in Guang languages as well; Nkonya (Peacock 2007, Asante 2009), Lɛtɛ (Akrofi Ansah 2009), Anum-Gua (Painter 1971, Obeng 1995). For most descriptions of the Guang languages, there is some regressive directionality, but the descriptions are not detailed enough to assess if they are purely regressive or have some bidirectionality. The exception to this is the Asante (2016) description of Nkami which provides some elaborate discussion of the regressive ATR harmony directionality. In Nkami, there is +ATR vowel harmony within words and across words. The examples below show regressive harmony within simple (40) and complex (41) words.

(40) **Nkami vowel harmony**

a.	o-ɲi	'mother'
b.	ɔ-sɪ	'father'
c.	o-fusuo	'animal (like cattle)'
d.	ɔ-bɔrɪ	'night adder'

(41)

a.	Mɪnɪ-bɛ-kʊdʒɪ abɛ		b.	Mini-be-bie abɛ
	2PL-FUT-give birth again			2PL-FUT-bath again
	'Will you give birth again?'			'Will you bath again?'
c.	Ama ɔɔ-yɛ-fɪrɪ.		d.	Ama oo-ye-kini.
	Ama PROG-DDP-swim			Ama PROG-DDP-wander
	'Ama is going to swim.'			'Ama is going to wander/stroll.'

Suffixes do not undergo nor trigger harmony. However, within compounds, harmony applies from the second word to the first one, and the process is iterative.

(42) **Nkami vowel harmony**

a.	ɔfɛ-obi	'beauty-child'	→	[ofebi]	'beautiful lady'
b.	tɪlɪ-obi	'goat-child'	→	[tilibi]	'young goat'
c.	ɔblɔ-obi	'neck-small'	→	[oblobi]	'throat'

Nkami appears to be similar to Gua because they both have regressive directionality within and across words, but while there are clear cases for harmony within roots in Gua, Nkami has no +ATR allophone of /a/, so it is not clear whether Nkami has root internal regressive harmony. So, this means that [a] can appear before and after +ATR vowels in roots. On the other hand, Tideman (2019) analyzed the acoustic properties of [a] preceding +ATR vowels in Nkami, such as those in (43a-b) and determined that their F1 is lower and they are distinct from [a].

(43)

a.	tasi	'aunt'
b.	apofra	'a type of fish'
c.	dʒasɔ	'forcefully collect'
d.	wura	'provide alimony/palimony'

Outside Africa, Karajá (Ribeiro 2002) and Assamese (Mahanta 2007) are two cases that are reported to show regressive directionality, both involving ATR harmony. Karajá is a Macro-Gê language of Brazil and Assamese is a Karamta language spoken in India. Karajá shows regressive harmony for ATR, as illustrated in (44) (Ribeiro 2002). In (44a), the leftmost +ATR vowel of the root, /ɗuhɔ/, triggers leftward ATR harmony while the rightmost vowel of the root and all subsequent morphemes are -ATR and are unaffected. In (44b,c), though, a [+ATR] enclitic triggers harmony on -ATR prefixes and root vowels. In (44c), the rightmost -ATR enclitic /=hɛ/ is unaffected although both root and affix vowels undergo assimilation triggered by the enclitic /=ikudĭ/.

(44) **Karajá ATR harmony** (Ribeiro 2002:482)

a.	/∅-r-ɔ-ɗuhɔ=rɛrɪ/	→	roʧuˈhɔrɛrɪ	'3-CTFG-ANTI-curse=CTFG.PROG'
			*roʧuˈhoreri	
b.	/∅-r-ɔ-ɗuhɔ=r-e/	→	roʧuˈhore	'3-CTFG-ANTI-curse=CTFG-IMPERF'
c.	/b-ɛ-ɗɛhɛ=ikudĭ=hɛ/	→	beɗeˈheikunihɛ	'2-INTR-look=IMPF=EMPH'

Finally, there is the case of Pulaar, an Atlantic Niger-Congo language spoken in Senegal and other countries, which shows regressive ATR harmony triggered by suffixes. Pulaar has received various treatment in phonological analysis, but the current data is from the Futankoore dialect described in Paradis (1992, 1996). See also Archangeli and Pulleyblank (1994), Niang (1997), Diop (1998) and Dye (2015). Pulaar is a seven-vowel language with complete ATR vowel pairs among non-high vowels only. The language has no prefixes, and as such, there is no regressive harmony from the root. Pulaar has suffixes with high vowels that trigger ATR harmony in a regressive fashion. The examples in (45a-e) show +ATR diminutive singular suffixes that trigger harmony onto the roots, while those in (46a)[20] to (46e) illustrate their -ATR plural counterparts. In each of the examples in (45), the affix does not alternate but the root does.

[20] The initial consonant undergoes mutation due to the plural suffix.

(45)	a.	ser-du	'butt of a rifle-SG.DIM'
	b.	mbeel-u	'shadow-SG.DIM'
	c.	peec-i	'crack-SG.DIM'
	d.	beel-i	'pool-SG.DIM'
	e.	dog-oo-ru	'runner-SG.DIM'

(46)	a.	cɛr-kɔn	'butt of a rifle-DIM.PL'
	b.	bɛɛl-ɔn	'shadow-DIM.PL'
	c.	pɛɛc-ɔn	'crack-DIM.PL'
	d.	bɛɛl-ɔn	'pool-DIM.PL'
	e.	dɔg-ɔ-w-ɔn	'runner-DIM.PL'

There are also cases in Pulaar in which a -ATR suffix follows a +ATR high vowel root (high vowels do not alternate, but they have the ability to trigger harmony, but only regressively), ex: *binnd-ɔɔ-wɔ* 'writer'. There can also be a series of suffixes in which the first is +ATR but the second is -ATR: compare *ɓɛt-dɛ* 'to weigh' (dɛ = INF) to *ɓet-ir-dɛ* 'to weigh with' where the comitative suffix triggers +ATR harmony to the left but not the right. And then there is *dog-oo-ru* 'runner-SG.DM', whereby -ru is the trigger vowel and [oo] gets harmonized. This shows that a second suffix is able to trigger regressive harmony onto a preceding one. Pulaar resembles Komo in that suffixes can trigger harmony on the root. However, in Komo, there is also progressive harmony from root to suffix, making it a bidirectional system.

The general patterns of directionality of ATR harmony process with regards to pure directionality have been summarized in the table in below. This table does not show just one example language per pattern, but provides a summary of those that have been attested to exhibit regressive directionality independent of morphological structure.

Table 3.4: Pure directionality patterns in dominant-recessive system.

Language example	P ← P	P ← R	R ← S	S ← S	P → P	P → R	R → S	S → S
Gua	yes	yes	yes	n/a	no	no	no	n/a
Nkami	yes	yes	yes	?	no	no	no	?
Mayogo	?	yes	yes	?	?	no	no	?
Assamese	?	yes	yes	?	?	no	no	?
Karajá	?	yes	yes	?	?	no	no	?
Bongo	?	yes	yes	?	?	no	no	?
Kalabari Ijo	?	yes	?	n/a	?	no	no	n/a
Pulaar	n/a	n/a	yes	yes	n/a	n/a	no	no

Hyman (2002) suggests that when harmony is not root-controlled, it is right-to-left biased. Linebaugh's (2015) survey also appears to support this. There are a number of identified cases of regressive harmony but no cases of pure progressive harmony. The current survey supports this contention, and does so by separating morphological structure from directionality. Since directionality is typically intertwined with the morphological structure of languages it can be hard to ascertain if a language has purely regressive or progressive harmony, or is combined with stem control in which the root or stem is the source of the harmony and affects affixes in either direction.[21] Furthermore, it is unclear if the directionality parameter is set for the system as a whole or for particular affixes or classes of affixes. Toposa, for instance, appears to be a case in which root control can be bidirectional but suffix triggered harmony is only ever regressive. Therefore, I have sought to discuss directionality typology by carefully separating out directionality that mirrors the morphological structure from systems in which directionality can be independent. Gua is of the latter type, exhibiting purely regressive directionality. Several other languages show similar patterns to Gua, although they do not all show such strong root-internal evidence. The missing case is one in which suffixes can also trigger harmony on preceding suffixes. Most of the regressive directionality cases, like Gua, have a limited set of suffixes or enclitics. Gua also has regressive cross-word harmony, adding to its regressive directionality profile, which I explore in the next chapter.

3.4 Conclusion

This chapter discusses directionality of ATR harmony in Gua with reference to the behavior of roots and affixes in the system. Gua has a +ATR dominant system that is regressive within words, roots and across words. With regard to morphological structure, roots and suffixes are triggers of harmony on the one hand while roots and prefixes are targets of harmony on the other. The chapter also surveys directionality in ATR systems to assess how Gua fits within the typology. The typology shows that cross-linguistically, ATR systems are regressive unless they match the morphological structure and allow stem-control. One area for future typological and theoretical research is whether regressive directionality can be an independent parameter at

[21] In addition to the directionality types discussed here, Essegbey & McCollum (2020) also identify prominence-driven harmony systems: metrical (stress), initial prominence, and final prominence. None of these appear to be attested in ATR systems.

different levels of the grammar. Is it set for the whole system (like Gua) or does it take precedence over stem control when suffixes are triggers (like possibly Toposa)? Can the directionality of cross-word harmony be independent and show different directionality than word-based harmony? In Gua, cross-word harmony is also regressive, but it shows some differences from word-internal harmony, as the next chapter will explore.

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CHAPTER FOUR

GUA CROSS-WORD HARMONY DOMAINS

4.0 Introduction

ATR vowel harmony in Africa has received a great deal of scholarly work from descriptive, typological and theoretical perspectives (see e.g. Casali 2008, Rolle et al. 2019 for typological overviews), but the domains of ATR harmony still remain under-researched. Although words and roots are largely considered to be the domain of harmony, cases of cross-word harmony are also reported. Akan (Clements 1981, Stewart 1983, Dolphyne 1988/2006, Kügler 2015), Nkami (Akanlig-Pare & Asante 2016), Nawuri (Casali 2002), Kɔnni (Cahill 2007), Kinande (Mutaka 1995, Archangeli & Pulleyblank 2002), Vata (Kaye, 1982 and Kimper 2011), Somali (Andrzejewski 1955, Nilsson & Downing 2019) and Luo (Swenson 2015) are all cases with cross-word ATR vowel harmony. Cross-word harmony domains have received some analysis from the perspective of phonology, syntax and the interface between the two. However, the domains under which it operates have not been investigated in detail. Is the process subject to the same kinds of phonology-syntax interface restrictions as other linguistic phenomena such as tone, duration and stress? If there are domain restrictions, what type are they? Are they determined by syntax alone or by prosodic groupings?

Gua exhibits cross-word regressive harmony, whereby a +ATR word causes the final vowel of a preceding -ATR word to become +ATR. However, cross-word harmony does not apply in every instance, but is constrained by binary phrasing and by syntactic structure. Cross-word harmony in Gua is non-iterative: it extends only to the final vowel of the preceding word. The affected vowel cannot in turn trigger harmony on vowels to its left even if they are in a separate word. The number of words in a construction is important in the cross-word harmony domains but the syntactic structure also plays a role, depending on, for example, the number of words that make up the subject and/or the object. In this chapter, I present the cross-word harmony domains in Gua and demonstrate that they show prosodic groupings that favor binary and ternary word groupings, but are still sensitive to syntactic structure. In particular, the size of the subject is important.

The rest of the chapter is organized as follows. Two and three word sentences are presented in section 4.1. Four, five and six word sentences showing instances of blocking in the harmony process are given in section 4.2. Section 4.3 provides exceptions to the regressive harmony patterns in Gua, and there is a conclusion in section 4.4.

4.1 Two-and-Three Word Short Sentence Constructions

Cross-word harmony can occur between all the words in two- or three- word utterances provided the relevant -ATR targets and +ATR triggers are present. Example (1) shows cross-word harmony between -ATR words and +ATR words where verbs trigger cross-word harmony on the final vowel of the preceding noun in subject-verb (SV) constructions (1a-b). (2a-b) shows cross-word harmony between objects and verbs in regressive fashion in imperative verb-object (VO) constructions. Gua has Subject-Verb-Object word order. Portions of the words that are +ATR have been underlined to ensure easy identification of the application of cross-word harmony. In all cases where cross-word harmony applies, only the final vowel of the preceding word undergoes harmony. When there are sequences of vowels, only the second half is affected (1c). These produce surface disharmonic words with -ATR +ATR sequences. Cross-word harmony is thus non-iterative.

SV Constructions

(1) a. àɲɛ̃́ hè → àɲẽ́ hè

man fall.PST

‘A man fell’

b. kpʊ̀tɔ́ tɕè → kpʊ̀tó tɕè

frog pass.PST

‘Frog passed’

c. dã̀ĩ téì → dã̀ĩ́ téì

cook.IMP food

‘cook food!’

(2) **VO Constructions**

a. sɔ̀tɛ́ bókìtì → sɔ̀té bókìtì

catch.IMP bucket

‘Catch a bucket!’

b. kwɛ̀lɛ́ téì → kwɛ̀lé téì

fry.IMP food

‘Fry food!’

The presence of a -ATR and a +ATR verb results in cross-word harmony between two verbs. Example (3) shows cross-word harmony between two verbs in imperative constructions where verb (V2) triggers cross-word harmony on (V1) like the cases involving subject and verb only in (1) or verb and object only in (3).

VV Constructions

(3) a. bɛ̀ tɕè → bè tɕè

come.IMP pass.IMP

'Come (and) pass!'

b. kʊ̀sʊ́ jèlí → kʊ̀sú jèlí

stand.IMP stand/stop.IMP

'Get up/stand up'

Although harmony occurred in the examples in (1), (2), and (3) where the second word triggers harmony on the first, the reverse scenario where the subject triggers +ATR cross-word harmony from the subject to the verb in the progressive direction is not possible, as illustrated in (4). In (4), the verb remains -ATR; it does not undergo +ATR harmony and it does not cause the preceding subjects (1) and verbs (2) respectively to undergo cross-word harmony by changing from +ATR to -ATR. This is due to two factors: regressive directionality and +ATR vowels are triggers. This indicates that -ATR cannot trigger harmony in either direction, and +ATR cannot trigger harmony in the progressive direction.

SV and VO Constructions

(4) a. ɜ̀tèbí bɛ̀
SG.animal come.HAB
'An animal comes'

b. ɜ̀bòbí kɔ̀
SG.bird defecate.PST
'A bird defecated'

c. sòbí ífì
pull.IMP rope
'pull a rope!'

d. kùbí ɛ́bì
cut.IMP PL.palm tree
'Cut palm trees!'

To sum up, when +ATR words (triggers for the harmony process) are preceded by -ATR words (targets of harmony), cross-word harmony applies. However, when the words appear in the reverse order, -ATR preceded by +ATR, cross-word harmony does not apply. This supports the description presented in chapter 3 that ATR vowel harmony in Gua is a case of pure regressive +ATR directionality and this pattern carries through to the cross-word harmony.

Like the two-word constructions, three-word constructions with subject, verb and object also allow cross-word harmony, between subjects and verbs as well as between verbs and objects. In (5a-b), there is cross-word harmony between the subjects and the verbs in regressive fashion while objects trigger cross-word harmony between verbs and objects in a similar fashion in (5c,d).

SVO Constructions

(5) a. àɲɛ̃́ <u>kúbì</u> bɔ̀lí → àɲ<u>ẽ́ kúbì</u> bɔ̀lí
man cut.PST python

‘A man cut python’

b. àɲɛ̃́ sóbì ífì → àɲɛ̃́ sóbì ífì

man pull.PST rope

‘A man pulled a rope’

c. àɲɛ̃́ kítɛ̀ bókìtì → àɲɛ̃́ kítè bókìtì

man hold.PST bucket

‘A man held a bucket’

d. àɲɛ̃́ kpɔ́lì ǹtɕú → àɲɛ̃́ kpɔ́lì ǹtɕú

man clean.PST water

‘A man cleaned/cleansed water (on the floor)’

When there is a subject and two verbs only as well as two verbs and an object only in three-word constructions, cross-word harmony applies between the subject and one of the verbs (6a-b), the two verbs only (6c-d), and between the object and one of the two verbs (6e-f) respectively in regressive fashion.

SVV Constructions

(6) a. àɲɛ̃́ jélì sɔ́tɛ̀ → àɲé̃ jélì sɔ́tɛ̀

man stand/stop.PST catch.PST

‘A man stood-up to catch (it)’

b. àɲɛ̃́ tɕínã̀ĩ́ lò → àɲẽ́ tɕínã̀ĩ́ lò

man sit.PST weave.PST

‘A man sat-down to weave’

c. àɲɛ̃́ kʊ́sʊ̀ wè → àɲɛ̃́ kʊ́sù wè

man stand.PST go.PST

‘A man stood-up to go/went’

d. àɲɛ̃́ kʊ́sʊ̀ jélì → àɲɛ̃́ kʊ́sù jélì

man stand.PST stand/stop.PST

‘A man stood-up’

e. kʊ̀sʊ́ bɛ̀ dó[22] → kʊ̀sʊ́ bè dó

stand.IMP come.IMP here

‘Stand-up and come here!’

f. kʊ̀sʊ́ k͡pɔ̀lí ǹtɕú → kʊ̀sʊ́ k͡pɔ̀lí ǹtɕú

stand.IMP clean.IMP water

‘Stand-up and clean water!’

As shown in (6e-f), cross-word harmony in Gua appears to be non-iterative irrespective of the size of the word. Examples (6e-f) show that harmony does not extend beyond the final syllable of the preceding word. In (6e), there is a monosyllabic verb *bɛ̀* ‘come!’ and harmony affects only the verb that immediately precedes the object to become *bè* without extension to the first word.

[22] Although, dó ‘here’ is translated as a locative adverb in English, it functions as a noun in Gua.

Likewise, although there is a bisyllabic verb in (6f), harmony only affects the final vowel of *kpɔ̀lí* 'clean!' to become *kpɔ̀lí* without cross-word harmony extending to the vowel of the first syllable.

The examples in (6) have either one subject or object and two verbs. In each case, the verbs appear to be sharing either the same subject or object, and they express a single event. These constructions are classified as serial-verb constructions. Serial verb constructions (SVCs) are a common feature in West African languages (Christaler 1875, Osam 1994). Haspelmath (2015) defines an SVC as a "monoclausal construction consisting of multiple independent verbs with no element linking them and with no predicate argument relation between the verbs." SVCs in this paper are considered as the successive occurrence of two verbs or more in a construction with a single subject and possibly sharing another argument, and with no linking element such as a conjunction.

Just as cross-word harmony can apply between two serial verbs, cross-word harmony can also apply between two words that make up a single subject. Examples (7a-b) show cross-word harmony between a noun and an adjective in subject position while (7c) shows cross-word harmony between the verb and the determiner that modifies the noun in the subject noun phrase. However, there is no cross-word harmony between the determiner and the verb in (7d) because the verb has -ATR vowels. I indicate the number of words in a subject with w: Sww indicates two words.

SwwV Constructions

(7)	a.	àɲɛ̃́	tɛ̃́ńté	bíè	→	àɲɛ̃́ tɛ̃́ńté bíè
		man	tall	bath.PST		
		'A tall man bathed'				
	b.	àtɕí	tĩ́mĩ́	fĩ́ńtĩ̀	→	àtɕí tĩ́mĩ́ fĩ́ńtĩ̀
		woman	short	jump.PST		
		'A short woman jumped'				
	c.	àɲɛ̃́	à	bíè	→	àɲɛ̃́ ɜ̀[23] bíè
		man	DET	bath.PST		
		'The man bathed'				
	d.	àɲɛ̃́	à	fĩ́ńtĩ̀		
		man	DET	jump.PST		
		'The man jumped'				

When there are two-word objects with a single verb, cross-word harmony applies between the verb and the direct object (8b, d) and between the two objects (8a,c). The verb in all these instances is imperative.

[23] Although [ɜ] cannot occur in single monosyllabic words as a phoneme, it can be derived via cross-word vowel harmony.

VOww Constructions

(8)	a.	sɔ̀kwí	àdɛ́	t̃ímí	→	sɔ̀kwí àdé t̃ímĩ́
		seize.IMP	cutlass	short		
		'Seize a short cutlass!'				
	b.	sɔ̀tɛ́	ɜ́kùtú	kɔ̂ː	→	sɔ̀té ɜ́kùtú kɔ̂ː
		catch.IMP	orange	red		
		'Catch a red orange!'				
	c.	kwɛ̀lɛ́	ábwî	téì	→	kwɛ̀lɛ́ ábwî téì
		fry.IMP	goat/animal	food		
		'Fry a goat's food!'				
	d.	kwɛ̀lɛ́	ɜ̀lèbí	téì	→	kwɛ̀lé ɜ̀lèbí téì
		fry.IMP	child	food		
		'Fry a child's food!'				

Cross-word harmony also does not apply in three-word constructions when the order of +ATR and -ATR words is reversed. This happens when there are +ATR -ATR -ATR constructions. In these cases, the trigger occurs before the targets, hence the failure for the application of cross-word harmony since ATR harmony has pure regressive directionality. The examples in (9) demonstrate that when +ATR words precede -ATR words, cross-word harmony does not apply.

SVO Constructions

(9)	a.	ɜ̀lèbí	kpɔ̀lì	sílɛ̀
		SG.child	clean.HAB	soil/ground

‘A child cleanses the ground’

b. ɜ̀lèbí bɔ̀tɛ̀ ɛ́dìdɛ́

SG.child remove.HAB mat

‘A child removes a mat’

As observed, cross-word harmony in both two-word and three-word sentences applies within subject noun phrases, between subjects and verbs, between two verbs, and between verbs and objects, and between the two objects. There are no syntactic restrictions on the application of harmony. It will apply between words one and two, or between words two and three regardless of the syntactic configuration. Again, when +ATR words occur before -ATR words, cross-word harmony does not apply. This confirms the regressive nature of the harmony process in Gua. In addition, the cross-word harmony process in Gua is non-iterative irrespective of the size of the word.

4.2.1 Sentences with Blocking Effects: Four Words

In this section and others that follow, we will demonstrate that cross-word harmony does have restrictions and that harmony is blocked in longer sentences. Here, let us consider four words in subject-verb-object (SVO) constructions. The examples in (10) contain four words with two-word subjects and a verb and an object. The example in (10a) shows cross-word harmony within the subject, between words 1 and 2, while the example in (10b) shows cross-word harmony between the verb and the object, words 3 and 4. However, cross-word harmony does not apply between words 2 and 3 in the example in (10c) although there is a +ATR trigger and a -ATR target in the required order for harmony to operate.

SVO with two-word subject

(10)	a.	mĩ́	sìsí	sɔ̀	átɕɔ̂	→	mĩ́ sìsí sɔ̀ átɕɔ̂
		my	sister	buy.PST	hoe		
		‘my sister bought a hoe’					
	b.	àɲɛ̃́	kɔ̂:	kítɛ̀	bókìtì	→	àɲɛ̃́ kɔ̂: kítè bókìtì
		man	red	hold.PST	bucket		
		‘A fair man held a bucket’					
	c.	àɲɛ̃́	à	kúbì	ɜ́dʑê	→	*àɲɛ̃́ ɜ̀ kúbì ɜ́dʑê
		man	DET	cut.PST	firewood		
		‘The man cut/fetched firewood’					

The constructions in (11) show four-word sentences with two-word objects. There is cross-word harmony between words 1 and 2 in (11a), and (11b) shows cross-word harmony within the two-word object, words 3 and 4. However, there is no harmony between the verb *kítɛ̀* ‘held’ and the direct object, *bókìtì* ‘bucket’, words 2 and 3 in (11c).

SVO with two-word object

(11) a. àɲɛ̃́ kúbì ɜ́ʥê à → àɲɛ̃́ kúbì ɜ́ʥê à
man cut.PST firewood DET
‘A man cut the firewood’

b. àɲɛ̃́ kítɛ̀ ɔ̀kɔ́tɔ́ dùúdùbí → àɲɛ̃́ kítɛ̀ ɔ̀kɔ́tó dùúdùbí
man hold.PST crab tiny
‘A man held a tiny crab’

c. àɲɛ̃́ kítɛ̀ bókìtì kɔ̂: → *àɲɛ̃́ kítè bókìtì kɔ̂:
man hold.PST bucket red
‘A man held a red bucket’

In four-word constructions with three-word subjects, cross-word harmony applies within the subject, but limited to words 1 and 2 only. Word 3 does not trigger harmony on word 2. Example (12a) shows cross-word harmony between the possessive and the lexical noun, words 1 and 2, while cross-word harmony also applies between the adjective and the verb, which are words 3 and 4 in (12b). However, (12c) does not show cross-word harmony between the adjective and the noun, words 2 and 3, although they are both part of a single syntactic constituent.

SVO with three-word subject

(12) a. mɪ̃̀ gbéì kɔ̂: hɔ́mɪ̃̀ → mɪ̃̀ gbéì kɔ̂: hɔ́mɪ̃̀
my dog red rest.PST
‘My red dog rested’

b.	mĩ́	ɔ̀kɔ́tɔ́	kɔ̂:	<u>hè</u>	→	mĩ́ ɔ̀kɔ́tɔ́ k<u>ɔ̂: hè</u>
	my	crab	red	fall.PST		
	'My red crab fell'					
c.	mĩ́	ɔ̀kɔ́tɔ́	<u>dùúdùbí</u>	hè	→	*mĩ́ ɔ̀kɔ́t<u>ó dùúdùbí</u> hè
	my	crab	tiny	fall.PST		
	'My tiny crab fell'					

So far, we observe that four-word constructions have harmony between words 1 and 2 and between words 3 and 4, but not between words 2 and 3. In (10c) for instance, there is no cross-word harmony between the subject and the verb, words 2 and 3. Yet, in (6a-b) and (7a-b) verbs trigger cross-word harmony on the subjects. It appears that the difference between constructions like *àɲɛ̃́ à kúbì ɔ́ʥê* 'The man cut/fetched firewood' in (10c) and *àɲɛ̃́ kúbì bɔ̀lí* 'A man cut a python' in (6a) is the presence of the determiner in the subject. Is it the case that a complex subject cannot undergo harmony from a verb? In this case, does having two words form a unit preventing cross-word harmony from taking place? This does not appear to be the case because in (7c), the construction has a three-word sentence, yet cross-word harmony was triggered from the verb onto the determiner *àɲɛ̃́ ɔ̀ bíè* 'The man bathed'. This shows that the complexity of the syntactic unit cannot be the cause for the non-application of cross-word harmony in some complex subjects. In another example, in (11a-b), *kúbì* and *dùúdùbí* are able to harmonize the nouns that preceded them although the constructions are also SVO but with a complex object. In these cases, we see cross-word harmony between subject and verb on the one hand and cross-word harmony between the adjective and the noun, but no harmony between object and verb. But objects can harmonize a preceding verb in other contexts, namely when a verb and an object are in a two-word or three-word sentence, and when they are the 3rd and 4th words in a sentence. There is just no harmony in constructions like (10c), (11c) and (12c) between words 2 and 3.

The constructions below illustrate how SVCs pattern with a single-word subject and a single-word object. Example (13) presents cases with two SVCs and shows cross-word harmony between words 1 and 2 and between words 3 and 4. However, in (13c) there is no harmony between the two verbs because they are in positions 2 and 3.

SVO with two-word serial verbs (VV)

(13)	a.	àɲɛ̃́	jélì	ʥì	téì	→	àɲɛ̃́ jélì ʥì téì
		man	stand.PST	eat.PST	food		
		'A man stood-up to eat food'					
	b.	àɲɛ̃́	téńté	kʊ́sù	jélì	→	àɲɛ̃́ téńté kʊ́sù jélì
		man	tall	stand.PST	stand/stop.PST		
		'A tall man stood-up'					
	c.	àɲɛ̃́	fĩ́ńtɪ̃̀	bì	ɜ́kùtú	→	*àɲɛ̃́ fĩ́ńtɪ̃̀ bì ɜ́kùtú
		man	jump.PST	pluck.PST	orange		
		'A man jumped to pluck an orange'					

The same pattern in the constructions in Gua appears to be the case with four-word constructions involving two verbs in SVCs.

The one consistency between the three types of structures in (10c, 11c, 12c & 13c) is the failure for cross-word harmony to apply between words 2 and 3 regardless of the syntactic structure. This indicates that there is a boundary of some kind between these words, preventing harmony, but not a boundary that is syntactic in nature. It appears that it has to do with the number of words in the sentence overall, and not the complexity of the subject. This suggests that words are grouped into binary prosodic units and that prosodic phrasing blocks harmony. Four word sentences are split into two prosodic phrases consisting of two words each: (ww)(ww). Obiri-Yeboah & Rose (2021) argue that each syntactic word in Gua is also a prosodic word, even monomoraic words. Although the determiner is just a single vowel and a functional word, it behaves like a lexical word in Gua with respect to vowel harmony which suggests that grammatical words and prosodic words are equivalent. One could potentially analyze the prosodic word as extending to include the rightmost vowel of the previous word, the one that gets harmonized. However, this would only be for vowel harmony purposes. There is no tone or other segmental interaction that could provide independent support for this. It would also entail that the vowel belonged to two prosodic words simultaneously as single syllable words such as /a/ would still need to be counted as a separate word for the purposes of prosodic phrasing; therefore, I do not adopt such an analysis. Cross-word harmony is only allowed within the prosodic phrase, but not across phrase boundaries. In three word sentences, there is no evidence for a split into one binary and one unary unit. Rather, all three words group together.

Since binary units are attested for four and two words, it appears that three-word units do not divide into a unit of two and one as harmony is observed between all of the words - 2 to 1 and 3 to 2. A three-word phrase is possible, therefore. However, with four words, binary units appear to be the strategy. That is, even the subject-verb with the complex three-word subject divides into two units of two and not a three-word unit corresponding to the subject and a one-word unit consisting of the verb. Although the third word is part of the subject with which it forms a syntactic unit, syntactic structure is ignored due to binarity restrictions.

4.2.2 Sentences with Blocking Effects: Five Words

Sentences with four words showed motivation for binary phrasing where the words group into two equal halves. This analysis would appear to cause problems for sentences with five words because there is an extra word which needs to be considered in the phrasal domains. We also observed that three words appear to allow cross-word harmony where both verbs and objects trigger cross-word harmony while verbs and subjects are also targets of cross-word harmony. The evidence for binary phrasing in two- and four-word sentences and for ternary phrasing in three-word sentences raises the question of how five-word sentences are divided up into prosodic phrases. Two possibilities are predicted: a binary phrase followed by a ternary phrase [(ωω)(ωωω)][24], or a ternary phrase followed by a binary phrase [(ωωω)(ωω)]. Both prosodic phrasings predict that there should be harmony between words 1 and 2 and between 4 and 5 consistently. The first structure predicts that there should also be harmony between words 3 and 4 but not between words 2 and 3, and the second structure predicts the reverse. The following discussion focuses on two- and three-word complex subjects and objects with a verb. It will also consider cases with two verbs in SVCs under the same constructions.

The constructions in (14) have two-word subjects and two-word objects, and harmony applies between words 1 and 2 in (14a) and between words 4 and 5 in (14b) as predicted. In (14c) there is no cross-word harmony between words 2 and 3 although there are the appropriate target and trigger forms, while cross-word harmony does apply between words 3 and 4 in (14d).

[24] From this point on, I represent prosodic word with (ω) notation to distinguish it from grammatical words because I will be talking about the words as belonging to phonological phrases.

SVO with two-word subject and two-word object

(14) a. àɲɛ̃́ tĩ́mĩ́ bɔ́tɛ̀ ɛ̀dídɛ̀ kɔ̂:. → àɲɛ̃́ tĩ́mĩ́ bɔ́tɛ̀ ɛ̀dídɛ̀ kɔ̂:

man short remove.PST mat red

'A short man removed a mat'

b. àɲɛ̃́ kɔ̂: bɔ́tɛ̀ ífì tɛ̃́ńté → àɲɛ̃́ kɔ̂: bɔ́tɛ̀ ífì tɛ̃́ńté

man red roll.PST rope long

'The tall man rolled the long rope'

c. àɲɛ̃́ à sóbì ífì à → *àɲɛ̃́ ɜ̀ sóbì ífɪ à

man DET pull.PST rope DET

'The man pulled the rope'

d. àɲɛ̃́ à kítɛ̀ bókìtì kɔ́ɔ̀ → àɲɛ̃́ à kítè bókìtì kɔ́ɔ̀

man DET hold.PST bucket red

'The man held a red bucket'

The blocking of cross-word harmony in (14c) and the application of cross-word harmony in (14d) shows that the verb forms a prosodic phrase with the two-word object but not with the two-word subject. This suggests that the two-word subject forms a binary prosodic phrase while the verb and the two-word object form a ternary prosodic phrase like the three-word constructions: (ωω)(ωωω). This could be due to two possibilities: i) there is a preference for the particular order binary-ternary (ωω)(ωωω) or ii) prosodic phrasing matches syntactic constituents, and since a verb and its object form a verb phrase (VP), there may be a preference for this.

The examples in (15) have a one-word subject and a three-word object. Cross-word harmony applies between words 1 and 2; the subject and the verb, while cross-word harmony also applies within the object, words 4 and 5 in (15b). However, there is no harmony between words 2 and 3 in (15c) but there is cross-word harmony between words 3 and 4 in (15d).

SVO with one-word subject and three-word object

(15) a. àɲɛ̃́ sóbì mɪ̃̀ ífɪ̀ kɔ̂ː → àɲẽ́ sóbì mɪ̃̀ ífɪ̀ kɔ̂ː

man pull.PST my rope red

'A man pulled my red rope'

b. àɲɛ̃́ sɔ́kwì mɪ̃́ ɔ̀kɔ́tɔ̀ dùúdùbí → àɲɛ̃́ sɔ́kwì mɪ̃́ ɔ̀kɔ́tò dùúdùbí

man cease.PST my crab tiny

'A man ceased my tiny crab'

c. àɲɛ̃́ kítɛ̀ bókìtì kɔ̂ː à → *àɲɛ̃́ kítè bókìtì kɔ̂ː à

man hold.PST bucket red DET

'A man held the red bucket'

d. àɲɛ̃́ kítɛ̀ mɪ̃́ bókìtì kɔ̂ː → àɲɛ̃́ kítɛ̀ mĩ́ bókìtì kɔ̂ː

man hold.PST my bucket red

'A man held my red bucket'

The constructions in (15) show the same prosodic phrasing, (ωω)(ωωω), as we saw in (14), and we also see that unlike the case in (14), the verb phrases prosodically with the subject in (15a): (SωVω)(Oωωω). However, the three-word phrase which is isomorphic with the object, is a syntactic constituent. If (ωωω)(ωω) were the phrasing, the phrases would not match any syntactic constituent. In order to test out whether binary-ternary is just the preferred order or whether syntactic constituency determines phrasing, a three word subject is needed. If it still parses as (ωω)(ωωω), then syntax plays no role. But, if it parses as (ωωω)(ωω), then syntax is playing a role.

In the examples in (16), there are three-word subjects and one-word objects and (16a) shows cross-word harmony between 1 and 2, (16b) shows harmony between 4 and 5, (16c) shows harmony between 2 and 3, and (16d) shows lack of harmony between 3 and 4.

SVO with three-word subject and one-word object

(16) a. àɲɛ̃́ tɛ̃́ńté mɔ̃́ bɔ́tɛ̀ ɛ́dídɛ̀ → àɲé tɛ̃́ńté mɔ̃́ bɔ́tɛ̀ ɛ́dídɛ̀

man tall/long DEM roll.PST mat

'This tall man rolled a mat'

b. àɲɛ̃́ fã́ńfã́ mɔ̃́ sɔ́kwì bókìtì → àɲɛ̃́ fã́ńfã́ mɔ̃́ sɔ́kwì bókìtì

man nice DEM cease.PST bucket

'This nice man seized a bucket'

c. mĩ́ ɔ̀kɔ́tɔ̀ dùúdùbí sóbì ífì → mĩ́ ɔ̀kɔ́tò dùúdùbí sóbì ífì

my crab tiny pull.PST rope

'My tiny crab pulled a rope'

d. àɲɛ̃́ fɛ̃́ńfɛ̃́ mɔ̃́ sóbì ífì → *àɲɛ̃́ fɛ̃́ńfɛ̃́ m<u>ɔ̃́ sóbì</u> ífɪ

man nice DEM pull.PST rope

'This nice man pulled a rope'

The constructions in (16) show that cross-word harmony applies within the three-word subject (16a), between words 1 and 2, and also between words 2 and 3 in (16c). It also applies between the object and the verb, words 4 and 5 in (16b). Cross-word harmony was, however, blocked between words 3 and 4 in (16d). This shows that the second possibility of (ωωω)(ωω) also appears to hold for five-word sentences, and that there appears to be a preference for matching prosodic phrasing to syntactic constituency. Although constituent matching was not shown to play any role in four-word sentences (cf. 11c), it appears to determine the prosodic phrasing of five-word sentences. When there is a three-word subject and one-word object, the three-word subject phrases alone while the verb and the object phrase together, hence the structure 3-2 (ωωω)(ωω), in which the ternary phrase matches the subject NP and the binary phrase matches the VP. In contrast, when the subject consists of two words, the preferred structure is 2-3 (ωω)(ωωω), again, with the phrasing matching the syntactic constituents. If the subject consists of one word, it does not phrase alone, but combines with the verb and the three word object NP will correspond to a prosodic phrase. Generally, binary and ternary phrases are sanctioned, and when there is a choice in phrasing, syntactic structure does determine prosodic phrasing, but with respect to the size of the subject.

Previous data concerning two-, three-, and four-word sentences have shown that SVCs pattern in a similar fashion to other constructions. The following discussion examines how SVCs operate with respect to harmony in five word sentences when two verbs are involved. The five word examples in (17) consist of a one-word subject, two verbs, and a two-word object. In example (17a), cross-word harmony applies between words 1 and 2; the subject and first verb, V1. In (17b), there is cross-word harmony between words 3 and 4; V2 and the object. In (17c), cross-word harmony does not apply between words 2 and 3 even though there is a +ATR vowel in word 3; in other words, harmony is blocked between the two verbs in the SVC. There is also cross-word harmony between the two-word object in (17d) between words 4 and 5. Even though this has no effect on the two verbs, it shows that when there are two verbs, harmony also applies within the object. These patterns indicate that the sentence is prosodically phrased as (SωVω)(VωOωω). This example demonstrates that phrasing to match an object does not force the phrasing (www)(ww) like it does for subjects.

SVO with one-word subject and two-word object

(17) a. àɲɛ́ jélì bì ɜ́kùtú kɔ̂ː → àɲé jélì bì ɜ́kùtú kɔ̂ː

man stand/stop.PST pluck.PST orange red

'A man stood to pluck a red orange'

b. àɲɛ́ kʊ́sʊ́ kpʊ́sɛ̀ ɜ́jì à → àɲɛ́ kʊ́sʊ́ kpʊ́sè ɜ́jì à

man stand.PST lean.PST tree DET

'A man stood-up to lean against the tree'

c. àɲɛ́ fíntì bì ɜ́kùtú à → *àɲɛ́ fíntì bì ɜ́kùtú à

man jump.PST pluck.PST orange DET

'A man jumped to pluck the orange'

d. àɲɛ́ dʑɔ́wɛ̀ kírì ɔ̀kɔ́tɔ́ dùúdùbí → àɲɛ́ dʑɔ́wɛ̀ kírì ɔ̀kɔ́tó dùúdùbí

man bend.PST catch.PST crab small

'A man bent down to catch a small crab'

The five word examples in (18) have a two-word subject, two verbs, and a one-word object. There is cross-word harmony between the two verbs in (18a), words 3 and 4. Cross-word harmony also applies between V2 and the object in (18c), words 4 and 5. However, there is no cross-word harmony between words 2 and 3 as in (18b). This indicates that the phrasing is (Sωω)(VωVωOω)

SVO with two-word subject and one-word object

(18) a. àɲɛ́ kɔ̂: fɪ̃́ńtɪ̃̀ bì ɜ́kùtú → àɲɛ́ kɔ̂: fɪ̃́ńtɪ̃̀ bì ɜ́kùtú

man red jump.PST pluck.PST orange

'A fair man jumped to pluck an orange'

b. àɲɛ́ kɔ̂: jélì sóbì ífî → *àɲɛ́ kô: jélì sóbì ífî

man red stand/stop.PST pull.PST rope

'A fair man stood-up to pull a rope'

c. àɲɛ́ kɔ̂: kʊ́sʊ́ kpʊ́sɛ̀ ɜ́jî → àɲɛ́ kɔ̂: kʊ́sʊ́ kpʊ́sè ɜ́jî

man red stand.PST lean.PST tree

'A fair man stood-up to lean against a tree'

The contrast between (17) and (18) shows that SVCs will be phrased together if the subject has two words to form a binary prosodic unit, but they will be split if the subject has one word and needs to form a binary prosodic unit with the following word.

All the five word SVC examples in (19) have a three-word subject and two verbs. Based on the previous behavior of three word subjects, it is expected that the subject should phrase as a ternary prosodic unit. Harmony always applies within the subject in (19a) words 1 and 2, between the two verbs in (19b), words 4 and 5 and between words 2 and 3. There is blocking of harmony between the subject and the verb in (19d) since there is no harmony between words 3 and 4. The sentence is phrased as (Sωωω)(VωVω).

SVO with three-word subject and two verbs only

(19) a. àɲɛ̃́ tɛ̃́ńté kɔ̂: jélì tɕà → àɲɛ̃́ tɛ̃́ńté kɔ̂: jélì tɕà

man tall red stand/stop.PST dance.PST

'A tall fair man stood-up to dance'

b. àɲɛ̃́ kɔ̂: mɔ́ kʊ́sʊ̀ jélì → àɲɛ̃́ kɔ̂: mɔ́ kʊ́sù jélì

man red DEM stand.PST stand/stop.PST

'This fair man stood-up'

c. àɲɛ̃́ kɔ̂: jélì tɕà ǹdí → àɲɛ̃́ kô: jélì tɕà ǹdí

man red stand/stop.PST dance.PST today

'This tall man stood-up to dance'

d. àɲɛ̃́ kɔ̂: mɔ̃́ jélì tɕà → *àɲɛ̃́ kɔ̂: m<u>ɔ̃́ jélì</u> tɕá

man red DEM stand/stop.PST dance.PST

'This tall man stood-up to dance'

SVCs follow the same patterns in five-word sentences as the other sentences. They phrase as (ωω)(ωωω), unless the subject has three words, in which case they phrase as (ωωω)(ωω). The table below presents a summary of the prosodic phrasings for five-word sentences.

Table 4.1: Five-Word Phrasing Pattern

	Prosodic Phrasing	**Relevant Examples**
(ωω)(ωωω)	(Sωω)(VωOωω)	14
	(SωVω)(Oωωω)	15
	(Sωω)(VωωOω)	18
	(SωVω)(ωOωω)	17
(ωωω)(ωω)	(Sωωω)(VωOω)	16
	(Sωωω)(Vωω)	19

The discussion of five-word sentences shows that two phrasings are possible, (ωω)(ωωω) or (ωωω)(ωω), which are determined based on the syntactic structure of the sentences.

4.2.3 Sentences with Blocking Effects: Six Words

The discussion of two- and four-word sentences showed that the words were neatly grouped into binarity units. However, five-word sentences – odd-numbered constructions – have other configurations for their phrasing. The phrasing in odd-numbered structures appears to pay attention to the syntactic constituency of the constructions. In view of that, six-word sentences could be phrased in different ways. Two main possibilities are likely: (1) they group into three binary phrases as (ωω)(ωω)(ωω) or (2) they group into two ternary phrases (ωωω)(ωωω). In both cases, we should expect to find cross-word harmony between words 1 and 2 and between 5 and 6.

The sentences in (20) have three-word subjects and two-word objects. (20a) shows cross-word harmony between words 1 and 2 while (20b) shows cross-word harmony between words 5 and 6. Also, cross-word harmony applies between words 2 and 3 in (20c), but there is no harmony between words 3 and 4 in (20d). However, cross-word harmony applies between words 4 and 5 in (20e).

SVO with three-word subject and two-word object

(20) a. àɲɛ̃́ tɛ̃́ńté à kítɛ̀ ɔ̀kɔ́tɔ́ à → àɲ<u>ẽ́ tẽ́ńté</u> à kítɛ̀ ɔ̀kɔ́tɔ́ à

man tall/long DET hold.PST crab DET

'The tall man held the crab'

b. àɲɛ̃́ kɔ̂ː à kítɛ̀ ɔ̀dídɛ̀ tímì → àɲɛ̃́ kɔ̂ː à kítɛ̀ ɔ̀díd<u>è tímì</u>

man red DET hold.PST metal short

'The fair man held a short metal'

c. àɲɛ̃́ kɔ̂: téntè sóbì ífì à → àɲɛ̃́ kô: téntè sóbì ífì à

man red tall pull.PST rope DET

‘A fair tall man pulled the rope’

d. àɲɛ̃́ ɔ̀bìná kɔ̂: sóbì ífì à → *àɲɛ̃́ ɔ̀bìná kô: sóbì ífì à

man big/fat red pull.PST rope DET

‘A fat fair man pulled the rope’

e. àɲɛ̃́ ɔ̀bìná kɔ̂: kítɛ̀ bókìtì à → àɲɛ̃́ ɔ̀bìná kɔ̂: kítè bókìtì à

man big/fat red hold.PST bucket DET

‘A fat fair man held the bucket’

When there is a three-word subject in a six-word sentence, cross-word harmony applies within the subject: word 2 triggers harmony on word 1 in (20a) and word 3 triggers harmony on word 2 in (20b). In addition, the verb appears to prosodically phrase with the two-word objects. This explains the cross-word harmony between words 4 and 5 in (20e), but word 4 was unable to trigger cross-word harmony on word 3 in (20d). Like the cases in five-word sentences, there appears to be a boundary between the subject and the verb, hence the inability for cross-word harmony to apply in (20d). Six-word sentences with three word subjects so far show evidence for ternary prosodic phrasing: (ωωω)(ωωω).

Let us now examine how the verb prosodically phrases when the subject has two words in a six-word sentence. The sentences in (21) have two-word subjects and three-word objects, and again, we expect to see cross-word harmony between words 1 and 2 and words 5 and 6. In (21a & b), there is cross-word harmony between words 1 and 2, and words 5 and 6 respectively, and cross-word harmony also applies between words 4 and 5 in (21c). In (21d), there is no cross-word harmony between words 2 and 3 although the trigger and the target are present. However, there is also no cross-word harmony between words 3 and 4 in (21d).

SVO with two-word subject and three-word object

(21) a. àɲɛ̃́ tɛ̃́ńté kítɛ̀ mí ɔ̀kɔ́tɔ́ à → àɲɛ̃́ tɛ̃́ńté kítɛ̀ mí ɔ̀kɔ́tɔ́ à

man tall hold.PST my crab DET

'A tall man held my crab'

b. àɲɛ̃́ kɔ̂: kítɛ̀ mí ɔ̀kɔ́tɔ̀ dùúdùbí → àɲɛ̃́ kɔ̂: kítɛ̀ mí ɔ̀kɔ́tò dùúdùbí

man tall hold.PST my crab tiny

'A tall man held my tiny crab'

c. àɲɛ̃́ à sóbì mì bókìtì dùúdùbí → àɲɛ̃́ à sóbì mì bókìtì dùúdùbí

man DET pull.PST my bucket tiny/small

'The man pulled my tiny/small'

d. àɲɛ̃́ kɔ̂: sóbì mì ífî kɔ̂: → * àɲɛ̃́ kô: sóbì mɪ ífî kɔ̂:

man red pull.PST my rope red

'The fair man pulled my red rope'

e. àɲɛ̃́ à kítɛ̀ bókìtì dùúdùbí à → *àɲɛ̃́ à kítè bókìtì dùúdùbí à

man DET hold.PST bucket tiny/small DET

'The man held the tiny bucket'

Crucially, it appears that the verb does not phrase with the object since *bókìtì* in (21e) did not trigger cross-word harmony on word 3, *kítɛ̀* 'held'. This shows that a four-word phrase appears not to be possible in Gua. It was not a possibility in four-word sentences unlike three-word sentences which prosodically group all the words together. And, it is also not a possibility in six-word sentences. Yet, the verb does not prosodically phrase with the two-word subject to form a ternary phrase since *sóbì* ‘pulled’ fails to trigger harmony on the preceding -ATR words in (21b & c). This suggests that the prosodic phrasing is neither (ωω)(ωω)(ωω) nor (ωωωω)(ωω), but instead (Sωω)(Vω)(Oωωω), with each noun phrase phrased separately and the verb prosodically phrasing alone.

I now turn to six-word sentences with SVCs. The examples in (22) have a one-word subject, two verbs and a three-word object, and they show that cross-word harmony applies between the subject and V1, words 1 and 2 in (22a). Harmony does not apply between the two verbs in (22b) nor between the verb and the object in (22c).

SVO with one-word subject, two verbs and three-word object

(22) a. àɲɛ̃́ jélì bì ɜ́kùtú kɔ̂: à → àɲẽ́ jélì bì ɜ́kùtú kɔ̂: à

man stand/stop.PST pluck.PST orange red DET

‘A fair man stood-up to pluck the red orange’

b. àɲɛ̃́ fɪ̃́ńtì bì ɜ́kùtú kɔ̂: à → *àɲɛ̃́ fɪ̃́ńtì bì ɜ́kùtú kɔ̂: à

man jump.PST pluck.PST orange red DET

‘A man jumped to pluck the red orange’

c. àɲɛ̃́ kʊ́sʊ̀ kpʊ́sɛ̀ ɜ́jî kɔ̂: à → * àɲɛ̃́ kʊ́sʊ kpʊ́sè ɜ́jî kɔ̂: à

man stand.PST lean.PST tree red DET

‘A man stood-up to lean against the red tree’

The prosodic phrasing for this case is again (ωω)(ω)(ωωω) rather than (ωωω)(ωωω): (SωVω)(Vω)(Oωωω). The pattern suggests that one of the verbs phrases with the subject if the subject consists of only one word. It shows that breaking with syntactic structure to achieve binarity is allowed, but not to achieve ternarity. The second verb prosodically phrases by itself.

The examples in (23) have two-word subjects, two verbs and two-word objects. There is harmony between the second verb and the object which are words 4 and 5 in (23b). There is no harmony between the two verbs in (23c), words 3 and 4. Harmony also does not apply between the subject and the verb in (23a), words 2 and 3. The harmony patterns again suggest the phrasing (ωω)(ω)(ωωω), with V2 phrasing with the object to form a ternary phrase, but the V1 phrasing alone: (Sωω)(Vω)(VωOωω). Again, ternarity in these longer sentences is allowed when it is consistent with syntax, otherwise it is blocked. This once again shows that the size of the object does not determine phrasing. A (Sωω)(VωVω)Oωω) phrasing would have matched both NP arguments better, but this is not what occurs.

SVO with two-word subject, two verbs and two-word object

(23) a. àɲɛ̋ kɔ̂: jélì bì ɜ̀kùtú kɔ̂: → * àɲɛ̋ k<u>ɔ̂: jélì</u> bì ɜ̀kùtú kɔ̂:

man red stand/stop.PST pluck.PST orange red

'A fair man stood to pluck a red orange'

b. àɲɛ̋ kɔ̂: fɪ̋ńtɪ̏ sɔ́tɛ̀ ɜ̀kùtú kɔ̂: → àɲɛ̋ kɔ̂: fɪ̋ńtɪ̏ <u>sɔ́tè ɜ̀kùtú</u> kɔ̂:

man red jump.PST catch.PST orange

'A fair man jumped to catch an orange'

c. àɲɛ̃́ kɔ̂: kʊ́sʊ̀ bì ɜ́kùtú à → *àɲɛ̃́ kɔ̂: kʊ́sù bì ɜ́kùtú à

man red stand.PST seize.PST stick/tree DET

'A fair man stood-up to pull a rope'

In (24), all the sentences have a three-word subject, two verbs and a one-word object. Cross-word harmony in these constructions occurred within the subject (24a), between the object and the second verb in (24b), or between the two verbs (24a). There is no cross-word harmony between words 3 and 4, the subject and the verb. The harmony patterns in this case suggest two ternary phrases: (ωωω)(ωωω), or (Sωωω)(VωVωOω). This also shows evidence for ternarity that is consistent with syntax.

SVO with three-word subject, two verbs and one-word object

(24) a. àɲɛ̃́ kɔ̂: tɛ̃́ńté kʊ́sù jélì sílɛ̀ → àɲɛ̃́ kô: tɛ̃́ńté kʊ́sù jélì sílɛ̀

man red tall stand.PST stand/stop.PST soil/land/floor

'A tall fair man stood-up there'

b. àɲɛ̃́ kɔ̂: mɔ́ kʊ́sʊ̀ kpʊ́sɛ̀ ɜ́jì → àɲɛ̃́ kɔ̂: mɔ́ kʊ́sʊ̀ kpʊ́sè ɜ́jì

man red DEM stand.PST lean.PST tree

'This fair man stood-up to lean against a tree'

c. àɲɛ̃́ kɔ̂: mɔ́ jélì bì ɜ́kùtú

man red DEM stand/stop.PST pluck.PST orange

'This fair man stood-up to pluck an orange'

Six-word sentences shows a phrasing with two ternary prosodic phrases (ωωω)(ωωω) if the subject consists of three words, but otherwise the phrasing (ωω)(ω)(ωωω), where the verb appears to phrase alone, is employed. The application of harmony depends on the structure of the sentences and the number of words in each sentence. A summary of the patterns with six-word sentences are presented in Table 4.2 below:

Table 4.2: Six-Word Phrasing Pattern

	Prosodic Phrasing	**Relevant Examples**
(ωω)(ω)(ωωω)	(Sωω)(Vω)(VωOωω)	22
	(SωVω)(Vω)(Oωωω)	23
	(Sωω)(Vω)(VωOωω)	24
(ωωω)(ωωω)	(Sωωω)(VωOωω)	21
	(Sωωω)(VωVωOω)	20

The domain effects show that both binary and ternary prosodic phrases are employed in the cross-word harmony process. Ternary phrases show up in five and six-word sentences depending on the syntactic structure of the sentences. The data from six-word sentences also suggests that verbs can phrase alone. Yet unary phrasing was disallowed elsewhere, such as in three-word sentences. It appears that unary phrases are allowed as long as they do not occur at the edges of sentences. A SωωVω sentence or a VωOωω sentence does not allow the verb to phrase alone, for example. Six word sentences also never split into three binary units, in contrast to expectations based on four word sentences.

Cross-word harmony operates in a non-iterative fashion between words that group into binary or ternary phrases but not across the phrases. In four-word sentences, it operates within binary phrases regardless of the syntactic structure. But in longer sentences of five and six words, the phrasing does depend on syntactic structure. Essentially, the patterns of the domain effects are that the verb prosodically phrases with the subject only if the subject has only one word. Otherwise, the verb prosodically phrases with the object if the object has one word or two words, but not three. Two verbs in SVCs may phrase together or apart depending on the size of the subject and the number of words in the sentence. For a formal analysis of these patterns couched within MATCH theory, see Obiri-Yeboah & Rose (2021)

4.3 Exceptionality in the Directionality of Gua Vowel Harmony

Although Gua ATR harmony generally appears to be regressive, there is one case where progressive harmony across words is observed, with the locative particle *dɛ̀* 'inside/it'. The examples in (25) show that the locative particle in (25a-c) undergoes harmony. Nevertheless, not all cases of *dɛ̀* harmonize, as the examples in (25d,e,f) show. Also, example (25d,e,f) suggests that the progressive harmony is only possible when the preceding word has a final high vowel, irrespective of the word class of the preceding word.

(25) a. ǹtɕú dɛ̀ → ǹtɕú dè

water inside/it

‘River side’

b. kòfí tù dɛ̀ → kòfí tù dè

kofi close inside/it

‘close an object (door)’

c. kòfí sóbì dɛ̀ → kòfí sóbì dè

kofi pull.PST inside/it

‘Kofi pulled it/inside’

d. kòfí k͡pítè dɛ̀ → kòfí k͡pítè dɛ̀

kofi pull.PST inside/it

‘Kofi pulled it/inside’

e. òkúrò dɛ̀ → òkúrò dɛ̀

town inside/it

‘downtown’

f. òbúròdʑwó dɛ̀/it → òbúròdʑwó dɛ̀

plantain inside

‘plantain (farm area) inside’

There are instances where when another word occurs between *dɛ̀* ‘inside’ and the preceding +ATR word and progressive harmony fails to apply on either the word between them or the *dɛ̀* (26). This suggests that there is something special about *dɛ̀* as a target.

(26) a. kòfí nɔ́ dɛ̀ → kòfí nɔ́ dɛ̀

kofi farm inside/it

'Kofi's farm (inside)

b. ɜ̀bú mɔ́ dɛ̀ → ɜ̀bú mɔ́ dɛ̀

house DEM inside/it

'Inside this house (room)'

Akanlig-Pare & Asante (2016) identify a similar pattern in Nkami and conclude that cases like those in (25a-c) are lexicalized into one complex stem but those in (25d,e) and (26) would be enclitics. In the case of Gua, the examples in (25a-c) could be considered to be locative particles or postpositions. However, this process only affects the *dɛ̀* postposition since other words with mid or low vowels that occur after words with high vowels do not undergo harmony.

(27) a. kòfí sóbì kɛ̃́ńtɕĩ̂: → kòfí sóbì kɛ̃́ńtɕĩ̂:

kofi pull.PST plate/bowl/cooking utensil

'Kofi pulled a plate/bowl/cooking utensil'

b. kòfí tɕù kɛ̃́ńtɕĩ̂: → kòfí tɕù kɛ̃́ńtɕĩ̂:

kofi take.PST plate/bowl/cooking utensil

'Kofi took a plate/bowl/cooking utensil'

Also, other postpositions in the language do not harmonize progressively (28) even following high +ATR vowels.

(28) a. kòfí tɕú sʊ̀ → kòfí tɕú sʊ̀

kofi take.HAB upper-surface/up

'Kofi picks it up'

b. kòfí tù sʊ̀ sɑ̃́ → kòfí tù sʊ̀ sɑ̃́

kofi throw upper-surface three

'Kofi became third (in an exam)'

c. kòfí jélì dá → kòfí jélì dá

kofi stand/stop.PST there

'Kofi stood there'

To sum up, one specific postposition or locative particle dɛ̀ may be harmonized by a preceding +ATR high vowel. This suggests that dɛ̀ may not necessarily be lexicalized as discussed in Nkami (Akanlig-Pare & Asante (2016), but rather there is a phonological restriction on its ability to harmonize. This is the only attested case of +ATR progressive harmony in the language. High vowels in general have special behavior when it comes to ATR harmony, particularly regarding cross-word harmony. In Nawuri, regressive cross-word harmony applies iteratively irrespective of vowel type, but progressive cross-word harmony can only apply non-iteratively to high vowels (Casali 2002). In Vata (Kaye, 1982 and Kimper 2011), there is a restriction that a non-high vowel cannot trigger harmony on a high vowel across a word boundary (so high vowels can trigger on any vowel, but a non-high can only be a trigger to another non-high). In Kinande, cross-word regressive harmony can only apply if the final target of the harmony is a high vowel (In Kinande, only high vowels are phonemically contrastive for ATR (Mutaka 1995)).

4.4 Typological of ATR Vowel Harmony and Phonological Phrasing

In two and four word sentences, we observed that, sentences are grouped into binary prosodic phrases without reference to syntax. Binary prosodic phrasing has been reported for other languages. Ghini (1993) reports that for stress retraction and Raddoppiamento Sintattico (cross-word gemination) in Italian, words are grouped into binary phonological phrase units which determine the domain of application of the phonological rules. He argues that the prosodic constituents do not align perfectly with syntactic constituents; in particular the branching nature of the constituent does not matter. A four-word sentence is parsed into two units by the principle of symmetry. The preference for binarity was later formulated in Optimality Theory (OT) as a constraint on minimal binarity (Selkirk 2011). Sandalo & Truckenbrodt (2002) use similar principles for Brazilian Portuguese stress, and Prieto (2011) for stress and intonation in Catalan. Binarity is also used to explain penultimate lengthening and high tone spreading in XiTsonga, (Kisseberth 1994, Selkirk 2011). This use of prosodic binarity is in contrast to the ‘branching condition’ which refers to syntactic structure (Nespor & Vogel 1986). If a syntactic phrase is binary, this can form a unit within which processes apply. Sensitivity to syntactic binary branching has been observed for tone in Kinyambo (Bickmore 1990). The Gua data is not subject to the branching condition, but instead involves binary prosodic phrasing.

A phonological phrasing analysis has also been applied to vowel harmony in Akan (Kügler 2015), which is a related Kwa language. However, there is no apparent binarity effect. Kügler notes that cross-word harmony in Akan is regressive and the process affects only the last vowel of the preceding word, so in this sense it is like Gua. Nevertheless, in Akan, harmony operates within syntactic phrases such as determiner phrase (DP) and verb phrase (VP) and does not operate across the VP boundary, such as between a subject and a verb (Dolphyne 1988/2006, Hess 1992, Kügler 2015). This is unlike Gua. The examples in (14a-b) show harmony applying within the verb phrase between verbs and objects, and the examples in (14c-d) show blocking of harmony between the subject and the VP. Data are from Genzel (2013) as cited in Kügler (2015:188).

(29) a. frɛ Kofi

frɛ̀ kòfí → frè kòfí

call.IMP Kofi

'Call Kofi'

b. ɔ-kyerɛ kube

ɔ̀-tɕìrɛ́ kùbé → ɔ̀-tɕìré kùbé

3SG-show coconut

'He/She shows a coconut'

c. adamfo di kube

àdàmfɔ̀ dí kùbé → (*àdàmfù dí …)

friend eat coconut

'A friend eats a coconut.'

d. Anane bisa sika ɛnɛ

ánàní bìsá sìká ɛ̀nɛ́ → (*ánàní bìsá …)

Anane ask money today

'Anane asks for money today.'

The lack of cross-word harmony between the subject and the verb in (29c-d) suggests that the phonological phrases are mapped to the syntactic ones in an isomorphic fashion. This means that a maximal phonological phrase corresponds to the VP and another to the subject DP. Those phrases under the VP are minimal phonological phrases. Harmony only operates within the maximal phonological phrases, but not across the boundary. It suggests that harmony can apply within VP and DP, but not from the VP to the DP since that will cross a syntactic boundary. Binarity sensitivity plays no role in Akan syntax/prosody cross-word vowel harmony domains. In contrast, cross-word vowel harmony in Gua, shows a different pattern: harmony applies within phonological phrases that preferentially consist of two or three words. These phrases ignore syntactic constituency, including the subject noun phrase/verb phrase boundary. While binarity has been argued to impact prosodic phrasing in other languages with different phonological phenomena, this is the first documented case of binarity applying to vowel harmony.

Other cases of cross-word vowel harmony have been reported for a number of languages. However, few of these studies have addressed the details of how syntax may constrain the application of cross word harmony, but those that do report that harmony operates within major syntactic phrases, such as DPs or VPs. In Kinande, ATR vowel harmony is reported to operate across word boundaries only within the DP and only if the final vowel is high, but not across other phrasal categories (Mutaka 1995); there is no harmony between a verb and its preceding subject or its following object. Cahill (2007) reports that ATR vowel harmony operates between a noun and a following adjective in Kɔnni, and between a verb and preverbal particles and pronominal subject or objects, but not if the subject or object is lexical. This suggests that the elements that do undergo harmony are part of a verbal complex. Similar effects are reported for Somali (Nilsson & Downing 2019) wherein harmony operates within noun complexes and verb complexes, but not across lexical word boundaries. All these patterns are different from the pattern presented for Gua so far.

Turning to issues of directionality in cross-word harmony, Luo has +ATR cross-word harmony which is regressive and does not show limitations in the type of word class (Swenson 2015). The process is also iterative within the preceding word but does not extend beyond that word. Although Luo shows pure regressive directionality in cross-word harmony and without any restriction on lexical class like Gua, the domain of the harmony process differs between the two languages. Luo cross-word harmony is iterative and its word-level harmony is bidirectional, whereas Gua harmony is non-iterative and sensitive to binarity effects, and its word-level harmony is unidirectional. It shows regressive directionality at all levels.

Another ATR system that shows cross-word harmony is Nawuri, a North-Guang language of Ghana (Casali 2002). The examples in (30) shows that cross-word harmony applies regressively and iteratively and has no restriction on the type of lexical words.

(30) a. /ɔ-sɪ wijɑ/ → [òsúwíjɑ̂] 'person whose father is living'
3SG-father owner

b. /ɪ-sɪ ɪ-bʊ o-bu-to/ → [ìsííbòòbùtò] 'sand is in the room'
NC-sand INCMPL-be NC-room-in

c. /ɛ-kɔɔlɪ ɑ-fulee/ → [èkóóláàfùléè] ‘he is collecting money’

PROG-he.receive NC-money

Apart from the regressive nature of the cross-word harmony effect, Nawuri also shows progressive directionality. Progressive cross-word harmony is restricted to words containing high vowels. Both words must contain high vowels, but the word class of the words is not restricted. In addition, the progressive harmony is only observed in rapid and casual speech. The examples in (31) illustrate cross-word harmony in progressive fashion triggered by the +ATR dominant words.

(31) a. /ɑ-fuu fʊʊtɪ-sa/ → [áfúúfúútísâ] ‘air for breathing’

NC-air breathe-ADJ

b. /gi-buu tʊʊ-sa/ → [gìbúútúùsà] ‘a stone for throwing’

NC-stone throw-ADJ

Nawuri has bidirectional harmony within words, and cross-word harmony shows bidirectionality. Regressive harmony is iterative whereas progressive cross-word harmony is non-iterative and only operates between high vowels. Therefore, Nawuri differs from Gua in directionality and iterativity.

Nkami, another Guang language, also show +ATR regressive harmony across words (Asante 2016) as in (32). Like the regressive harmony in Nawuri, the process is iterative through the entire preceding word, and there is no reported case of restriction of applicable word class. There is not enough information to assess whether there are blocking effects based on prosodic phrasing as in Gua.

(32) a. ɔkʊ yɪrɪ obu amʊ sʊ → [yiri obu]

someone stand house DET on

'Someone is standing on the building.'

b. bʊ oyire 'have goodness' → [buoyire] 'be good'

Languages with ATR harmony across words show different patterns with respect to directionality and iterativity. There are cases where the word level harmony has bidirectionality but the cross-word harmony effects are purely regressive harmony (Luo) and cases where both the word-level harmony and the cross-word effect is bidirectional, but with limits on the progressive harmony (Nawuri). In addition, there are cases where both word-level and cross-word harmony show regressive harmony which is either iterative within the preceding word (Nkami) or non-iterative and affects the final vowel of the preceding word only (Gua, and Akan (Casali 2012 & Kügler 2015)).

4.5 Conclusion

Gua [+ATR] harmony applies regressively within words, roots and across word boundaries. The cross-word harmony effects in Gua show that harmony operates across word boundaries in non-iterative fashion. Prosodic words show a preference for being grouped into binary phonological phrases, within which harmony applies. In four word sentences, two binary groupings are formed regardless of syntax. However, syntax does play a role in sentences with five or six words, favoring a better match between syntactic phrasing of the subject and phonological phrasing if there is a choice. The sentences provided in this section are simple declarative sentences. I have not considered question formation or focus marking with particles, but preliminary data collection suggests that focused constituents form their own prosodic phrases. Most of the words in this chapter were consonant-initial. I will assess in more detail how hiatus functions across words and how it might interact with harmony in chapter six.

The Gua harmony data contributes to linguistic description and typology in two ways. First, aside from words and roots, it demonstrates a case of pure regressive directionality in an African language ATR system with cross-word harmony. Second, it demonstrates prosodic binarity sensitivity effects in vowel harmony. Although binary sensitivity has been reported for stress, lengthening or gemination, and tone, this is the first known case for vowel harmony. Third, ternarity is usually not favored in phrasing (as is evidenced by constraints such as MAX-BIN (Sandalo & Truckenbrodt 2002, Ito & Mester 2007, Selkirk 2011) or *TERNARITY (Antilla et al 2010)), but in Gua, it is sanctioned.

The current work has raised some typological issues relating to how domains of vowel harmony are expressed across Guang languages which needs further research. Some descriptions are available, but they are not detailed enough. Further studies regarding the status of prosodic domains of vowel harmony in Guang languages would be very useful. Also, although cross word harmony has been discussed in the literature, this chapter provides a detailed account of how the process can be constrained. For formal analysis of the patterns discussed in this paper, see Obiri-Yeboah & Rose (2021).

Acknowledgement:

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CHAPTER FIVE

CONSONANT SYSTEM AND CONSONANT-VOWEL INTERACTION

5.0 Introduction

This chapter describes the consonant inventory of Gua, as well as phonological processes involving consonant-vowel interactions and consonant-consonant interactions. The first section provides a detailed description of the place, voicing and manner features of the consonants as well as the plain versus labialized consonants in the language. There is also a discussion of the distributional properties of the consonants. I provide a voice onset time (VOT) analysis of stop consonants in the language situating the results typologically in section 5.2. The distribution of the consonants is discussed in section 5.3. There is a detailed discussion of phonological processes involving consonant nasal interactions: nasal place assimilation, homorganic nasal assimilation, and consonant and vowel fusion in section 5.4 while section 5.5 concludes the chapter.

5.1 Consonant Inventory

Gua has thirty phonemic consonants with twenty-one plain ones /p, b, t, d, s, f, k, g, m, n, ɲ, ŋ, ŋ͡m, l, h, w, j, ʨ, ʥ, k͡p, g͡b/ and nine labialized counterparts /b^w, d^w, g^w, f^w, k^w, l^w, h^w, $ŋ͡m^w$, $ʨ^w$/ of some of the consonants. The table below represents the consonants in Gua based on voicing, manner and place of articulation features.

Table 5.1: Gua Plain and Labialized Consonants

	Bilabial	Labiodental	Alveolar	Postalveolar /Palatal	Velar	Labial-velar	Glottal
Stop/Plosive	p b bʷ		t d		k g kʷ gʷ	k͡p g͡b	
Affricate				t͡ɕ d͡ʑ t͡ɕʷ d͡ʑʷ			
Nasal	m	[ɱ]	n	ɲ	ŋ ŋʷ	ŋ͡m ŋ͡mʷ	
Trill			[r]				
Fricative		f fʷ	s	[ɕ]			h hʷ
Glides				j		w	
Lateral			l lʷ				

Table 5.1 shows that Gua has stops, fricatives, affricates, nasals, laterals and glides. Within each row for place of articulation, the plain consonants are listed on top while the labialized consonants are below them under each identified place of articulation. The table follows the IPA chart convention of representing voiceless sounds on the left while their voiced counterparts appear on the right side. Apart from the phonemic nasal consonants, there is another nasal consonant in parentheses [ɱ] that appears as an allophone and only occurs before the voiceless labiodental fricative /f/ or /fʷ/ through nasal place assimilation. Further details of this process are discussed in section 5.3.1. There is also an alveolar trill, [r] and palatal fricative, [ɕ] which occur between vowels only and are free variant allophones of /l/ and /h/ respectively in the language.

Phonemic distinctions are determined through minimal or near minimal pairs. The following sub-sections provide minimal and near minimal pairs that illustrate the consonant types in Gua with reference to voiced-voiceless contrasts, nasal place contrasts and plain-labialized contrasts.

5.1.1 Voicing Contrasts of Consonants

The examples in (1) show voiceless consonants on the left while their voiced counterparts are on the right. All the fricatives are voiceless so only stops and affricates are given.

(1)	/p/	pébí	‘small’	/b/	bé	‘innocence/winner’
	/t/	té	‘an oath’	/d/	dè	‘big, grow!’
	/t͡ɕ/	t͡ɕè	‘pass/walk-away!’	/d͡ʑ/	d͡ʑè	‘sack!’
	/k/	kɔ́ɔ̀	‘red’	/g/	gɔ́ɔ̀	‘cemetery’
	/k͡p/	ɜ́k͡pê	‘thousand’	/g͡b/	ɜ́g͡bêlì	‘cassava’

5.1.2 Place of Articulation Contrasts for Consonants

Consonant contrasts in terms of place of articulation are illustrated by the examples in (4) with regard to place of articulation for stops, fricatives and glides.

(4)	/p/	pébí	‘small’	/t/	ɜ̀tèbí	‘an animal’
	/p/	pébí	‘small’	/k/	èkêːmĩ́	‘rib’
	/t/	tàkɛ́	‘cut/fell (a tree)!’	/k/	kàlí	‘count/read!’
	/b/	bɔ́	‘a mountain’	/d/	dɔ̀	‘climb/weed.v!’
	/b/	ɜ̀bú	‘a house’	/g/	ɜ̀gùmã́	‘reckless play’
	/d/	ɜ̀dú	‘a tail’	/g/	ɜ̀gùmã́	‘reckless play’
	/d/	dó	‘here’	/dʑ/	dʑò	‘wait’

	/g/	gɔ̀ʊ́	'cemetery'	/dʑ/	dʑɔ̀wɛ̃́	'squate!'
	/s/	sɔ̀	'buy!'	/f/	fɔ̀	'wash!'
	/s/	sɛ̀	'fetch!'	/h/	hɛ̀	'cover'
	/f/	fɔ̀	'wash!'	/h/	hɔ̀	'to water!'
	/w/	ɜ̀wùlé	'a chief!'	/j/	ɜ̀júlè	'strength'

There are differences between manner relating to glides and liquids as illustrated in (5) below.

(5)	/l/	lé	'a song'	/j/	jèlí	'stop/stand!'
	/l/	lʊ̀	'weave!'	/w/	wʊ́	'you'

5.1.3 Plain versus Labialized consonants

Plain and labialized consonants are contrasted in the forms here; the plain consonants are on the left while their labialized counterparts are on the right. The only alveolar is /l/ The only labials are /b/ and /f/.

(6)	/b/	bɛ̀	'come!'	/bʷ/	bʷɛ̀	'do/perform!'
	/t͡ɕ/	t͡ɕɪ̃̀	'tie/squeeze!'	/t͡ɕʷ/	t͡ɕʷí	'eight'
	/d͡ʑ/	d͡ʑè	'sack/dismiss (from employment)!'	/d͡ʑʷ/	òd͡ʑʷé	'yam'
	/k/	kɛ̀	'show/teach!'	/kʷ/	kʷɛ́	'debt'
	/f/	áfì	'an axe'	/fʷ/	áfʷɛ̂	'stranger/messenger'
	/h/	hɛ̀	'cover!'	/hʷ/	hʷɛ́	'Saturday'
	/l/	lɛ̀	'hang!'	/lʷ/	lʷɛ̀	'get sick!'
	/d/	dè	'grow!'	/dʷ/	dʷè	'sorry'

5.1.4 Nasal Contrasts

The nasal consonants here show contrasts based on the place of articulation of the nasals. In example (7), I show a four-way contrast for /m, n, ɲ and ŋ͡m/.

(7)	/m/	mɔ̃̀	‘kill!’	/n/	nɔ̃́	‘farm’
	/m/	mɔ̃̀	‘kill!’	/ɲ/	ɲɔ̃̀	‘lite/drive (fufu)!’
	/m/	mɔ̃̀	‘kill’	/ŋ͡m/	ŋ͡mɔ̃́	‘dozing’
	/n/	nɔ̃́	‘farm’	/ɲ/	ɲɔ̃̀	‘lite/drive (fufu)!’
	/n/	nɔ̃́	‘farm’	/ŋ͡m/	ŋ͡mɔ̃́	‘dozing’
	/ɲ/	ɲɔ̃̀	‘lite/drive (fufu)!’	/ŋ͡m/	ŋ͡mɔ̃́	‘dozing’
	/m/	mṍ	‘he/she’	/ŋ/	ŋṹ	‘head’
	/n/	ɜ̀nṹḿ	‘an elder	/ŋ/	ɜ̀ŋṹŋṹnĩ̀	‘spatula (for banku)!’
	/ɲ/	ɲɔ̃́	‘two’	/ŋ/	ŋṹ	‘head’
	/ŋ/	ŋú	‘head’	/ŋm/	ŋ͡mṹnɔ̃̀	‘rubbish’

Although all the nasal consonants cited here exist as phonemes in the language, /ŋ/ is restricted in terms of its distribution. The velar nasal can only be followed by /u/, hence the restriction in finding some minimal pairs. This suggests that [ŋ] may have been derived from another nasal when occurring before /u/. Two possible candidates are /m/ or /ɲ/, as both /n/ and /ŋ͡m/ do occur before /u/. Nevertheless, there are no active processes in the language that could test this theory.

5.2 Voiced Onset Time (VOT) of Gua Consonants

Languages show variation in voice onset time (VOT) (Lisker and Abramson 1964; Cho & Ladefoged 1999; Cho et al 2019). This measure establishes distinctions between categories of stops in terms of voicing and aspiration. VOT measures the period of time between the burst release of a stop and the beginning of voicing, or the onset of periodic vocal fold vibration. When the voicing onset occurs after the burst, there is a voiceless period referred to as positive VOT. Positive VOT with a short range is referred to as short-lag while positive VOT with a longer duration is long-lag VOT; stops with long-lag VOT are characterized as aspirated while those with short-lag VOT are classified as unaspirated. In voiced sounds, there is voicing during the period of closure prior to the burst, referred to as negative VOT. English stops show a contrast between short-lag VOT and long-lag VOT. Some languages have zero VOT or close to it. French, for instance, has negative versus zero voicing VOT (Netelenbos et al 2016).

Cho et al. (2019) note different forms of contrast that are measured in VOT in their edited collection of typological studies of VOT. Languages may exhibit a two-way contrast between either "true" voiced and voiceless (e.g. Turkish) or voiceless unaspirated and voiceless aspirated (e.g. English), or a three way contrast between voiced, voiceless unaspirated and aspirated (e.g. Thai). Some languages exhibit a fourway contrast (e.g. Urdu). Cho et al. (2019) report that true voiced VOT ranges between -139ms to -60ms, voiceless unaspirated ranges between an average 1.4ms to 41ms, and voiceless aspirated, the longest ranges, between 57ms to 97ms. Chodroff et al (2019) categorize languages according to VOT measurements as follows: long-lag as ≥ 35 ms, short-lag as ≥ 0 ms, but < 35 ms and lead or negative VOT as < 0 ms. These ranges are important for assessing how a two-way contrast should be categorized.

In terms of VOT range by place of articulation, Lisker and Abramson (1964) observe that labial stops have the shortest VOT, followed by alveolar stops, and then velar stops. Chodroff et al. (2019) take variation into account and survey more languages, but still report the same pattern, which is especially strong for short lag VOT where dorsal > labial > coronal. For negative VOT, velars tend to be the shortest and labials the longest, but there is variation.

Obiri-Yeboah (2013) reports a three-way voicing and aspiration distinction in Gua between voiced, voiceless unaspirated and voiceless aspirated, but where the aspiration is conditioned by a following H tone. However, this was based on impression, without any instrumental analysis. Therefore it is necessary to measure VOT to determine whether a voiceless unaspirated and voiceless aspirated difference is present in the language or not. This section therefore provides VOT measurements for Gua oral stops and I will show that there is only a two-way distinction. Differences in VOT that investigated place of articulation note only bilabial, alveolar and velar stops, and affricates in some cases (Lisker and Abramson 1964, Abramson 1977 and Abramson 1995). However, Gua has labial-velar stops, so the current measurements consider these sounds as well.

5.2.1 Methods

Data for this study are from real words in Gua, as produced by two female speakers. The word list is in example (5) below. The voiced labiovelar stop [g͡b] was measured in intervocalic position, but all others were word-initial. Obiri-Yeboah (2013) claimed that aspiration occurs with stops preceding H-toned vowels, but no aspiration occurs before L-toned vowels, but no measurements were provided.[25] The word té is included with H tone, so if aspiration does occur with H-toned vowels, it should appear with this word.

[25] Obiri-Yeboah (2013) reported the word kʰɛ́ 'show/teach' with H tone, but this is incorrect – all monomoraic imperatives have low tone. This undermines the claim that aspiration is associated with H tone.

(8)	**Voiceless stops**			**Voiced stops**		
a.	/p/	pébí	‘small’	/b/	bɛ̀	‘come!’
b.	/t/	té	‘an oath’	/d/	dè	‘big, grow!’
c.	/k/	kɛ̀	‘show/teach!’	/g/	gɔ́tà	‘gutter’
d.	/k͡p/	k͡pìté	‘clean!’	/g͡b/	ɜ́g͡bêlì	‘cassava’

The recordings were done in a quiet room with a Zoom H4N recorder with an external microphone. The participants produced the words in isolation a minimum of two times. The words were segmented, and VOT portions of each of the consonants in the words were measured manually. For the voiceless consonants, VOT was measured from the release burst to the onset of the periodic waveform of the following vowel. For voiced stops, negative VOT or prevoicing was measured from the onset of voicing (onset of periodicity and onset of energy in the voicing bar) up to the release burst of the stop (Francis et al. 2002).

The following illustrate examples of word-initial voiceless stops as produced by speaker 1 (EO). The label *rel* indicates the VOT from the point of release of the stop to the onset of voicing.

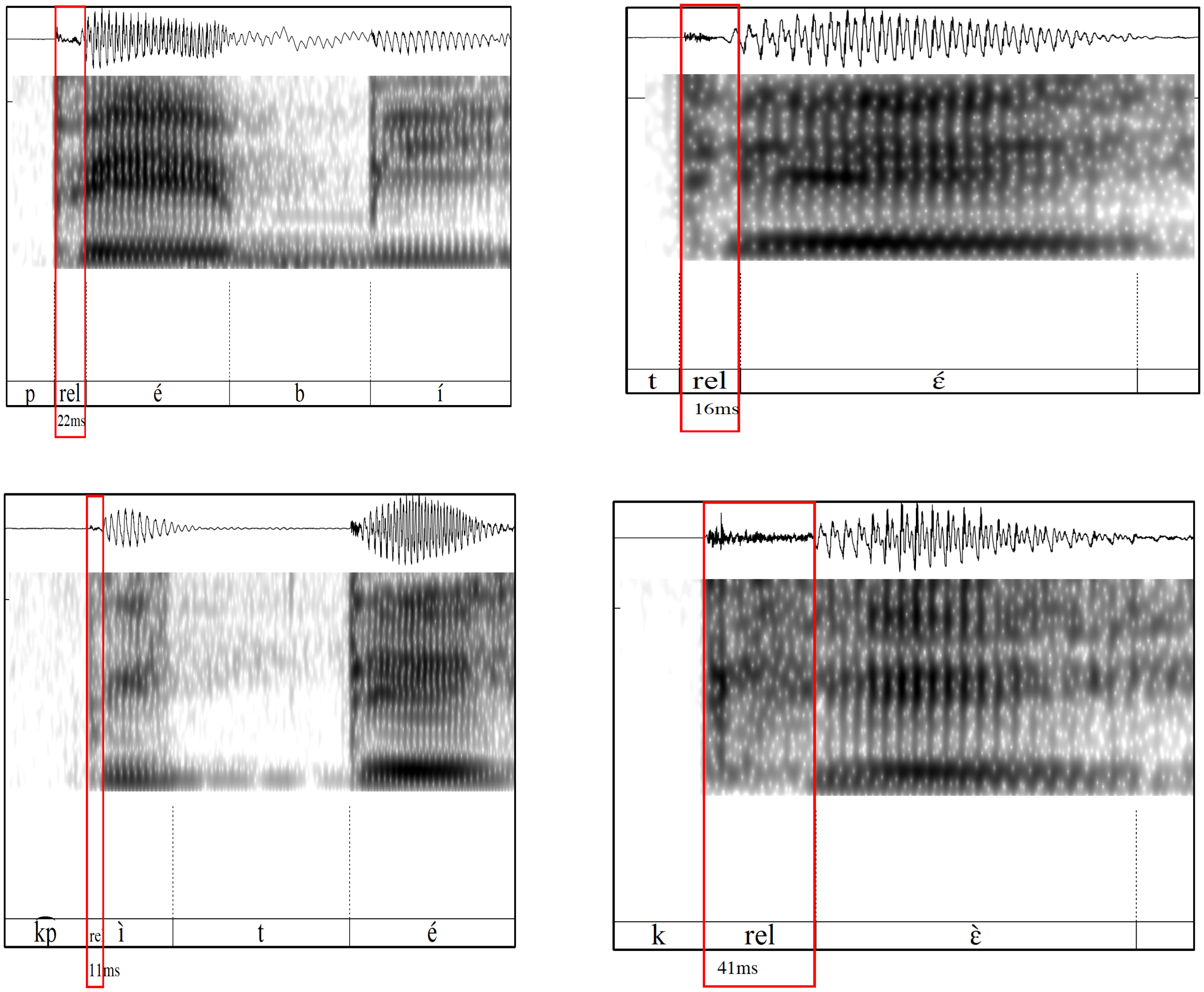


Figure 5.1: VOT for voiceless stops

The following figure shows voiced stops as produced by Speaker 1 (EO).

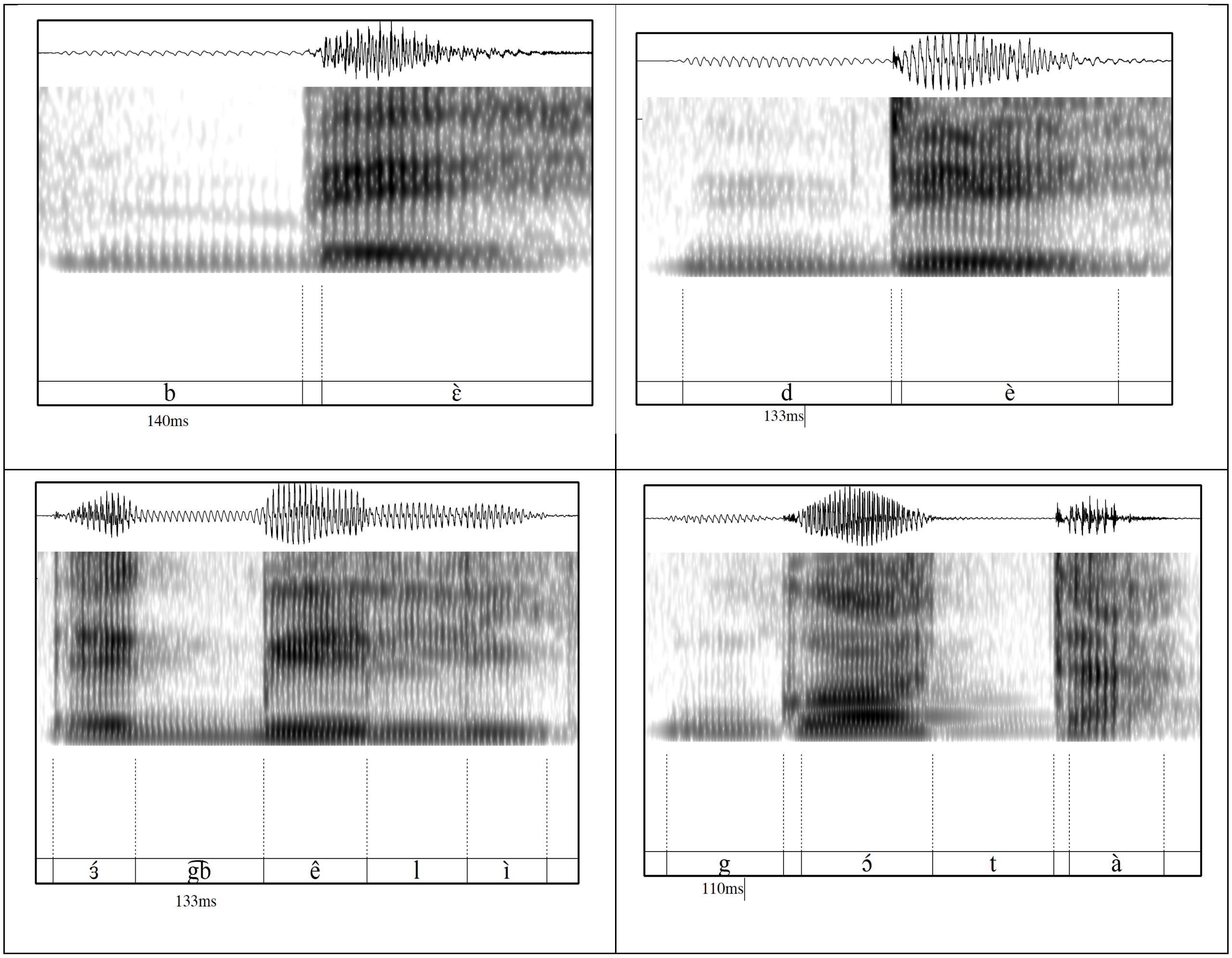


Figure 5.2: VOT for voiced stops

5.2.2 Results

The table provides a summary of the average of the two tokens for each speaker. Speaker 2 has longer VOT times on average than Speaker 1.

Table 5.2 VOT measurements

	Speaker 1 (EO)		Speaker 2 (VOY)	
	Voiceless	Voiced	Voiceless	Voiced
Labial	19.5 ms	-140 ms	25 ms	-125 ms
Alveolar té	15 ms	-140 ms	33 ms	-119 ms
Velar	43 ms	-110 ms	52 ms	-136 ms
Labial-velar	12 ms	-140 ms	38 ms	-87 ms

For both speakers, voiceless velar sounds have the longest VOT, while the speakers vary on the VOT duration for the other sounds. For Speaker 1, labial-velar stops have the shortest VOT, but for speaker 2, labial-velar stops have the second longest VOT. For Speaker 1, labials are longer than alveolars, but for speaker 2, labials are the shortest. For Speaker 1, the voiced stops have similar negative VOT values and do not differ much by place of articulation, except for velars, which have the shorted lead VOT. However for speaker 1, velars are the longest.

5.2.3 Discussion

Gua exhibits a two way contrast between voiced and voiceless unaspirated stops. The results show a prevoicing VOT that ranges between -110ms and -140ms for Speaker 1 and -87ms to -136ms for Speaker 2. These duration values are relatively long for true voicing languages (Chodroff et al 2019, Cho et al 2019). The positive VOT ranges between 12ms to 43ms for Speaker 1 and 25ms to 52ms for Speaker 2. Despite the longer positive VOT values for Speaker 2, these measurements do not reach the long-lag values for aspirating languages such as English, whose mean VOT is 94ms (Cho et al 2019). Gua patterns more like the true VOT languages (voicing vs. short-lag aspiration) with negative and positive VOTs. The results also indicate that there is not an aspiration distinction in Gua as reported by Obiri-Yeboah (2013). That study was based on impression; this instrumental analysis is more accurate.

Gua matches the typological pattern where velar sounds have the longest VOT (Abramson and Whalen 2017, Cho et al 2019). However, there is variation between the speakers for the VOT of the other voiceless sounds. For the voiced sounds, Chodroff et al (2019) report that velars tend to have the shortest negative VOT values and labials the longest crosslinguistically. Speaker 1 matches this pattern. However, there are languages which diverge from this pattern and dorsals have the longest negative VOT, the pattern that Speaker 2 exhibits. More research is needed to get a fuller picture of VOT as well as individual variation. However, I conclude that Gua shows a voiced vs. voiceless unaspirated distinction.

5.3 Distribution of Consonants

This section discusses the distribution of the consonants within words. It accounts for possible combinations of sounds and those with restrictions on their occurrence.

5.3.1: Distribution of Consonants: Plain and Nasal Consonants

All the phonemic consonants including nasals in Gua can occur intervocalically and in word initial position. The only word-final sound permitted is /m/, and this is only observed in few native words, loan words and at least one ideophone. The examples in (9) show a native word in (9a), ideophone in (9b), and cases involving loan words have been cited in chapter 2 of this dissertation.

(9) a. ɜ́nű́m̀ ‘elder/Anum town’

b. k͡pő́m̀ ‘ideophone for noise made when an object bursts’

The absence of word-final nasal consonants is largely due to the development of nasal vowels from oral vowels that previously occurred before nasal consonants in South Guang languages, and the nasal consonants were then dropped word-finally, resulting in nasal vowels in the final syllable as compared to North Guang and Proto-Guang (Painter 1967); North Guang languages still have the nasal consonants word finally.

All the nasal consonants can occur in medial coda[26] position. Word medial codas share the same place of articulation with the following consonant. The examples in (10) illustrate these patterns with the alveolar nasal in (10a), velar nasal in (10b), palatal nasal in (10c) and labial-velar nasal in (10d). A labiodental nasal coda is also illustrated in (10e) while labial nasal occurs in (10f). The examples in (10g) and (10h) show that the nasals occur before not just obstruents, but sonorants as well. Apart from nasals, no other consonants occupy the coda position within words. It must be noted that [ɱ] only occurs before /f/ in the language, hence it is an allophone.

(10)	a. ɜ̀nɛ̃́ńtèmí	‘a deer’
	b. ɜ́dʑɔ̃̀ŋ̀kú	‘hip’
	c. dɜ̃̀ɲ̀tɕĩ́	‘turn!’
	d. nɜ̃́ŋ͡ḿk͡pǒːmí	‘ankle’
	e. mɛ̃́ɱ́fɔ̀	‘I did not wash’
	f. mɛ̃́ḿbɛ̀	‘I did not come’
	g. mɛ̃́ńlʊ́lwɛ̀	‘I did not prepare’
	h. mɛ̃́ɲ́ɲĩ́nã́tɕĩ̀	‘I did not melt’

[26] See chapter 2 for arguments that support the fact that the word-internal N in NC sequence are codas.

5.3.2 Distribution of Consonants: Labialized Consonants and Round Vowels

Aside from the plain consonants, the labial consonants can occur in word-initial and medial position except /fʷ/ which can only occur in word medial position after a vowel or consonant.

Round vowels do not occur after labialized consonants although I had previously incorrectly transcribed ŋṹ as ŋʷú (Obiri-Yeboah 2013). It points to a general restriction crosslinguistically where round vowels are barred from occurring after labialized consonants (Kim 2010). In contrast, apart from /p/ which does not have round vowels following it, round vowels occur after all plain consonants in Gua. Dakubu (1988) notes that Gua and other South Guang languages lack the sound /p/. In Gua, /p/ only occurs in a few limited words. Therefore, the absence of /p/ preceding a round vowel may be an accidental gap. The examples in (11) show cases where round vowels follow plain consonants.

(11)	a. bʊ̀	‘has’	tʊ́	‘gourd’
	b. kú	‘hole’	fɔ̀	‘wash!’
	c. t͡ɕù	‘take!’	d͡ʑò	‘wait!’
	d. sɔ̀	‘buy!’	hɔ́	‘water.v!’
	e. nɔ́	‘farm’	ɲɔ̀	‘lite/drive (fufu)
	f. ŋú	‘head’	mʊ́	‘he/she’
	g. lʊ́	‘hernia’		
	h. gɔ̂ː	‘cemetery’		
	i. ɜ̀ló	‘squirrel’		

Also, although round vowels cannot follow labialized consonants in Gua, round vowels following the bilabial glide /w/ are permitted in the language. The examples in (12) shows the presence of round vowels following the bilabial glide.

(12) a. wʊ́ ‘You’

b. wù ‘die!’

c. wɔ̀ ‘pound!’

d. wó ‘ideophone – a sound made by a barking dog’

Although there are clear distinctions between the labialized consonants, some of them are restricted in their occurrence. First, there appears to be restriction on the occurrence of /g/ and /gw/. While /g/ only occurs before back round vowels, /gw/ does not occur before round vowels or front vowels. There are examples such as gɔ́ʊ̀ ‘cemetery’, ɜ̀gùmã́ ‘play’ for /g/ while only /a/ vowels can occur after the voiced labialized velar stop /g^{w}/, eg. g^{w}à ‘run’. /ŋ^{w}/ and /ŋ͡m^{w}/ also have limited distributions. While only /a/ follows /ŋ^{w}/, ŋ^{w}à ‘gobble!’, /ŋ͡m^{w}/ can only be followed by /a/ and /ɛ/. Examples of /ŋ͡m^{w}/ include ŋ͡m^{w}ɛ̃́ ‘life’, àŋ͡m^{w}ã́ ‘fist’.

5.3.3 Distribution of Consonants: Free Variation

Gua has free variation for two consonants; for [l] and [r]. Free variation in the language occurs intervocalically. The consonant [l] occur in both word initial and medial positions while [r] occur intervocalically in word medial positions only. This suggests that /l/ has two allophones: [l]. It is in free variation intervocalically. Examples that illustrate free variants in Gua are cited in (13) below where (13a-d) shows cases with [l] ~ [r] variants. The examples in (13 e-g) illustrate cases where the [l] also occur word-initially without alternation.

(13)	a. hʊ̀lɔ̂:	hʊ̀rɔ̂:	'finger-nails'
	b. hílè	hírè	'River Volta'
	c. hɔ̀lɛ́	hɔ̀rɛ́	'water.v'
	d. jìlɛ́	jìrɛ́	'hide!'
	e. lé		'song'
	f. lʊ́		'hernia'
	g. lʊ̀lʷɛ́		'prepare/make ready!'

Related languages show similar free variation with [r]~[l]. Akan has free variation that shows variants for /r/ as [l, d, r] in words like *akɔraa, akɔlaa, akɔdaa* 'a child' (Dolphyne 1988, Abakah 2004). This is typically found in the Asante dialect of Akan. In Nkami and Lɛtɛ, there is also free variation between [r] and [l]. Asante (2016) cites cases like *tɪlɪ ~ tɪrɪ* 'goat', *ntʃulo ~ ntʃuro* 'source of water' as free variants in Nkami.

5.4 Phonological Processes and consonant-consonant and consonant-vowel interactions

Gua exhibits several phonological processes that operate between consonants, and consonants and vowels. In this section, I will present data that illustrates nasal place assimilation (NPA), homorganic nasal assimilation (HNA), and consonant and vowel deletion. These phonological processes occur in different morphological environments, including nouns and verbal paradigms. To give a preview, the 1SG verb forms that exhibit these processes are given below. The 1SG has two allomorphs, N- and mí-. Other prefixes that indicate TAM or negation are also provided. Nasal place assimilation is found in the past forms and the negative forms. Vowel deletion and homorganic nasal assimilation are found in the future forms. Consonant deletion is found in the negative forms. There are also processes affecting vowel sequences, such as glide formation and deletion. Tones are grammatical and will be not be addressed here – see chapter 7 for an explanation of their distribution.

Table 5.3 Paradigm of 1SG forms

	Prefixes	Affirmative		Prefixes	Negative	
		‘roll up’	‘read’		‘roll up’	‘read’
Present	mí-	míbɔ̀tɛ̀	míkàlì	N-bɛ́-	mɛ̀bɔ̀tɛ̀	mɛ́kàlì
Past	Ǹ-	m̀bɔ́tɛ̀	ŋ̀kálì	N-bɛ́-N-	mɛ́ḿbɔ́tɛ̀	mɛ́ŋ́kálì
Future	mí-bɛ̀-	ḿmɛ̀bɔ́tɛ̀	ḿmɛ̀kálì	N-bɛ́-bɛ̀-	mɛ́ɛ̀bɔ́tɛ̀	mɛ́ɛ̀kálì
Progressive	mí-ɛ̀ɛ́-	mjɛ̀ɛ́bɔ̀tɛ̀	mjɛ̀ɛ́kàlì	N-bɛ́-ɛ̀ɛ́-	mɛ̀ɛ́bɔ̀tɛ̀	mɛ̀ɛ́kàlì
Perfective	mí-ɛ́ɛ̀-	mjɛ́ɛ̀bɔ̀tɛ̀	mjɛ́ɛ̀kàlì	N-bɛ́-ɛ́ɛ̀-	mɛ́bɔ́tɛ̀	mɛ́kálì

Before beginning, the following verb template will be assumed that shows the order of affixes, where COMPL = completive: SUBJ(sg)-NEG-TAM-COMPL-ROOT

5.4.1 Nasal Place Assimilation (NPA)

Nasal place assimilation is a process that causes a nasal consonant to share the same place of articulation with a neighboring consonant, usually a following oral consonant. In Gua, nasal place assimilation occurs due to the addition of a noun class prefix, and verbs in some tense-mood-aspect (TAM) constructions. Within nouns, there is a nasal prefix that marks plurality for one class of nouns. The nasal consonant takes the same place of articulation as the following oral consonant (14), either obstruent or sonorant.

	Singular Nouns		**Plural Nouns**	
(14)	a. ɜ̀-bòbí	'a bird'	m̀-bòbí	'birds'
	b. ɜ̀-tèbí	'an animal'	ǹ-tèbí	'animals'
	c. ɜ̀-lèbí	'a child'	ǹ-lèbí	'children'
	d. á-kìrɛ́nì	'chicken'	ŋ́-kìrɛ́nì	'chicken'
	e. à-k͡pɔ̀lí	'ladle'	ŋ͡m̀-k͡pɔ̀lí	'ladles'
	f. á-bíè	'a chair'	ḿ-bíè	'chairs'

Like their noun counterparts in (14), when the root begins with a consonant, the nasal consonant of the first person singular subject prefix shares the same place of articulation with the initial consonant of the root in the past tense (15). In these examples, the initial verb root consonants are all oral, but include fricatives and affricates in addition to stops. In (15f) we observe that the nasal prefix is [n] before /h/, which suggests that this may be the underlying form of the prefix or the default place of articulation when the following consonant has no place of articulation specified, a common assumption for laryngeal consonants. I will assume the latter analysis and treat the nasal prefix as /N-/, unspecified for place. The past forms are compared with the present/habitual to show that the nasal consonant must be adjacent to the root consonant to undergo assimilation. There are two allomorphs of the 1st person prefix used in different TAM constructions; mɪ- is used in the present/habitual, and N- is used in the past.

	Present/Habitual		**Past**	
(15)	a. mí-bɔ̀tɛ̀	'I roll (a mat) up'	m̀-bɔ́tɛ̀	'I rolled (a mat) up'
	b. mí-fʊ̀t͡ɕì	'I sweep'	ɱ̀-fʊ́t͡ɕì	'I swept'
	c. mí-sɔ̀tɛ̀	'I catch (a falling object)'	ǹ-sɔ́tɛ̀	'I caught (a falling object)'

d. mí-kàlì	'I read'	ŋ̀-kálì	'I read'
e. mí-k͡pʊ̀tɛ̀	'I separate (a fight)'	ŋ͡m̀-k͡pʊ́tɛ̀	'I separated (a fight)'
f. mí-hè	'I fall'	ǹ-hè	'I fell'
g. mí-tɕì	'I watch/look'	ɲ̀-tɕì	'I watched/looked'

Given that the 1SG present/habitual forms have a CV singular pronoun whereas the past forms have a single segment pronoun, the question is raised whether the past pronouns are derived from the CV forms via deletion, thus feeding the nasal place assimilation for 1SG, that is /mɪ/ → [m]. Two hypotheses are explored with respect to what may account for the identity of the singular subject pronoun. Hypothesis A states that the single segment forms are derived via deletion – the vowel is deleted in mɪ. Hypothesis B states that the past tense forms are just the way that singular forms are expressed in the past tense. They are allomorphs of the singular subject pronouns that appear in the past tense due to a selectional restriction. To assess the two analyses, the 2SG and 3SG data are considered, too.

The 2SG has two different allomorphs: wʊ- and ɔ-. In the present/habitual tense/aspect, both 1st and 2nd singular persons have a CV prefix; however, in the past tense form, they have a single segment prefix, a nasal consonant N- in the first person, and a single vowel V- in second and third person. The 3SG pronouns are segmentally identical, but differ in tone. The first person nasal pronominal marker shares the same place of articulation with the following consonant in the past tense construction (16a). The TAM tones are grammatical and the subject tones alter in accordance with the following tone (See chapter 7).

		Present/Habitual	Past
(16)	a.	mí-bɔ̀tɛ̀	m̀-bɔ́tɛ̀
		'I roll (up)'	'I rolled (up)'
	b.	wʊ́-bɔ̀tɛ̀	ɔ̀-bɔ́tɛ̀
		'You roll (up)'	'You rolled (up)'
	c.	á-bɔ̀tɛ́	à-bɔ́tɛ̀
		'S/he roll (up)'	'S/he rolled (up)'

The following arguments point to the fact that Hypothesis B separately listed allomorphs, is the most probable option for the forms. First, there is no unifying deletion rule that would delete a vowel in one form /mɪ/ → m and a consonant in another /wʊ/ → ɔ (a vowel bears a mora but a consonant does not in onset position). Second, there is the additional lowering of the vowel in 2SG for which there is no clear explanation – it is not conditioned by the verb stem. Third, there is no reduction in the plural forms. If deletion applied to the past tense prefixes to produce the single segment forms, we might expect it to apply to the plural forms as well, but this is not the case as shown in the examples in (17).

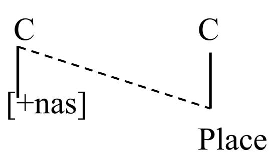
			Present			Past
(17)	a. ɛ̀ní + bɔ̀tɛ̀	→	ɛ̀ní bɔ̀tɛ̀	ɛ̀ní + bɔ́tɛ̀	→	ɛ̀ní bɔ́tɛ̀
			'We roll (up)'			'We rolled (up)'
	b. ɛ́nì + bɔ̀tɛ̀	→	ɛ́nì bɔ̀tɛ̀	ɛ́nì + bɔ́tɛ̀	→	ɛ́nì bɔ́tɛ̀
			'You(pl) roll (up)'			'You(pl) rolled (up)'
	c. ɛ̀mʊ̀ + bɔ̀tɛ̀	→	ɛ̀mʊ̀ bɔ̀tɛ̀	ɛ̀mʊ̀ + bɔ́tɛ̀	→	ɛ̀mʊ́ bɔ́tɛ̀
			'They roll (up)'			'They rolled (up)'

The absence of any deletion changes in the plural pronouns suggest that they are independent words[27], but the singular subject allomorphs are prefixes. We assume that they are prefixes due to their interaction with the verb in terms of assimilation and tone dependency (see chapter 7). Hence, we conclude that the singular subjects in the past tense forms in example (16) are allomorphs of their full form counterparts in the present forms. We shall see that other TAM forms select from these two sets.

(18) Allomorphs of Singular Subject Pronouns

Set 1	1SG mɪ-	2SG wʊ-	3sg a-
Set 2	1SG N-	2SG ɔ-	3sg a-

In both the noun and the verb forms, the nasal prefixes are attached directly to the verb roots. The phonological rule that captures homorganic nasal place assimilation is illustrated with an autosegmental rule following Paster (2010). The autosegmental rule illustrates that the place feature of the consonant is transferred to the nasal consonant that occurs before the obstruents.

(19)


Nasal place assimilation in Gua is different from other reported cases in related Guang languages like Nkami (Asante 2016) and the most widely spoken Ghanaian language, Akan (Dolphyne 1988) which show assimilation of both place and nasality. In these languages, nasal

[27] Indeed, cross-word vowel harmony only affects the final vowel; if they were prefixes, both vowels should be affected.

place assimilation causes the plural nasal marker to share the same place of articulation with the initial consonant of the root, and if the initial consonant is a voiced obstruent, it changes from obstruent to nasal. In Nkami, nasal place assimilation applies to roots with obstruents. When the following consonant is voiceless, the voiceless consonant does not become nasal, it remains voiceless as illustrated in (20). In example (20) from Asante (2016:83), all the roots start with nasal plural markers and the plural marker assumes the place of articulation feature of the initial consonants of the roots.

(20) **Nkami nasal place assimilation**

a. N-pa	→	m-pa	'beds'
b. N-frɛlɪɪ	→	ɱ-frɛlɪɪ	'bush cattle'
c. N-sɪkã	→	n-sɪkã	'cutlasses'
d. N-tʃebi	→	ɲ-tʃebi	'cloths'
e. N-kɪlɛtɪ	→	ŋ-kɪlɛtɪ	'cats'
f. N-kosi	→	ŋ-kosi	'yam mounds'

However, when the consonant that starts the root is voiced, the oral consonant also becomes nasal. As the examples in (21) below show, Nkami has NPA application in plural nouns and nasalization of the following oral consonant, creating a geminate.

(21) **Nkami nasal assimilation**

a. m-bɪrɪsɛ	→	m-mɪrɪsɛ	'elders'
b. n-dɔlɪ	→	n-nɔlɪ	'soil'
c. n-dɔ	→	n-nɔ	'farms'

d. ɲ-yi → ɲ-ɲi 'trees'

e. ɲ-yebi → ɲ-ɲebi 'children'

Akan has a similar pattern as indicated in Dolphyne (1988). In Akan, just like Nkami, Dolphyne shows that partial assimilation takes place between the nasal and the voiceless oral consonant where both sounds share the same place of articulation, but different manner (22).

(22) **Akan nasal place assimilation**

a. asɛm + hunu → ase**nh**unu

news/settle empty 'nonsense'

b. N- + pam → **mp**am

NEG sew 'don't sew'

c. N- + tu → **nt**u

NEG dig 'don't dig it up'

d. ɔ- + N + kɔ → ɔ**ŋk**ɔ

3SG NEG go 'he doesn't go'

e. ataade(ɛ) ntaade(ɛ)

'dress' 'dresses'

However, when the oral consonant is voiced, total assimilation applies where both the nasal and oral consonants share the same place and manner of articulations. The oral voiced stop becomes nasal. Examples are illustrated in (23) below.

(23) **Akan nasal assimilation**

a. asɛm +	di	→	ase**nn**i
news/settle	eat		'judgment'
b. N +	bu	→	mmu
NEG +	break		'don't break'
c. N +	gyina	→	ŋŋina
NEG	stop/stand		'don't stop/stand'

Nasal place assimilation in Gua has been discussed in this section. The patterns identified are in past tense (for first-person singular subject pronoun) constructions and plural markers in nouns. The interactions between the nasal consonant and the oral consonants in Gua for nasal place assimilation focuses on assimilating only the place feature of the nasal consonant to the oral consonants that begins the root whereas in related languages, voiced oral stops undergo nasal assimilation.

5.4.2 Homorganic Nasal Assimilation

In this section, we will consider nasal assimilation, specifically Homorganic Nasal Assimilation (HNA). HNA in Gua applies when the first person singular subject pronoun mí 'I' occurs before the future marker bɛ̀-. First, there is the deletion of the vowel so that the [m] and [b] come together and the [m] causes nasalization of the oral stop. The examples in (24a) show the application of HNA in first person constructions, as compared to 2SG and 3SG, so that the unassimilated form of /bɛ̀-/ can be seen.

(24)	PRO		FUT		VERB		
	a. mí	+	bɛ̀-	+	bɔ́tɛ̀	→ ḿmɛ̀bɔ́tɛ̀	‘I will roll (up)’[28]
	b. wʊ́	+	bɛ̀-	+	bɔ́tɛ̀	→ wʊ́bɛ̀bɔ́tɛ̀	‘You will roll (up)’
	c. á-	+	bɛ̀-	+	bɔ́tɛ̀	→ ábɛbɔ́tɛ̀	‘S/he will roll (up)’

The examples in (25) illustrate additional application of HNA in first person constructions in Gua. In all cases the first person singular subject prefix reduces to ḿ- and the bilabial stop in the future marker assimilates to the nasal feature of the preceding bilabial nasal pronoun.

(25)	a. mí	+	bɛ̀-	+	bɛ́	→ ḿmɛ̀bɛ́	‘I will come’
	b. mí	+	bɛ̀-	+	d͡ʑí	→ ḿmèd͡ʑí	‘I will eat’
	c. mí	+	bɛ̀-	+	k͡pɔ́lì	→ ḿmɛ̀k͡pɔ́lì	‘I will clean’
	d. mí	+	bɛ̀-	+	bólì	→ ḿmèbólì	‘I will break’

Apart from first person singular constructions, no other phonological changes are observed that affect consonants in the paradigm. In the examples below in (26) and (27), examples of the second person singular and third person singular future forms are shown.

(26)	PRO		FUT		VERB		
	a. wʊ́	+	bɛ̀-	+	bɛ́	→ wʊ́bɛ̀bɛ́	‘You will come’
	b. wʊ́	+	bɛ̀-	+	d͡ʑí	→ wúbèd͡ʑí	‘You will eat’
	c. wʊ́	+	bɛ̀-	+	k͡pɔ́lì	→ wʊ́bɛ̀k͡pɔ́lì	‘You will clean’

[28] This suggests mora preservation. Here the vowel deletes, but leave its mora and tone behind, which is then recuperated by the nasal consonant, creating the syllabic ḿ seen here.

d. wʊ́ + bɛ̀- + bólì → wúbèbólì ‘You will break’

(27) PRO FUT VERB

a. á- + bɛ̀- + bɛ́ → ábɛ̀bɛ́ ‘He/she will come’

b. á- + bɛ̀- + d͡ʑí → ɜ́bèd͡ʑí ‘He/she will eat’

c. á- + bɛ̀- + k͡pɔ́lì → ábɛ̀k͡pɔ́lì ‘He/she will clean’

d. á- + bɛ̀- + bólì → ɜ́bèbólì ‘He/she will break’

For completeness, (28) presents cases with plural subject pronouns. None of the examples here shows deletion of the final vowel and subsequent application of HNA. Only single segment pronoun prefixes with either a C or a V or monosyllabic CV can be affixed onto the verb stem. Unlike the pronoun prefixes, since the plural forms are full words by themselves whose final vowels do not appear to be deleted, there is no interaction between the pronouns and the future marker which is part of the verb stem. They are separate words.

(28) PRO FUT VERB

a. ɛ̀ní + bɛ̀ + bɛ́ → ɛ̀ní bɛ̀bɛ́ ‘We will come’

b. ɛ́nì + bɛ̀ + bɛ́ → ɛ́nì bɛ̀bɛ́ ‘You.pl will come’

c. ɛ̀mʊ́ + bɛ̀ + bɛ́ → ɛ̀mʊ́ bɛ̀bɛ́ ‘They will come’

The examples in (29) show singular and plural noun forms where sequences of [mb] arise in the plural due to NPA, but no application of HNA. This suggest that HNA in Gua only applies between the nasal pronoun prefix and the future marker that starts with the bilabial consonant [b]. HNA application in Gua only takes place between two prefixes but not between prefixes and a root/stem. Similar patterns are observed in verbs with the first person subject pronoun prefix N- in (30) below which shows that the N- becomes a bilabial nasal, the same place of articulation with the following nasal. Like the nouns, HNA did not apply in those contexts either.

(29)	a. ɜ́bíè	‘chair’	ḿbíè	* ḿmíè	‘chairs’
	b. ɜ̀bòbí	‘a bird’	m̀bòbí	* m̀mòbí	‘birds
	c. ábwî	‘goat’	ḿbwî	* ḿmwî	‘goats’
	d. àbɛ́lì	‘whistle’	m̀bɛ́lì	* m̀mɛ́lì	‘whistles’
(30)	a. N +	bólì	m̀bólì	* m̀bólì	‘I broke’
	b. N +	bíè	m̀bíè	* m̀bíè	‘I bathed’
	c. N +	b^{w}ɛ̀	m̀b^{w}ɛ̀	* m̀b^{w}ɛ̀	‘I did (it)’
	d. N +	bùtɕí	m̀bútɕì	*m̀bútɕì	‘I opened’

There are two arguments in support of vowel deletion from /mɪ/ rather than assuming the prefix is N- instead. First, the full CV form of the second singular subject pronoun wʊ́- as well as the future marker bɛ́- are realized in the second person future construction. Given that singular pronouns tend to have identical shapes in paradigms, this supports the selection of mí- in the first person construction rather than N-. As noted earlier, subject prefixes are monosyllabic or shorter. Otherwise they appear as separate words. Second, the reduction of a CV leads to a syllabic nasal with high tone [ḿ-], suggesting a recuperation of the high tone of the 1SG mí- on the nasal. We shall see shortly that when the negative marker N- occurs before the future prefix bɛ́, the result is instead a single consonant [m] in onset position rather than [ḿm].

Although the occurrence of [mb] sequence involving the first person singular subject pronoun results in HNA in the future, the process does not apply to other cases with [mb] sequences, as we saw with plural nouns and past tense forms. Furthermore, there is no vowel deletion when mɪ- is positioned before a verb root in the present/habitual form. These two processes occur in the future and are due to the sequencing of two prefixes. Independent evidence that high vowels are prone to deletion can be found in Gua. In Chapter two, I showed that high vowels delete in CVrV contexts. In chapter 6, I will show how the final [ʊ] of the object pronoun mʊ̀ also deletes.

The two rules are provided below. The prefix boundaries are indicated with +. Vowel deletion with moraic representation indicates that a vowel deletes before the prefix that starts with the bilabial sound but the mora is conserved. This allows the [m] to be syllabic and bear the tone that was on the vowel. The HNA rule depicts that the obstruent in the future prefix takes the manner feature of the nasal prefix preceding it.

(31) Vowel deletion /V/--> $\varnothing$ / m__+ b

μ μ μ μ
╪ | | |
m V + b V + → m b V
[+high,
-back]

(32) Homorganic Nasal Assimilation /b/ --> [m] / m __ V +

m + b V +
[+nas]
Lab

The derivation in (33) shows that the vowel deletion rule applies before the application of HNA. HNA applies following reduced [ḿ] but does not apply following the past tense nasal prefix. NPA is shown following HNA or that HNA is blocked from applying to the root consonant.

(33)

		1SG future	1SG present	1SG past
	Underlying Form	/mí + bɛ̀ + bɔ́tɛ̀/	/mí + bɔ̀tɛ̀/	/Ǹ-bɔ́tɛ̀/
	V-Deletion	ḿbɛ̀bɔ́tɛ̀	--	--
	HNA	ḿmɛ̀bɔ́tɛ̀	--	--
	NPA	--	--	m̀bɔ́tɛ̀
	Surface Form	[ḿmɛ̀bɔ́tɛ̀]	[míbɔ̀tɛ̀]	[m̀bɔ́tɛ̀]

HNA application is possible in Gua, but its application is extremely limited and restricted between the reduced first person subject pronoun ḿ- and the future maker bɛ̀-. It only occurs between prefixes. While NPA is shown following HNA in (33), it is more likely HNA is blocked from applying between a prefix and a root rather than being due to crucial rule ordering. All other pronouns that occur before the future marker bɛ̀- are not affected. The application of HNA in Gua is different from what is observed in Nkami and Akan. As was shown in section 5.4.1 while [mb] sequences trigger HNA in Nkami (Asante 2016) and Akan (Dolphyne 1988), HNA in Gua applies only to sequences of prefixes, but does not apply to the prefix-root boundary. Moreover, the vowel deletion rule also seems to be sensitive to the prefixal nature of the trigger, as it does not apply in the present tense, where the mɪ- appears directly before the root.

5.4.3 Deletion

This section discusses cases in which the 1SG nasal prefix causes deletion of a [b] consonant from the following negative prefix bɛ́-. This is a third type of interaction between the 1sg and a following obstruent.

In present/habitual constructions, the full form of subject pronouns is maintained for all cases. However, in the present/habitual negative constructions, the forms of the singular subject pronominals are the same as those that were attested in the past tense – namely N-, ɔ- and a-. However, the initial [b] of the negative marker is not present in the 1SG, and instead [m] is found. The form of the negative prefix can be deduced by examining the other forms.

	Present/Habitual			**Negative of present/habitual**		
(34)	a. mí- + bɔ̀tɛ̀	→	míbɔ̀tɛ̀	Ń- + bɛ́- + bɔ̀tɛ̀	→	mɛ́bɔ̀tɛ̀
	1SG roll up		'I roll up'	1SG NEG roll		'I do not roll up'
	b. wʊ́- + bɔ̀tɛ̀	→	wʊ́bɔ̀tɛ̀	ɔ́- + bɛ́- + bɔ̀tɛ̀	→	ɔ́bɛ́bɔ̀tɛ̀
	2SG roll up		'You roll up'	2SG NEG roll		'You do not roll up'
	c. á- + bɔ̀tɛ̀	→	ábɔ̀tɛ̀	á- + bɛ́- + bɔ̀tɛ̀	→	ábɛ́bɔ̀tɛ̀
	3SG roll up		'S/he rolls up'	3SG NEG roll		'S/he does not roll up'

When the pronoun is attached before the negative marker, the nasal undergoes place assimilation and then the bilabial stop [b] of the negative marker deletes. Another possible analysis is that there is fusion between the two bilabial sounds leaving a single bilabial nasal consonant (Pater 1999). I adopt the deletion rule here. The behavior of the m-b sequence in these examples contrasts with that of the N-b sequence in the past tense, where only nasal assimilation is observed to produce [m̀b], and with the future, where /mí-b/ resulted in [ḿm]. Note that the nasal in the negative present is in an onset position and so does not bear tone.

The phonological rule that applies to these forms is given in (35) below. The + indicate the prefix boundaries, as this is a rule that applies uniquely to a prefix following another prefix.

(35)

b-deletion

/b/ --> ∅ / m + ___ V +

This rule is ordered after NPA so that the labial quality of the [b] is preserved on the nasal.

In the case of negative past tense constructions, the singular subject pronoun allomorphs are also 1SG N-, 2SG ɔ́- and 3SG á-. In addition, the past negative construction also has a nasal consonant [N], a completive prefix, which conveys completion of a task. It assimilates in place to the following root consonant, but like in past tense forms, a root consonant [b] does not delete. In the first person form, the /b/ of the negative marker deletes after the bilabial nasal of the first person singular pronoun, and only a single bilabial nasal remains: /m-bɛ-N-/ → [mɛ́m-], just like the negative present forms.

		Past Tense		**Negative Past Tense**	
(36)	a.	m- + bɔ́tɛ̀ →	m̀bɔ́tɛ̀	m- + bɛ́-Ń- + bɔ́tɛ̀ →	mɛ́ḿbɔ́tɛ̀
		1SG roll up		1SG NEG-COMPL roll.PST	
		'I rolled up'		'I did not roll (up)'	
	b.	ɔ́- + bɔ́tɛ̀ →	ɔ̀bɔ́tɛ̀	ɔ́- + bɛ́-Ń- + bɔ́tɛ̀ →	ɔ́bɛ́ḿbɔ́tɛ̀
		2SG roll up		2SG NEG -COMPL roll.PST	

	‘You rolled up’		‘You did not roll (up)’	
c. á- + bɔ́tɛ̀ →	àbɔ́tɛ̀		á- + bɛ́-Ń- + bɔ́tɛ̀	→ ábɛ́ḿbɔ́tɛ̀
	3SG roll up		3SG NEG-COMPL roll.PST	
	‘S/he rolled up’		‘S/he did not roll (up)’	

The first person nasal consonant allomorph in past tense and the completive morpheme in the negative construction share the same place of articulation with the initial consonants of the roots they precede. The examples in (37) below show bilabial nasal in (37a), alveolar nasal in (37b), velar nasal in (37c), labiodental nasal in (37d) and labial-velar nasal in (37e) because of the place value of the initial consonant of the root. There is application of NPA with the completive markers assimilating to the place feature of the following consonant. Also, in all cases in (37) that involves the first person singular subject pronoun, the bilabial stops of the negative marker delete or fuse with the bilabial nasal of the first person singular subject.

(37)	a. m̀-bɔ́tɛ̀	‘I rolled up’	mɛ́-ḿ-bɔ́tɛ̀	‘I did not roll up’
	b. ǹ-sɔ́tɛ̀	‘I caught (a falling object)’	mɛ́-ń-sɔ́tɛ̀	‘I didn’t catch (falling object)’
	c. ŋ̀-kálì	‘I read’	mɛ́-ŋ́-kálì	‘I did not read’
	d. ɱ̀-fʊ́t͡ɕì	‘I swept’	mɛ́-ɱ́-fʊ́t͡ɕì	‘I did not sweep’
	e. ŋ͡m̀-k͡pʊ́tɛ̀	‘I separate (a fight)’	mɛ́-ŋ͡ḿ-k͡pʊ́tɛ̀	‘I did not separate (a fight)’

So far, we have observed that there is interaction between the singular pronoun prefixes and the negative prefix. However, unlike the application of HNA in section 5.4.2, the output here is different. With the negative constructions, the bilabial stop of the negative marker deletes, leaving a single bilabial nasal, whereas with HNA, the nasal pronoun caused nasal assimilation of the following /b/, creating a geminate [mm]. The table below shows the forms that exist in the various TAM forms and illustrates the rule applications so far.

Table 5.4: Phonological Derivation of interactions between pronoun and negative prefixes

TAM\Affix	Subject + Prefixes +Root	Rule Application
Present/Habitual	mí-bɔ̀tὲ	----
Past	Ǹ-bɔ́tὲ → m̀bɔ́tὲ	NPA
Future	mí-bὲ-bɔ́tὲ → ḿmὲbɔ́tὲ	V-deletion and HNA
Present/Habitual Negative	Ń-bέ-bɔ̀tὲ → mέbɔ̀tὲ	NPA and b-deletion
Past Negative	Ń-bέ-Ń-bɔ́tὲ → mέḿbɔ́tὲ	NPA and b-deletion

I now turn to the final forms to be presented and analyzed: progressive, perfective and future negative. Future tense constructions have the future marker bὲ-, a prefix that precedes the root. We have already seen the future construction in section 5.4.2. Recall that the full form of both the singular subject pronoun and the future markers are realized in both second- and third-person singular subject pronouns in the affirmative constructions (38b-c). However, with the first person singular subject pronoun mí-, the vowel in the pronoun deletes and the bilabial stop assimilates to the nasal just like the nasal pronoun in the affirmative constructions (38a). But in their negative counterparts, the first person marker is N-, like in all the negative forms, so [b] deletion occurs. Furthermore, the sequence of two bɛ- prefixes triggers deletion of the [b] of the second prefix. The result is a long vowel with falling tone, an amalgamation of the high tone of the negative marker and the low tone of the future marker. The presence of this HL tone shows that the order of the prefixes is NEG-FUT. The NEG prefix also precedes other TAM markers (such as PROG and PERF to be shown below). It is also observed that [b] deletion applies only to this sequence, and not just when [b] occurs between two vowels that are both part of prefixes, as can be seen from the non-negative 2SG and 3SG future forms, where á-bɛ̀ is fine, or to prefix-root combinations with the same vowels, such as bɛ̀-bɛ́ (FUT-come). The examples in (38) below provide further illustration of the patterns.

	Future Tense			Negative Future Tense		
(38)	a. mí- + bɛ̀- + bɔ́tɛ̀	→	mmɛ̀bɔ́tɛ̀	Ń- + bɛ́- bɛ̀- + bɔ̀tɛ́	→	mɛ́ɛ̀bɔ́tɛ̀
	1SG FUT roll up			1SG NEG FUT roll.FUT		
	'I will roll up'			'I will not roll up'		
	b. wʊ́- + bɛ̀- + bɔ́tɛ̀	→	wʊ́bɛ̀bɔ́tɛ̀	ɔ́- + bɛ́- + bɛ̀- + bɔ̀tɛ́	→	ɔ́bɛ́ɛ̀bɔ́tɛ̀
	2SG FUT roll up			2SG NEG FUT roll.FUT		
	'You will roll up'			'You will not roll up'		
	c. á- + bɛ̀- + bɔ́tɛ̀	→	ábɛ̀bɔ́tɛ̀	á- + bɛ́- +bɛ̀- + bɔ̀tɛ́	→	ábɛ́ɛ̀bɔ́tɛ̀
	3SG roll up			3SG NEG FUT roll.FUT		
	'S/he will roll (up)'			'S/he does not roll up'		

The b-deletion rule applying in these forms is given here:

(39) **Intervocalic b-deletion**

/b/ --> ∅ / V_i + ___ V_i +

It is not possible to group the two b-deletion rules together as one rule as the N-bɛ- and bɛ-bɛ- environments would have to be grouped together to the exclusion of other sonorant-b prefix sequences such as [mɪ-bɛ], [ɔ-bɛ] and [a-bɛ].

In progressive aspect constructions, the progressive marker ɛ̆ː- occurs as a prefix to the root. In second person singular plural structure, the pronoun wʊ́- is selected. Vowel hiatus resolution results in [ɔ̆ː] where the rounding feature of [ʊ] is maintained in the affirmative sentence. The rounding feature is maintained here possibly because of the two round vowels in succession since similar pattern with single vowels at the juncture position results in [wɛ]. See chapter 6 of this dissertation for more on vowel hiatus patterns. The example in (40b) also shows that, there is the fusion in the negative constructions with the prefixes resulting in a [wɛ̆ː] form for the pronoun and the progressive marker where both height and ATR values are kept, while the rounding of the ʊ is also kept. In the case of the third person, there is the fusion between á- and ɛ̆ː- resulting in a long ǎː- in the progressive construction (40c). In the case of the first person singular pronoun, mĩ́ becomes mj- before ɛː (40a) which shows that the high vowel in the pronoun becomes a palatal glide, an expected pattern[29] before glides (see chapter 6).

	Progressive Aspect			**Negative Progressive Aspect**		
(40)	a. mí- + ɛ̆ː- + bɔ̀tɛ̀	→	mjɛ̌ːbɔ̀tɛ̀	Ń- + bɛ́- ɛ̆ː- + bɔ̀tɛ̀	→	mɛ̌ːbɔ̀tɛ̀
	1SG PROG roll			1SG NEG PROG roll		
	‘I am rolling up’			‘I am not rolling up’		
	b. wʊ́- + ɛ̆ː- + bɔ̀tɛ̀	→	wɔ̌ːbɔ̀tɛ̀	ɔ́- + bɛ́- + ɛ̆ː- + bɔ̀tɛ̀	→	ɔ́bɛ̌ːbɔ̀tɛ̀
	2SG PROG roll			2SG NEG PROG roll		

[29] As an example, /mí ɛ́bì/ sd--> [mjɛ́bî] ‘my palm tree’

'You are rolling up' 'You are not rolling up'

c. á- + ɛ̌ː- + bɔ̀tɛ̀ → ǎːbɔ̀tɛ̀ á- + bɛ́- +ɛ̌ː- + bɔ̀tɛ̀ --> ábɛ̌ːbɔ̀tɛ̀

3SG PROG roll 3SG NEG PROG rolling

'S/he is rolling up' 'S/he is not rolling up'

However, in negative constructions, just like the previous negative constructions, the single segment pronoun allomorphs are selected in all the constructions, hence N- in first person, ɔ́- in second person and á- in third person as illustrated in (40). But, there is a deletion of the [b] in the first person construction, a pattern that has been observed in the same environment in the negative past and habitual/present tenses. The combination of bɛ́- with ɛ̌ː- results in bɛ̌ː due to vowel hiatus resolution, with the tone pattern of the progressive; the high tone of the negative marker is not realized. This negative form behaves just like the other cases, except that due to deletion of [b] and vowel hiatus resolution, there is no overt presence of the negative prefix in the first person construction. The only way to deduce the difference between affirmative and negative 1SG is due to the presence or absence of [j]. But, in the second and third person constructions, which also select the allomorphs ɔ́- and á- respectively, the negative marker is overtly marked.

Similar patterns to those illustrated in the progressive forms are also found in the perfective constructions, with some differences. First, the perfective marker ɛ̂ː- of the verb has a falling tone and not rising tone like the progressive ɛ̌ː-. Second, the combination of the negative bɛ́ with ɛ̂ː- results in [bɛ́] with a short vowel rather than expected [bɛ̂ː]. Or, it could be that there is no perfective prefix added at all in these forms. This makes it almost identical to the negative present ɔ́bɛ́bɔ̀tɛ̀, except for the tone in the root – low-low for perfective and high-low tone for present in the bisyllabic verb. Just like the first person constructions in the negative progressive construction, the [b] in the negative marker is deleted in 1SG. The examples in (41) illustrate these.

	Perfective Aspect			**Negative Perfective Aspect**		
(41)	a. mí- + ɛ́ɛ̀- + bɔ́tɛ̀	→	mjɛ́ɛ̀bɔ́tɛ̀	m- + bɛ́- ɛ́ɛ̀- + bɔ́tɛ̀	-->	mɛ́bɔ́tɛ̀
	1SG PERF roll up			1SG NEG PERF roll.PERF		
	‘I have rolled up’			‘I have not rolled up’		
	b. wʊ́- + ɛ́ɛ̀- + bɔ́tɛ̀	→	wɔ́ɔ̀bɔ́tɛ̀	ɔ́- + bɛ́- + ɛ́ɛ̀- + bɔ́tɛ̀-->		ɔ́bɛ́bɔ́tɛ̀
	2SG PERF roll up			2SG NEG PERF roll.PERF		
	‘You have rolled (up)’			‘You have not rolled up’		
	c. á- + ɛ́ɛ̀- + bɔ̀tɛ̀	→	áàbɔ́tɛ̀	á- + bɛ́- + ɛ́ɛ̀- + bɔ̀tɛ̀	-->	ábɛ́bɔ́tɛ̀
	3SG PERF roll up			3SG NEG PERF roll.PERF		
	‘S/he has rolled (up)’			‘S/he has not rolled up’		

As observed from above in this section, there are various phonological processes that affect consonants in the interaction between TAM and negation prefixes and subject pronouns. The table in (3) summarizes the various rules that are applied in the different forms. They show patterns involving affirmative and negative constructions in habitual/present, past and future tenses, and progressive and perfective aspects. The choice of subject allomorph is morphologically determined.[30]

[30] Although there is a correlation with tone in most forms (N if following tone is H, mí if following tone is L) the perfective does not match this pattern. See chapter 7 for more on tone.

Table 5.5: Phonological Rules applying in affirmative and negative constructions

TAM	Subject + Prefixes +Root	Rule Application
Present/Habitual	mí-bɔ̀tɛ̀	----
Past	Ǹ-bɔ́tɛ̀ → m̀bɔ́tɛ̀	NPA
Future	mí-bɛ̀-bɔ́tɛ̀ → ḿmɛ̀bɔ́tɛ̀	V-deletion, HNA
Progressive	mí-ɛ̌ː-bɔ̀tɛ̀ → mjɛ̌ːbɔ̀tɛ̀	Glide formation
Perfective	mí-ɛ̂ː-bɔ̀tɛ̀ → mjɛ̂ːbɔ́tɛ̀	Glide formation
Present/Habitual Negative	Ń-bɛ́-bɔ̀tɛ̀ → mɛ́bɔ̀tɛ̀	NPA, b-deletion
Past Negative	Ń-bɛ́-Ń-bɔ́tɛ̀ → mɛ́ḿbɔ́tɛ̀	NPA, b-deletion
Future Negative	N-bɛ́-bɛ̀-bɔ́tɛ̀ → mɛ̂ːbɔ́tɛ̀	NPA, b-deletion, intervocalic b-deletion
Progressive Negative	N-bɛ́-ɛ̌ː-bɔ̀tɛ̀ → mɛ̌ːbɔ̀tɛ̀	NPA, b-deletion, vowel deletion
Perfective Negative	N-bɛ́-ɛ̂ː-bɔ̀tɛ̀ → mɛ́bɔ́tɛ̀	NPA, b-deletion, vowel deletion

This subsection has discussed affirmative and negative constructions with regards to TAM constructions and prefix selection. There are two sets of subject allomorphs. Past tense constructions select the short prefix pronouns N-, ɔ- and a- for first, second and third persons respectively for both affirmative and negative constructions. All the other affirmative constructions select the full form of the subject pronouns mɪ-, wʊ- and a-, but their negative forms select the short forms. There are also three changes that apply to nasal-stop consonant sequences that arise in the verbal affixation domain: i) NPA, ii) HNA and iii) [b]-deletion. NPA applies to

N-b sequences where [b] is in the root. HNA applies to m-b sequences where [b] is a prefix and [m] is the reduced form of /mí/. [b]-deletion applies to m-b sequences where [b] is in a prefix, and [m] is the assimilated form of /N/. There is also b-deletion that applies intervocalically to a sequence of bɛ- prefixes. The way that nasal-stop sequences are resolved is conditioned by the type of morpheme sequences. We also observed in this section that the initial root consonant is not affected.

As to why prefixes and roots behave differently with respect to the phonology, it seems the phonological rules occurs in a more external layer of the morphology or that the initial root consonant is protected from being changed, but prefixes are not. Two theoretical tools are available to account for this. Positional faithfulness (Beckman 1997) involves special constraints on root or word-initial syllables protecting them from change. This could be employed to allow assimilation of prefixes but preserve the root initial consonant. However, it is not just that the root is more faithful, it is also that vowel deletion does not apply between the prefix and the root (mí-bɔ̀tɛ̀), but does apply between two prefixes (mí-bɛ̀-bɔ́tɛ̀ → ḿmɛ̀bɔ́tɛ̀). Cophonology by phase (Sande 2019, Sande et al 2020) is a step-wise process of morpho-syntactic derivation that would allow for one type of phonology to apply in the domain associated with the vP phase (with faithfulness to the input), but allow changes when subject, negation and TAM prefixes are added in the CP phase. This model might fare better in accounting for why vowel deletion and b-deletion also only apply between (certain kinds of) prefixes. Or, we may need to consider a different type of morphological structure for verbs where the prefixes form an independent domain for phonological processes. See McCollum & Essegbey (2020) on vowel harmony in Tutrugbu that only applies among prefixes. We do not develop theoretical analytical accounts here, as the focus of the dissertation is on the basic description, but note these possible avenues of exploration.

5.5 Conclusion of the chapter

This chapter has discussed consonant inventories and their interactions with vowels in Gua. It shows that Gua has thirty phonemic consonants with twenty-one plain ones and nine labialized counterparts. There are five phonemic nasal consonants /m, n, ŋ, ŋ͡m, ɲ/ with an allophonic one [ɱ] that only occurs before other consonants that share the same place of articulation with them.

VOT differences of Gua consonants were analyzed. The results reveal that Gua has a two-way distinction between voiced and voiceless sounds in the language. It points out that previously analyzed aspiration in the language (Obiri-Yeboah 2013) is not a contrastive feature of Gua consonants. Velar stops have longer VOT values than the other stops.

Gua consonants interact with other consonants and vowels in the application of several phonological processes in the language. These processes included nasal place assimilation, homorganic nasal assimilation, and deletion. The chapter also reveals a distinction between place of articulation assimilation and homorganic nasal assimilation. Gua NPA is different from what happens in Nkami, another Guang language where HNA is triggered by voiced consonants. Gua has NPA with both voiced and voiceless root consonants except in future tense where a consonant nasal prefix triggers HNA on the following oral sound in the prefix. All the phonological rules apply to prefixes and between prefixes. While the root can trigger nasal place assimilation, it is never affected by the change. It also does not trigger vowel deletion.

CHAPTER SIX

INTERACTION BETWEEN VOWEL HARMONY AND NASALITY AND HIATUS RESOLUTION

6.0 Introduction

ATR vowel harmony is widely reported for many languages in Africa (Casali 2008, Rolle et al. 2020), but vowel harmony studies mainly report harmony patterns regarding oral vowels without showing whether vowel harmony is affected by the presence of nasal vowels or nasality in general. Nasal vowels are prevalent in the languages of West Africa, but sometimes form a subset of the oral vowels. In particular, the mid +ATR /ẽ, õ/ nasal vowels are often lacking. Rolle (2013) has analyzed 168 African languages with nasal vowels focusing on their distributions and gaps, and notes that of the 100 West African languages in the study, only 34% have contrastive mid-nasal vowels /ẽ, õ/. Other authors who have also described nasal vowels in African languages regarding the presence and gaps in nasal vowels distribution include Hyman (1972), Williamson (1973), Ruhlen (1978), Maddieson (1984, 2007), Clements (2000), Clements & Rialland (2006), and Hajek (2011). Hyman (1972) observed a restriction such that mid-vowels do not usually occur after [n] leading to restricted patterns such as *[ne]~*[nẽ] and *[no]~*[nõ]. Given this, the first part of this chapter will explore how ATR vowel harmony and nasality interact in Gua.

First, we need to determine whether nasal vowels can be triggers of vowel harmony. Second, as targets, there are four possibilities for how non-high /ɛ̃ ɔ̃ ã/ nasal vowels could behave with respect to being targets of vowel harmony. They could be opaque and block ATR harmony so as not to derive [ẽ õ], so hypothetical /ɛdɛ̃-bi/ where /-bi/ triggers regressive +ATR harmony, could become [ɛdɛ̃bi]. They could be transparent and be skipped in ATR harmony, so /ɛdɛ̃-bi/ will surface as [edɛ̃bi]. They could fully participate so /ɛdɛ̃-bi/ will surface as [edẽbi]. In this case the nasal vowel can be both a target and a trigger. Finally, they could be semi-participatory so /ɛdɛ̃-bi/

will surface as [ɛdẽbi], where the nasal vowel is a target but not a trigger. In addition to phonemic nasal vowels, another source of nasal vowels is nasalization. If a language has productive nasalization, can non-phonemic nasal vowels [ẽ õ] result due to nasalization of oral /e o/? Although the non-high +ATR vowels do not occur phonemically in Gua, we will show in this chapter that they can be derived allophonically via either nasalization, vowel harmony or both. All vowels in Gua are fully participatory, both as targets and as triggers, creating a fully symmetric twenty vowel surface system of oral and nasal (short) vowels.

The second part of the chapter discusses ATR vowel harmony interactions with hiatus resolution in the language. It will highlight what occurs when two vowels are juxtaposed across word junctures, especially when the same vowels are involved, since such patterns are least discussed in the hiatus resolution literature (Casali 1997, 2011). All combinations of oral vowels are considered, and it will be argued that ATR vowel harmony occurs prior to hiatus resolution, leading to opacity effects. The chapter includes ATR vowel harmony interaction with nasality in section 6.1, an overview of ATR vowel harmony and its interactions with hiatus resolution in 6.2 and then a conclusion.

6.1 Interaction between ATR Vowel Harmony and Nasality

Recall from chapters two and three that, apart from the ten phonemic and allophonic oral vowels in Gua /i, e, ɛ, a, o, ɔ, ʊ, ɪ, u/ and [ɜ], the language also has seven phonemic nasal vowels /ĩ, ɛ̃, ã, ɔ̃, ʊ̃, ɪ̃, ũ/. Furthermore, Gua has a process of vowel nasalization triggered by tautosyllabic nasal consonants which can create the allophones [ẽ õ ɜ̃] even if these vowels do not appear as phonemes. In this section we will show that Gua nasal and nasalized vowels interact fully with ATR harmony. Nasal and nasalized vowels can trigger harmony and be the target of harmony. The non-contrastive nasal vowels can therefore be produced in three ways: i) nasalization of oral /e o/

ii) vowel harmony targeting nasal phonemic vowels /ɛ̃ ɔ̃ ã/ and iii) nasalization and vowel harmony both targeting oral /ɛ ɔ a/.

6.1.1 Word-internal vowel harmony and nasality

In Chapter 3, we saw that vowel harmony in Gua is a +ATR regressive system, but the focus was on oral vowels. Nasal vowels and nasalized vowels (those in the same syllable as a nasal consonant) can also trigger and be targets of vowel harmony word-internally. Root-internally, final nasal vowels trigger +ATR vowel harmony (a-b), and so do nasalized vowels (c-d).

(1)	a.	òsĩ́	'horn'
	b.	òsṹ	'crying'
	c.	ə́k͡pìnĩ̂ː	'okro/okra'
	d.	tĩ́mĩ́	'short'

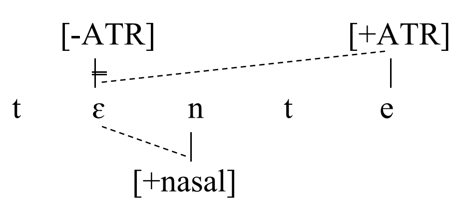
Roots with nasal vowels also cause prefixes to harmonize. An example of a nasal vowel and a nasalized vowel are provided.

(2)	a.	á-bɛ̀-kɛ́ (ɛ̀dɛ́)	's/he will teach'	ə́-bè-sṹ	's/he will cry'
	b.	á-bɛ̀-ɲɛ̃́ (ɛ̀dɛ́)	's/he will get something'	ə́-bè-ɲĩ́ (ɛ́bî)	's/he will harvest'

As targets, nasal and nasalized vowels also undergo +ATR harmony. This means that nasalized vowels can become [+ATR] via vowel harmony, producing the allophonic [ẽ õ ɜ̃] vowels which are absent as phonemes. The examples in (3) show examples of these vowels preceding +ATR vowels in roots, the result of both nasalization and +ATR harmony targeting a presumed underlying /ɔ ɛ a/.

(3)	a.	[õ]	ɲõ̀kúrùbí	'a type of meal'
	b.	[ẽ]	ɜ̀ɲẽ́tì	'morning'
	c.	[ɜ̃]	nɜ̃́mĩ̂	'toe'
	d.	[õ]	ɜ̀ʥõ̀ŋ̀kú	'hip'
	e.	[ẽ]	tẽ́ńté	'long/tall'
	f.	[ɜ̃]	dɜ̃̀ɲ̀tɕĩ́	'turn!'

This can be modeled as follows in autosegmental phonology, assuming that the first vowel is underlyingly [-ATR], although it's possible that it lacks ATR specification. Both +ATR vowel harmony and nasalization target the first vowel to produce [tẽ́ńté].



There are no prefixes with nasal vowels, we see the effect of vowel harmony producing the allophonic nasal vowels in the first half of a compound due to the following +ATR word. In the first two examples, the final vowel follows a nasal consonant so I assume that it becomes [ẽ] or [õ] due to application of both nasalization and vowel harmony. In (4c), the vowel is an underlying nasal vowel, and so becomes [ɜ̃] through vowel harmony. This last example shows that non-high +ATR nasal vowels both undergo and trigger harmony to their left.

(4)

a.	àɲɛ̃́	+	nṹm̀	→	ɜ̀ɲẽ́nṹm̀
	male		elder		elderly man
b.	òdòɲɔ̃́	+	nĩ́	→	òdòɲṍnĩ́
	twenty		five	→	twenty-five
c.	ɛ̀d^{w}ɛ̀sã́	+	nĩ́	→	èd^{w}èsɜ̃́nĩ́
	thirty		five		thirty-five

Word-internally, nasal and nasalized vowels are fully participatory in vowel harmony, acting as triggers and targets. There is no resistance to the creation of allophonic [ẽ õ ɜ̃].

6.1.2 Cross-word resyllabification and nasalization of +ATR vowels

As discussed briefly in chapter 2, Gua resyllabifies nasals across word-boundaries. This is of interest for ATR vowel harmony in that nasalization can affect +ATR oral vowels that are triggers of regressive harmony and in the process produce the allophonic vowels [ẽ õ ɜ̃]. There are two ways in which this process occurs: 1) deletion of a vowel in an NV syllable that leads to resyllabification of a nasal consonant and nasalization, and 2) resyllabification that makes the nasal consonant in nasal-consonant (NC) sequences become part of the preceding syllable.

Nasalization after resyllabification affects the third person object pronouns. In (5), the final vowel of the third person object pronouns deletes and the nasal consonant resyllabifies. It becomes the coda of the preceding syllable and nasalizes the preceding vowel. This is the final vowel of the verb in (5a-c) with the singular pronoun. The final nasal that remains bears L tone after the deletion of the round vowel. With the LH bisyllabic imperative in (5a), it does not, and a HL sequences is found when the nasal occurs in a word final position. However, if the word is monomoraic, a LL sequence is found instead. (5c) also shows that the final /o/ becomes allophonic nasal [õ] due to the resyllabification of the nasal coda.

(5)	a.	sòbí	+	mʊ̃̀	→	[sò.bĩ́m̀]
		pull		him/her/it		‘Pull him/her!’
	b.	kpɔ̀	+	mʊ̃̀	→	[kpɔ̃̀m̀]
		get out		him/her/it		‘Get him/her/it out!’
	c.	kpò	+	mʊ̃̀	→	kpõ̀m̀
		close		him/her/it		‘Close him/her/it!’

The vowels that delete under such circumstances are high round vowels regardless of their ATR status. No other vowels under similar circumstances undergo such deletion and resyllabification processes. In the examples in (6) below we see the full form of both the first person singular object pronoun form realized without the deletion and resyllabification processes. Also, in (7), the vowel that follows the nasal consonant in the demonstrative does not delete, so the deletion and resyllabification that triggers nasalization is not observed.

(6)	a.	sòbí	+	mɪ̃̀	→	[sòbí mɪ̃̀]
		pull		1SG.OBJ		‘Pull me!’

	b.	sɔ̀	+	mɪ̃̀	→	[sɔ̀ mɪ̃̀]	
		buy		him/her/it		‘buy him/her/it’	
(7)	a.	sòbí	+	mɔ̃́	→	[sòbí mɔ̃́]	
		pull		this		‘Pull this!’	
	b.	sɔ̀	+	mɔ̃́	→	[sɔ̀ mɔ̃́]	
		buy		this		‘buy this’	

The second case of resyllabification that results in nasalization is when the first word ends in a vowel and the second word begins with an NC sequence. This results in resyllabification, wherein the initial nasal consonant of the second word becomes part of the preceding syllable as a coda. This results in a change of tone on the nasal consonant to share tone with the preceding vowel, if the tone is not already matching that of the vowel. Examples in (9) illustrate this pattern. The cases in (8) are provided to show that this effect does not occur if the second word only begins with a nasal consonant, not an NC cluster. The examples in (9c-d) also show that [õ ẽ] are produced via nasalization of /o, e/ due to resyllabification.

(8)	a.	àtɕí	+	nɛ̃̀nɛ̃́	→	[à.tɕí.nɛ̃̀.nɛ̃́]	‘A woman’s grandmother’
	b.	bìsé	+	nɛ̃̀nɛ̃̀	→	[bì.sé.nɛ̃̀.nɛ̃̀]	‘ask grandmother!’
	c.	kʊ̀sʊ́	+	ɲã̀kɛ̃́	→	[kʊ̀.sʊ́.ɲã̀.kɛ̃́]	‘get-up and dress (sore)!’
	d.	sòbí	+	nɛ̃̀ɲɛ̃́	→	[sò.bí.nɛ̃̀.ɲɛ̃́]	‘pull grandfather!’
(9)	a.	àtɕí	+	ǹtɛ̃́	→	[à.tɕɪ̃́ń.tɛ̃́]	‘A woman’s drink’
	b.	ɜ̀lèbí	+	ǹtɛ̃́	→	[ɜ̀.lè.bɪ̃́ń.tɛ̃́]	‘A child’s drink’
	c.	kpò	+	ǹtèbí	→	[kpõ̀ǹ.tè.bí]	‘Close animals (from work)!’
	d.	tè	+	ǹtèbí	→	[tẽ̀ǹ.tè.bí]	‘Kill animals!’

In summary, vowel nasalization in Gua can affect a word-final vowel due to resyllabification of a nasal consonant into a coda position across the word boundary. This triggers nasalization of previously word-final vowels and can produce nasal allophones [ẽ õ] of word-final +ATR /e o/, which are word-internal regressive +ATR harmony triggers. Also, unlike the word final VN that does not have to share the same tone, word-medial VN does share the same tone with the preceding vowel, and will change tone upon resyllabification.

Vowel nasalization in Gua is similar to the case reported for Nkami (Asante 2016). In Nkami, nasalization also affects vowels that occur in the same syllable. The examples below show cases involving nasalization within the same syllable within words (monosyllabic and compound words) (10) and across words (11) in Nkami.

Vowel Nasality Patterns in Nkami

(10)	a.	mɔ̃	'kill'
	b.	nɔ̃	'what'
	c.	a.bĩɱ.fɔ	'palm kernel oil'
	d.	ɲɔ.gɔ̃ɲ.tʃu	'breast milk'

(11)	a.	bɔ mpayɛ	→	[bɔ̃m.pa.yɛ]
		hit prayer		'pray'
	b.	fʊ tʊ mʊ	→	[fʊ.tʊ̃m]
		take put there		'put it there'
	c.	fʊga mʊ	→	[fʊ.gãm]
		greet him		'greet him'

The examples in (11b-c) show the deletion of the final vowel of the pronoun and the postposition that triggered resyllabification and the nasalization that followed. In this case, the nasal consonant of the postposition (11b) and the third person singular object pronoun (11c) attach as codas to the preceding syllable that triggers the nasalization of the preceding vowel in that syllable.

The section shows that both Gua and Nkami have vowel nasalization that applies within and across words, and the process applies tautosyllabically in both languages. In Gua, this can result in the nasalization of oral /e o/ vowels producing the allophonic [ẽ õ], but it is unclear if the same is true for Nkami since only few examples are provided for [õ] for instance, *aɲõ* 'two' by Asante (2016). Examples are not provided for [ẽ]; future studies of Nkami could clarify this issue.

6.1.3 Cross-word ATR Vowel Harmony and Nasal/Nasalized Vowels

Recall from chapter 4 that cross-word ATR vowel harmony affects the final -ATR vowel of a word preceding a word that begins with a +ATR vowel in the same phonological phrase domain. Cross word vowel harmony interacts with nasal vowels in two ways: when nasal vowels are targets and when they are triggers.

The examples in (12) show nasal vowels acting as triggers of cross-word ATR vowel harmony but no nasalization is transferred. Gua does not have nasal harmony either within words or across them.

(12)	a.	kòfí sɔ̀ sĩ́ɛ̃̀	→	kòfí sò sĩ́ɛ̃̀	'Kofi bought six'
	b.	kòfí bɔ́tɛ̀ sĩ́ɛ̃̀	→	kòfí bɔ́tè sĩ́ɛ̃̀	'Kofi rolled-up six'
	c.	àtɕí tĩ́mĩ́	→	àtɕí tĩ́mĩ́	'Short woman'

The examples in (13) show ATR harmony involving -ATR phonemic high nasal vowels that become +ATR. The nasal vowel targets in (14) are non-high /ɛ̃ ɔ̃ ã/, and when they interact with ATR vowel harmony, they result in allophonic nasal vowels [ẽ õ ɜ̃] that do not occur in the phonemic inventory of the language.

(13)	a.	àtɕɪ̃́ téńté	→	àtɕɪ̃́ tẽ́ńté	'long sponge'
	b.	àtʊ̃́ k͡pô:mɔ̃́	→	àtṹ k͡pô:mɔ̃́	'big buttocks'
(14)	a.	kòfí dɛ̃̀ téì	→	kòfí dẽ̀ téì	'Kofi hit food'
	b.	kwámɪ̃̀ tɕã̀ téì	→	kwámɪ̃̀ tɕɜ̃̀ téì	'Kwame changed food'
	c.	sìsì sɔ̃̀ téì	→	sìsì sõ̀ téì	'Sister burnt food'

We have thus seen two methods for the vowels [ẽ õ ɜ̃] to arise in cross-word interaction – either through nasalization affecting oral +ATR vowels or vowel harmony affecting -ATR nasal vowels. We now show how both these processes can combine to create +ATR nasal vowels from -ATR oral vowels including the allophonic versions. The examples in (15) show ATR harmony targeting nasalized -ATR vowels. The nasalization occurs word-internally from the nasal consonant onset and the ATR harmony is cross-word. I note, however, that while we assume that the final nasal vowel is due to nasalization of the preceding nasal onset, these final vowels could also be underlyingly nasal, since nasal vowels are allowed word-finally.

(15)	a.	kwámɪ̃̀ téì	→	kwá**mĩ̀** téì	'Kwame's food'
	b.	ɜ̀lèbí kpã́mã́ wè	→	ɜ̀lèbí kpã́**mɜ̃́** wè	'A bad child left'
	c.	àɲɛ̃́ mɔ̃̀ ɜ̀tèbí	→	àɲɛ̃́ **mõ̀** ɜ̀tèbí	'A man killed an animal'
	d.	kòfí nɛ̃̀ téì	→	kòfí **nẽ̀** téì	'Kofi gave/offered food'

Resyllabification of a nasal can apply across words along with ATR vowel harmony. The nasal consonant in an NC sequence resyllabifies as a coda to the preceding syllable, and the preceding vowel is nasalized. In addition, [+ATR] vowel harmony can also apply and cause the final vowel of the first word to become [+ATR] in those contexts. The examples in (16a-b) below illustrate this applying to final high vowels, and the examples in (16c-e) show it applying to non-high vowels, creating the allophonic [õ ẽ ɜ̃].

(16)	a.	àhʊ́	+	ǹt͡ɕú	→	[à.**hṹń**.t͡ɕú]	'breast-milk'
	b.	àt͡ɕí	+	ǹtèbí	→	[à.**tɕĩ́ń**.tè.bí]	'Woman's clothes/things'
	c.	sɔ̀	+	ǹt͡ɕú	→	[**sõ̀ǹ.**t͡ɕú]	'buy water!'
	d.	kwɛ̀lɛ́	+	ǹtèbí	→	[kwɛ̀.**lẽ́ń**.tè.bí]	'fry things/animals'
	e.	k͡pʊ̀sá	+	ǹtèbí	→	[k͡pʊ̀.**sɜ̃́ń**.tè.bí]	'squeeze items/things'

6.1.4 Summary and discussion

We have shown that nasal vowels are fully participatory with ATR vowel harmony. ATR harmony creates +ATR nasal vowels within words and across words, including the allophonic vowels [ẽ õ ɜ̃]. In addition, nasal vowels can trigger ATR harmony. However, as triggers, they only transfer their ATR feature onto other vowels not nasality.

The nasal vowel system of Gua with contrasts between two high vowels but no contrasts between mid vowels can be characterized as a 2IU7 system (Casali 2008, Rose 2018), also referred to as 4Ht(H) – by Casali (2003), a label given to the oral vowel inventory consisting of seven vowels: /i u ɪ ʊ ɛ ɔ a/ with contrasts for ATR among high vowels, but not mid vowels. Cross-linguistically, in 2IU7 languages, the unattested oral /e, o/ are missing at the phonemic level, but are typically produced allophonically through ATR vowel harmony (Rose 2018). This is also what occurs in Gua for nasal vowels .

Casali (2003) also indicates that "there are strong indications that [+ATR] regularly functions as the dominant value in 5Ht and 4Ht(H) languages, while [-ATR] is regularly dominant in 4Ht(M) languages", where 4Ht(M) refers to systems with mid vowel contrasts, but not high vowel contrasts. If the nasal vowel system is treated separately, both 2IU7 (nasal) and 2IU9 (oral) vowel systems can be attested in a single language, namely Gua. But it is highly likely that oral and nasal vowels function as part of the same harmony system. These patterns present interesting implications for typological and theoretical study of languages that have not considered the interaction between nasal vowels and ATR. Other ATR vowel systems need to be investigated to know whether nasality interaction with ATR harmony is always participatory like the patterns in Gua, or whether there could be some cases of opaque or non-participatory transparent patterns. Are the sets of vowels distinct from each other or do they function together as a system with respect to ATR harmony? In a language like Gua, one would expect allophones to be created because the oral vowels are a 9 vowel system with +ATR dominance and a +ATR allophone of /a/. But other systems may behave differently. For example, in an 1IU7 oral system (/i u e o ɛ ɔ a/), high vowels can be transparent to ATR harmony, as in Wolof (Ka 1994, Dye 2015). In such languages, if there are also nasal vowels, such as the five vowels /ĩ ũ ɛ̃ ɔ̃ ã/, does /ɛ̃ ɔ̃/ become [ẽ õ] or does the nasal vowel system act like the oral vowel system and just treat those vowels without counterparts as transparent? In a language in which /a/ is opaque or transparent to ATR harmony, does /ã/ follow suit? In Gua, /a/ is participatory, so it seems that /ã/ is also. However, the related Guang language Nkami has /a/ as an opaque vowel and also has /ã/. It is not clear if the nasal low vowel is also opaque. Unfortunately, Asante (2016) does not provide details on these interactions in Nkami for comparison so this is left to future research.

6.2 Interaction Between ATR Vowel Harmony and Hiatus Resolution

Vowel hiatus occurs when two vowels occur in succession either within the same word or across words. Some languages treat vowel hiatus as undesirable so there are various processes that are applied to resolve the hiatus situation. Vowel hiatus resolution therefore can lead to vowel deletion, one vowel becoming a glide, assimilation/fusion, or epenthesis of a consonant between the vowels (Rosenthall 1994, 1997).

Gua has a noun class system that is decayed, but there are remnants of the system in the language which appear on some nouns as vocalic noun class prefixes. Where such nouns occur after other words ending in vowels, this leads to vowel hiatus. Within monomorphemic words, vowel sequences are not resolved, such as *téì* 'food', *kpàí* 'a basket for storing smoked fish/meat' etc. However, within polymorphemic words, vowel hiatus occurs between subject prefixes and tense, mood and aspect vowel-initial prefixes, and they are resolved. These situations create many opportunities for vowel hiatus and resolution to arise within and across words. We can also examine how vowel hiatus interacts with ATR vowel harmony across words in domains where cross-word harmony would apply in Gua. Does harmony apply before hiatus resolution or the other way around? Casali (1997/2011) indicates that the second vowel (V2) usually deletes in hiatus resolution between content words, but when there is a content versus grammatical or function word, the vowel in the grammatical word deletes. Does Gua have the same pattern? This section discusses ATR vowel harmony interactions with hiatus resolution. It discusses the interactions between specific vowels based on their ATR value and reports the results of the interaction. It will be shown that ATR vowel harmony is applied before hiatus is resolved, leading to opacity effects.

6.3.1 Vowel Hiatus Resolution

Vowel hiatus applies within and between words in Gua. Within monomorphemic words, hiatus is not resolved, as in (17) (see also chapter 2).

(17)	a.	téì	‘food’
	b.	k͡pàí	‘fish storage’
	c.	sɪ̃́ɛ̃̀	‘six’
	d.	sɛ̀í	‘spoil!’

The patterns show that either the vowels agree for ATR within the same word or they can disagree but the -ATR vowel must occur after the +ATR vowel as shown in (17c), the same pattern noted if a consonant intervenes between the vowels.

Unlike unresolved cases of hiatus in monomorphemic words, vowel hiatus is resolved across words and across morpheme boundaries in Gua. The examples in (18) below show how hiatus has been resolved between the vowels. The examples show that there is no hiatus situation in (18a) as there is no hiatus situation to be resolved. However, in (18b-d), there is a hiatus situation between the plural pronouns and the following verb or nouns, so hiatus is resolved by the final vowel of the first word becoming a glide. The fact that the H tone of the pronoun is lost in these examples is another good argument that the vowel becomes a glide. If it were a vowel sequence one would expect *ɛ̀níà*.

(18)	a.	ɛ̀nɪ̃́	bɛ̀	→	ɛ̀nɪ̃́	bɛ̀	‘we are coming’
	b.	ɛ̀nɪ̃́	àkpàkʊ́	→	ɛ̀nj	àkpàkʊ́	‘our goat’
	c.	ɛ̀nɪ̃́	ɔ̀k͡pʊ̀nɔ̃́	→	ɛ̀nj	ɔ̀k͡pʊ̀nɔ̃́	‘our table’

d. ɛ̀ní ɛ̌:k͡pɔ̀lì → ɛ̀nj ɛ̌:k͡pɔ̀lì ‘we are cleaning’

In (19), we see vowel deletion (19a) and no evidence of vowel deletion (19 b-c). The same pattern is observed in compounds and affixation. The examples in (19d-e).

(19)	a.	bɔ̀lí	ísɛ̂	→	[bɔ̀lísɛ̂]	‘python grass’
	b.	kpɔ̀tɔ́	ɔ̀kɔ́tɔ̀	→	[kpɔ̀tɔ̀:kɔ́tɔ̀]	‘grind a crab!’
	c.	kwɛ̀lɛ́	ònɪ̃́	→	[kwɛ̀lò:nɪ̃́]	‘fry fish!’
	d.	kòfí	ě:bìè	→	[kòfjě:bìè]	‘kofi is bathing’
	e.	ɱ̀fódʑò	ɛ̂:kpɔ́lì	→	[ɱ̀fódʑɛ̂:kpɔ́lì]	‘Mfodʑo has cleansed

The examples in (18) show what occurs between two vowels where the first one is a high vowel, while those in (19) shows cases with vowels that resolves hiatus through deletion or assimilation/fusion. (19a,b) show identical vowels, but while the high vowels in (19a) appear to delete one of the vowels, the mid vowel sequence in (19b) results in a long vowel. (19c) shows an example of non-identical vowels resulting in a long vowel with the features of the second. In order to systematically determine how hiatus resolution operates and how it interacts with ATR vowel harmony, sentences were constructed to test all possible vowel combinations. This is explored in detail in the next section. The details of the patterns are analyzed and discussed below.

As shown in (18) and (19), hiatus across words is resolved in Gua but exactly how this is done and how it interacts with ATR vowel harmony where both the target and the trigger end and begin with vowels respectively remains to be explored. There were two individual words that were selected for the speakers to produce for recording and analysis. In order to determine if the duration of a vowel is short or long, the duration of the remaining sound in the hiatus context was compared to the same sound in other contexts. This strategy was used to check hiatus resolution among all the participants.

The tables in 6.1 and 6.2 illustrate how hiatus is resolved with vowels with the same ATR value. The table in 6.1 has -ATR vowels while those in 16 have +ATR vowels. Most of the words have verbs in V1 while V2 is either a noun or an adjective. However, this was not always possible, so some of them are Noun – Noun combinations. There is a lack of /u/ and /ʊ/ high vowels in initial position of words, so words with initial high round vowels are not considered. Also, the allophonic vowel [ɜ] is not included in V1 position in table 6.2 because it does not occur in word final position. The result of the vowel hiatus resolution is provided in phonetic brackets to the right of the words.

Table 6.1: Vowel Hiatus Resolution for -ATR vowels.

V1/V2	ɪ	ɛ	ɔ	a
ɪ	bɔ̀lí ísɛ̂ [í] python grass	bɔ̀lí ɛ́dɛ̂ [jɛ́] python thing	fintí ɔ̀kpɔ̀nɔ̃́ [jɔ̀] jump table	bɔ̀lí àdɛ́ [jà] python's cutlass
ʊ	wʊ̀sʊ́ ísɛ̂ [ʊ́] shake grass	wʊ̀sʊ́ ɛ́bî [wɛ́] shake palm tree	wʊ̀sʊ́ ɔ̀kpɔ̀nɔ̃́ [wɔ̀] shake table	wʊ̀sʊ́ àkpàkʊ́ [wà] shake he-goat
ɛ	bɔ̀tɛ́ ífî [ɛ́ɛ́] roll rope	bɔ̀tɛ́ ɛ̀dídɛ̀ [-ɛ́ɛ̀] roll mat	bɔ̀tɛ́ ɔ̀wɛ́ [-ɔ́ɔ̀] roll snake	sɔ̀tɛ́ àbɛ́lì [-áà] catch whistle
ɔ	sɔ̀ ífî [ɔ̀j] buy rope	kpʊ̀tɔ́ ɛ́bî [-ɛ́ɛ́] frog's palm tree	kpɔ̀tɔ́ ɔ̀kɔ́tɔ̀ [-ɔ́ɔ̀] grind crab	sɔ̀ àkpákʊ̀ [-àà] buy he-goat
a	bʊ̀á ífî [áj] prepare rope	tʊ̀á ɛ́sɛ̃̂ [-ɛ́ɛ́] stitch people (= to chase people)	kpʊ̀sá ɔ̀wɛ́ [-ɔ́ɔ̀] swish snake	kpʊ̀sá ásɛ̃̀ [áá] swish someone (bother someone)

There are cases where there is variation in the results among speakers where having a short word containing mid round vowels in V1 in monosyllabic become a glide before a non-high vowel in V2 but gets elided when V1 is in a bisyllabic word. Two of the speakers produced sɔ̀ ɛ́dɛ̂ as [swɛ́dɛ̂] 'buy something' but when V1 is part of a bisyllabic word like kpɔ̀tɔ́ ɛ́dɛ̂ they result as [kpɔ̀tɛ́ɛ́dɛ̂] 'grind something'. This happens irrespective of the ATR value in V1 (cf. Table 6.2).

Table 6.2: Vowel Hiatus Resolution for +ATR vowels.

V1/V2	i	e	o	ɜ
i	kùbí ìdʑójì [í] cut stalk (for yam)	kùbí ékpû̂ [jé] cut garden eggs	bòlí òsé [jò] break earthenware	kùbí ɜ̀tèbí [jɜ̀] cut animal
u	bùtú ìbíèsʊ̀ [ú] squart/bend at a market	bùtú èbísè [wè] cover fibre	bùtú òní [wò] cover fish/meat	bùtú ɜ̀bòbí [wɜ̀] cover bird
e	kpè ísî [èj] weed ant-hill	bìsé ésê [-éé] ask news	wùlé òbíè [-óò] finish bathing	kpìté ɜ́bùdè [-ɜ́ɜ̀] clean house-inside
o	kpò ìbíè [òj] stop market(ting)	kpò èsímì [-èè] finish/close work	kpò òní [-òò] finish/close fish	kpò ɜ̀tèbí [-ɜ̀ɜ̀] finish/close animal

Let us examine how hiatus effects are resolved across words in Gua when the vowels are of different ATR values. Table 6.3 shows the order that results in cross-word vowel harmony application, namely V1 -ATR and V2 +ATR. The table also has an additional row for /a/ in V1 and +ATR vowels in V2. Table 6.4 shows the reverse direction, with +ATR vowels preceding -ATR vowels.

Table 6.3: Vowel Hiatus where V1 is -ATR and V2 is +ATR

V1/V2	i	e	o	ɜ
ɪ	bɔ̀lí ìbíè [í] python market	bɔ̀lí ésê [jé] python news/matter	bɔ̀lí òsé [jò] python earthenware	bɔ̀lí ɜ́dʑè [jɜ́] python fire/wood
ʊ	wòsʊ́ ìdʑójì [ú] shake stalk (for yam)	wòsʊ́ ébì [wé] shake palm kernel	wòsʊ́ ókítɪ̏ [wó] shake lizard	wòsʊ́ ɜ́dʑè [wɜ́] shake fire/wood
ɛ	fìtɛ́ íkû [éj] dry group	kwɛ̀lɛ́ ébì [-éé] fry palm kernel	kwɛ̀lɛ́ òní [-óò] fry fish/meat	sɔ̀tɛ́ ɜ́tɕî [-ɜ́ɜ́] catch knife
ɔ	sɔ̀ ìbíè [òj] buy market	sɔ̀ ébî [-èé] buy palm kernel	kpɔ̀tɔ́ òní [-óò] grind fish/meat	sɔ̀ ɜ́dʑè [-ɜ̀ɜ́] buy fire/wood
a	kpʊ̀sá íkù [ɜ́j] swish group	kpʊ̀sá ébî [-éé] swish palm kernel	kpʊ̀sá òní [ɜ́ɜ̀-] swish fish/meat	kpʊ̀sá ɜ́bî [ɜ́ɜ́] swish snail

Table 6.4: Vowel Hiatus where V1 is +ATR and V2 is -ATR.

V1/V2	ɪ	ɛ	ɔ	a
i	sòbí ísɛ̂ [í-] pull grass	twùkwí ɛ́bî [jɛ́] uproot palm tree	sòbí ɔ̀kɔ́tɔ̀ [jɔ̀] pull crab	sòbí àdɛ́ [jà] pull cutlass
u	bùtú ísɛ̂ [ú-] cover grass	bùtú ɛ́dɛ̂ [wɛ́] cover something/thing	bùtú ɔ̀kɔ́tɔ̀ [wɔ̀] cover crab	bùtú àkpákʊ̀ [wà] cover he-goat
e	kpìté ífî [éj] clean rope	kpìté ɛsɛ̂̂ [-ɛ́ɛ́] clean people	kpìté ɔ̀wɛ́ [-ɔ́ɔ̀] clean snake	kpìté àkpákʊ̀ [-áà] clean he-goat
o	kpò ífî [òj][31] close rope	kpò ɛ́sɛ̂̂ [-ɛ̀ɛ́] close/stop people	kpò ɔ̀kɔ́tɔ̀ [-ɔ̀ɔ̀] close/stop crab	kpò àkpákʊ̀ [-àà] close/stop he-goat

Table 6.5 shows the hiatus patterns for all the combinations in a summary chart. Color coding indicates different resolution strategies. Blue color illustrates the result between high versus mid and low vowels, green is for mid and low vowels versus high vowels, white areas show cases with same height while pink is for the combination of low vowels only. Gray shows areas that are unattested and vowels in red are the results for identical vowels with the same ATR value. Yellow color shows an unexpected situation among the attested patterns.

[31] Note the loss of the high tone here.

Table 6.5: General patterns of hiatus resolution in Gua

V1/V2	ɪ	ʊ	ɛ	ɔ	a	i	u	e	o	ɜ
ɪ	ɪ		jɛ	jɔ	ja	i		je	jo	jɜ
ʊ	ʊ		wɛ	wɔ	wa	u		we	wo	wɜ
ɛ	ɛɛ		ɛɛ	ɔɔ	aa	ej		ee	oo	ɜɜ
ɔ	ɔj		ɛɛ	ɔɔ	aa	oj		ee	oo	ɜɜ
a	aj		ɛɛ	ɔɔ	aa	ɜj		ee	oo	ɜɜ
i	i		jɛ	jɔ	ja	i		je	jo	jɜ
u	u		wɛ	wɔ	wa	u		we	wo	wɜ
e	ej		ɛɛ	ɔɔ	aa	ej		ee	oo	ɜɜ
o	oj		ɛɛ	ɔɔ	aa	oj		ee	oo	ɜɜ
ɜ										

The patterns are systematic and can be summarized as follows:

1. A high vowel plus a non-high vowel or a non-high vowel plus a high vowel results in the high vowel becoming a glide. The exception is /ɛ-ɪ/ which becomes [ɛɛ] not *[ɛj]. (highlighted in yellow). There is no compensatory lengthening.

2. When two high vowels occur in a hiatus situation, this results in a single short high vowel, and if they are i-ɪ, the first vowel is maintained. But, non-identical high combinations are always round vowel first due to the restriction against word-initial round vowels, and these all resolve in favor of the round vowel: ʊ-ɪ → ʊ; ʊ-i → u; u-ɪ → u; u-i → u. If V2 is +ATR, this feature is preserved on V1.

3. The non-high vowel combinations results in a long vowel with the features of V2.

Assuming that both vowels are mora-bearing, the patterns can be analyzed as follows, where I = high vowel, O = non-high vowel (mid or low) and G denotes a glide:

1. Glide formation (bidirectional) 2. High vowel deletion

```
μ     μ    -->         μ          μ      μ      -->   μ
|     |                |          |      |            |
I     O           G    O          I1     I2           I1
```

3. Non-high vowel assimilation

```
μ     μ    -->   μ      μ
|     |           \    /
O1    O2            O2
```

The case of deletion with high vowels does not conform to the patterns identified in Casali (1996, 1997, 2011) who noted that V1 usually gets deleted in hiatus situations between two content/lexical words. However, in Gua we observe a deletion of the second of two high vowels in this context. The fact that the second vowel is deleted in these cases may be due to a preference to preserve the [round] feature of the first vowel. However, the sequence /i-ɪ/ also results in [i]. As vowel harmony is regressive, the preservation of the [+ATR] vowel cannot be due to harmony affecting the second vowel. Furthermore, [+ATR] is not preserved in /e-ɛ/ sequences. Tone data also supports preservation of the first of the two high vowels, as the tone of the first vowel is maintained.

We have analyzed the low vowel and the mid vowel patterns as assimilation to V2. This accounts for the preservation of vowel length and maintenance of the tone.

The retention of the +ATR feature if V1 is -ATR and V2 is +ATR even if the other features are preserved from V1 -- for example, /ʊ-i/ results in [u], not *[ʊ] -- suggests the prior application of +ATR vowel harmony: /ʊ-i/ → u-i → [u]. Further arguments for ordering cross-word vowel harmony prior to hiatus resolution will now be presented. Where nasal vowels are involved, two issues are of importance. First, for sequences like /ã-e/, a long vowel [eː] results, and the whole vowel is oral, supporting the total assimilation account. However, since nasal vowels do not start words in Gua, patterns like /e-ã/ do not occur in the language. The sequence /ĩ-ɪ/ results in [ĩ], as we expect if the second vowel deletes. But, the reverse is unattested in the language.

Within words, hiatus resolution is not usually resolved so there are cases of sequences of words like *téì* 'food', *fũ̀ĩ́* 'open!', *kpàí* 'a type of basket for fish/meat storage. However, there are other instances where hiatus is resolved with varying degrees as compared to the resolution strategies across words. For instance, within the verb prefix domain, we see a + ɛɛ becoming ɛɛ, which conforms to the patterns, as well as ɪ-ɛɛ → jɛɛ. It's +ATR counterpart also becomes i-ee → jee. But within compounds and numerals, there seem to be exceptions to the pattern, so *aɲɛ* 'man'+ *ɜnum* 'elder' → *ɜɲenum* 'elderly man, where one would have expected *ɜɲɜnum* due to the second vowel [ɜ] taking precedence. However, it is also possible that the [ɜ] in ɜ̀núm̀ deletes since the word núm̀ 'older/elder' is also used to refer to an older person. Perhaps, the combination within the compounds is between *àɲɛ̃́* 'man' + *núm̀* 'older/elder'. Also, the numeral *òdòɲɔ̃́* 'twenty' + *àkʊ́* 'one' has vowel hiatus resolution where we expect the ɔ becomes a glide *òdòɲwàkʊ́* 'twenty-one'.

6.3.2 Vowel hiatus resolution and vowel harmony: ordering

In the paragraphs that follow, some relevant data on hiatus resolution interactions with ATR vowel harmony are introduced here for two reasons: i) they show that vowel harmony applies prior to vowel hiatus and does not reapply if vowels delete, reinforcing the non-iterativity analysis of the harmony process, and ii) they suggest that vowel hiatus operates within the same phonological phrase domains as vowel harmony.

In chapter 4 of this dissertation, we established that Gua does not allow a monomoraic word that has undergone cross-word harmony to further extend that harmony onto a preceding word (See Obiri-Yeboah & Rose (2021) for an analysis). In (20a), the word /sɔ/ undergoes harmony, but does not extend it to the subject. In (20b), vowel hiatus juxtaposes /ʊ́ ó/ across a word boundary, and the first vowel /ʊ́/ undergoes glide formation. However, the /ó/ does not cause harmony on the remaining vowel in the first word. This could be construed as a failure to affect a word internal vowel, but (20c) shows that this explanation fails. The vowel /ɔ/ (or harmonized [o] is deleted or merged, but the long vowel [eː], the result of assimilation between /ɔ/ and /e/, does not trigger harmony on the final vowel of àɲɛ́. This is an opacity effect, as the reason for the failure for harmony to apply is not obvious from the surface form.

(20)	a.	áfwɛ̂	sɔ̀	kúrî	→	[áfwɛ̂ sò kúrî]	*[àfwê sò kúrî]
		stranger	buy.PST	pig			
		‘A stranger bought a pig’					
	b.	wʊ̀sʊ́	òkítɪ̏		→	[wʊ̀swòkítɪ̏]	*[wùswòkítɪ̏]
		shake.IMP lizard					
		‘shake a lizard!’					
	c.	àɲɛ̋	sɔ̀	ébî	→	[àɲɛ̋ sèébî]	*[àɲê̋ sèébî]
		man	buy.PST	palm kernel			
		‘a man bought palm kernel’					

These data suggest that cross word vowel harmony applies prior to vowel hiatus resolution, and does not reapply. If it had affected the final vowel (/ɔ/ → [o]), that vowel is then merged or deleted, but vowel harmony does not apply again from the new +ATR long vowel.

Second, the trigger vowel in a short word can be deleted via vowel hiatus resolution, but it leaves the previous harmony intact. In example (21), although hiatus is resolved in (21a), there is no harmony. This is expected because harmony is not progressive. But, in example (21b), there is evidence that harmony applies before hiatus is resolved. The subject *àɲɛ̃́* 'man' becomes *àɲẽ́* 'man' even though there is no +ATR vowel in kwɛ̀ɛ́dɛ̀ to trigger harmony in regressive fashion. This indicates that harmony first applies from /kwè/ and then hiatus resolution assimilates [e] in favor of [ɛ] in V2, and opacity results.

(21)	a.	kwè	ɛ́dɛ̂		→	[kwɛ̀ɛ́dɛ̂]
		grind.IMP	something/thing			
		'Grind something'				
	b.	àɲɛ̃́	kwè	ɛ́dɛ̂	→	[àɲẽ́ kwɛ̀ɛ́dɛ̂]
		man	grind.HAB	something/thing		
		'A man grinds something'				
	c.	sɔ̀	sùmɑ̃́		→	[sò sùmɑ̃́]
		buy.IMP	god			
		'Buy a god!'				

The first case in (20) is counterfeeding on environment - the +ATR trigger is present on the surface in the right context (-ATR followed by +ATR), but no harmony occurs. The second is counterbleeding – harmony has applied, but there is no surface +ATR trigger vowel. In order to account for the application and non-application of harmony in these cases, vowel hiatus resolution would apply after harmony as part of a serial or level-ordering model. This is shown here:

(22)

	/àɲɛ̃́ kwè ɛ́dɛ̂/	/àɲɛ̃́ sɔ̀ ébî/
Vowel harmony	àɲẽ́ kwè ɛ́dɛ̂	àɲɛ̃́ sò ébî
Hiatus resolution	àɲẽ́ kwɛ̀ɛ́dɛ̂	àɲɛ̃́ sèébî
	[àɲẽ́ kwɛ̀ɛ́dɛ̂]	[àɲɛ̃́ sèébî]

The reverse application of the rules shows how harmony would either fail to apply (bleeding) or would overapply (feeding):

(23)

	/àɲɛ̃́ kwè ɛ́dɛ̂/	/àɲɛ̃́ sɔ̀ ébî/
Hiatus resolution	àɲɛ̃́ kwɛ̀ɛ́dɛ̂	àɲɛ̃́ sèébî
Vowel harmony	--	àɲẽ̀ sèébî
	*[àɲɛ̃́ kwɛ̀ɛ́dɛ̂]	*[àɲẽ̀ sèébî]

A further question these data raised is whether vowel hiatus operates within the same phonological phrases as vowel harmony (see chapter 4). This would lend further support to the phrasing if more than one process were sensitive to it. An examination of some three word and four word sentences does show different application of vowel hiatus. In (24a) vowel hiatus applies between the verb and the object. This is expected as three word sentences form a single prosodic domain. In (24b), there are four words. Four word sentences divide into two phonological phrases consisting of two words for the purposes of vowel harmony. The same hiatus resolution between verb and following object is not observed. Although the vowels are pronounced close together without an observable pause, the [ɔ] vowel does not assimilate. This suggests a prosodic boundary between verb and object due to the additional word, splitting the sentence into two phonological phrases. In (24c), there are two possible hiatus resolution locations. Again, no hiatus resolution takes place between words two and three, but hiatus is repaired between object and following adverb. This is as expected if they are within the single phonological phrase.

(24)	a.	àɲɛ̃́	sɔ̀	ɛ́dɛ̂		→	[àɲɛ̃́ sɛ́ɛ́dɛ̀]
		man	buy.PST	something			
		'A man bought something.'					
	b.	àɲɛ̃́	sɔ̀	ɛ́dê	kpôːmṍ	→	[àɲẽ́ sɔ̀ ɛ́dê kpôːmṍ]
		man	buy.PST	something	big		
		'A man bought something big.'					
	c.	àɲɛ̃́	sɔ̀	ɛ́dɛ̂	ɜ̀ɲɛ̃̀tí	→	[àɲɛ̃́ sɔ̀ ɛ́dɜ́ɜ̀ɲɛ̃̀tí]
		man	buy.PST	something	morning		
		'A man bought something in the morning.'					

The application of vowel hiatus assimilation appears to fuse two words together and creates a new prosodic word, but as seen above, vowel harmony does not reapply.

6.4 Conclusion

This chapter has discussed ATR vowel harmony interactions with both nasality and hiatus resolution. In terms of ATR vowel harmony interactions with nasality, nasal vowels fully participate in ATR harmony and nasalization can produce +ATR [ẽ õ] even if these vowels do not occur phonemically. Nasalized allophonic vowels are created either via nasalization, ATR harmony or both. Although Hyman (1972) observed a restriction in the pattern of [n] (and sometimes [m]) where mid-vowels do not usually occur after [n] leading to restricted patterns such as *[ne]~*[nẽ] and *[no]~*[nõ], Gua has the mid nasal vowels following the [n] nasal consonant, but the oral vowels /o e/ do not follow nasal consonants.

The interaction of ATR vowel harmony and hiatus resolution was also examined. First, I presented a comprehensive study of all the possible combinations of vowels in hiatus contexts to assess how hiatus was resolved. Casali (1997) notes that, "at the boundary between two lexical words, elision is always of V1. Exceptions occur only under very special circumstances, such as those involving the idiosyncratic behavior of particular vowels in some languages (e.g. the vowel /i/ is elided after a preceding word-final vowel in Yoruba (Pulleyblank 1988), even though elision otherwise generally targets V1)." In Gua, deletion of V2 is found when two high vowels are juxtaposed, which does not conform to Casali's cross-linguistic observations. Other hiatus contexts result in glide formation if the high vowel is preceded or followed by a non-high vowel, or deletion of V1 when there are sequences of non-high vowels.

Gua vowel harmony interaction with hiatus data provides evidence for ordering. When words occur in sentences, harmony applies non-iteratively across words, constrained by phonological phrasing (See further details in chapter 4 and Obiri-Yeboah & Rose 2021). The additional process of vowel hiatus resolution applies following vowel harmony. Two kinds of opacity result from this ordering, one a counterfeeding relationship and the other a counterbleeding relationship. In addition. hiatus resolution appears sensitive to the same phonological phrasing as vowel harmony, even though it may result in prosodic restructuring.

CHAPTER SEVEN

GUA TONOLOGY

7.0 Introduction

Tonal languages comprise 70% of the world's languages (Yip 2002), and can be found across the world, but they are particularly widespread across Asia, Africa and some parts of North America. Gordon (2016) notes that genetically balanced surveys such as LAPSyD (Maddieson et al. 2020) and WALS Maddieson (2013) show lower percentages at about 40-50% of tone languages; nevertheless, tone languages abound. Tones can be classified as level or contour, which involve a fall or rise. In African languages, contours are often the result of concatenation of level tones on a single tone bearing unit. Tonal distinctions – realized as pitch differences – can be employed to convey both lexical and grammatical functions, the latter referred to as grammatical tone (Rolle, 2018) or melodic tone in Bantu languages (Odden & Bickmore 2014, Marlo et al. 2015, Bickmore 2015). Grammatical tones mark distinctions between grammatical categories like tense, mood, aspect, etc., and can be found in a variety of languages. Rolle (2018:3) notes they are found in "Dogon (Heath 2008, a.o., McPherson 2014, McPherson & Heath 2016), Gur (Hyman & Olawsky 2004, Roberts 2016), Ijoid (Efere 2001, Harry 2004, Harry & Hyman 2014), Bantu (Odden & Bickmore 2014, Marlo et al. 2015), and Nilotic (Andersen 1995, Trommer 2011), as well as families outside of Africa such as Oto-Manguean in Mexico (Cruz 2011, McKendry 2013, Campbell 2014, Villard 2015, McIntosh 2015, Sullivant 2015, Palancar & Leonard 2016, Zimmermann 2016)…".

In this chapter, I present the tonal system of Gua. Tone has a lexical function in nouns, adjectives and postpositions. However, in the verbal system, Gua has grammatical tone that can be analyzed as tone melodies (systematic tone patterns) L, LH and HL which are exponents of the

Tense, Aspect and Mood (TAM) system. The implications of the patterns in Gua for linguistic theory and typology are also discussed.

The remainder of the chapter discusses basic tones and tone processes in section 7.1, lexical and grammatical tone functions are discussed in sections 7.2 and 7.3 respectively, grammatical tone and prefix selection constructions are in section 7.4. Interaction between grammatical tone and lexical subjects are discussed in section 7.5 and other prefixes' interaction with grammatical tone in TAM is discussed in section 7.6. Conclusion of the chapter is found in section 7.7.

7.1 Basic Tone in Gua

Gua has two basic level tones: low (L) and high (H), with downstep. Example (1) shows level tone distinctions between verbs and nouns in monomoraic words. The verbs have L tone while the nouns have H tone. All the verb examples connote the imperative forms of the verb. It is not possible to find monomoraic words within the same category that contrast for tone, as nouns including numerals, and some postpositions are always H toned and verbs are always L toned.

(1)	a.	tè	'weed (along a path)!'	té	'oath'
	b.	bã̀	'sew!'	bã́	'garden'
	c.	mĩ̀	'swallow!'	mĩ́	'1SG pronoun'

The tone bearing unit (TBU) is the mora. As the examples in (1) shows in the monosyllabic words, each word bears a single tone. Two main arguments support the mora as the TBU. First, long vowels and vowel sequences can bear two distinct tones, ex. bùá 'respond!' as part of the LH grammatical tone melody assigned, as we will see shortly. Second, a final nasal consonant coda also bears tone (see chapter 2). If the TBU were to be the syllable, long vowels would have had a single tone, but this is not the case in Gua.

Falling (HL) tone occurs on some nouns as illustrated in (2). This happens on the final vowel of bimoraic, bisyllabic nouns when the initial syllable has high tone. These nouns usually have noun class prefixes that bear high tones. Verbs do not show contour tones on monomoraic vowels, as will be shown in section 3.

(2) a. ɜ́nî̂ ‘mother’

b. ásî ‘father’

c. áfî ‘axe’

d. íkwâ ‘neck’

e. átɕɔ̂ ‘hoe’

f. ákʊ̂̂ ‘honey’

g. ɜ́bî ‘child’

h. ébî ‘children’

Contour tones on verbs occur on vowel sequences and long vowels. Yip (2002) notes that rising and falling tones result from the combination of two-level tones. See Odden (1995) and Silverman (1997) who shares the same assumptions. This appears to be the case in Gua. Example (3) shows cases of contour tones on sequences of vowels. Example (4) also demonstrates contour tones on long vowels. These tones are decomposable into either low-high or high-low. Sequences of low-high tones indicate imperative forms while sequences of high-low tones express past forms of the verbs.

(3)	a.	sìá	‘leave (some behind)!’	síà	‘..left (some behind)!’
	b.	bìá	‘break!’	bíà	‘..broke’
	c.	bùá	‘respond/answer!’	búà	‘..responded/answered’
(4)	a.	k͡pɔ̀ɔ́[32]	‘scald!’	k͡pɔ́ɔ̀	‘..scalded’
	b.	nũ̀ṹ	‘drink!’	nṹũ̀	‘drunk!’
	c.	dìí	‘sleep!’	díì	‘slept!’

In terms of distribution, short vowels bear single tones as shown in (1). However, there are limited cases where short vowels bear falling tones in bisyllabic nouns. In verbs, contour tones appear on bimoraic vowels, and are composed of high-low or low-high level sequences.

Does the falling tone suggest a third tone in Gua? The falling tones do not appear to be a third underlying tone. As noted, their occurrence is restricted to appear following high tones in nouns only. It is lexically-specific tone of nouns whose pattern does not occur in other word classes like adjectives, verbs, or other noun forms. The examples in (5) below show a contrast between the falling tone and the H-L pattern of past tense in Gua, where there is no falling tone.

(5)	a.	ɜ́nĩ̂	‘mother’	ɜ́nĩ̀	‘He/she knows’
	b.	ɜ́bî	‘child’	fálì	‘cleaned (body with towel)’
	c.	ásî	‘father’	bólì	‘broke’
	d.	ífî	‘a rope’	bírì	‘talked/spoke’

[32] From this point, I will represent long vowels as sequences of two vowels for tone purposes.

I analyze the falling tone in nouns as a H-tone spreading rule, but specific to nouns, similar to what occurs in languages like Yoruba (Connell & Ladd 1990). The consonant between the vowels is also required for this rule, as vowel sequences have a contour tone composed of a H and L tone. So this appears to be a case of peak delay where the drop to the low pitch is delayed into the second vowel. HF nouns are HL underlyingly.

(6)

```
H       L
|       |
V   C   V
```

7.2 Tone Processes in Gua

Tone processes refer to how different tonemes interact with other tonemes and segmental structures. Three processes in the language are tone stability, tone deletion and downstep.

7.2.1 Tone Stability

Tone stability occurs when a tone remains after the deletion or change of its tone bearing unit. There are two specific instances where tone is stable in Gua after the deletion of its TBU. The first case is observed when the final low tone of the third person singular object pronoun is not deleted but docks onto the nasal consonant that remains.

(6)	a.	sòbí mʊ̃̀	→	sòbĩ́m̀	'pull him/her!'
	b.	kpìtɛ̃́ mʊ̃̀	→	kpìtɛ̃́m̀	'separate him/her (from a fight)'
	c.	kpìsɛ́ mʊ̃̀	→	kpìsɛ̃́m̀	'lean against him/her!'
	d.	wʊ̀sʊ́ mʊ̃̀	→	wʊ̀sʊ̃́m̀	'shake him/her!'

Nevertheless, although the tone of the deleted vowel is low and the vowel on the final nasal is also low, it is not clear whether this is entirely due to tone stability. The bilabial nasal /m/ is the only nasal that can occur in word final position, and when it does, the tone is always low.

In the second case, a V1 assimilates to a V2, but the tones remain unchanged. This occurs in hiatus contexts with non-high vowels. So *bɔ̀tɛ́* 'roll-up' + *ɔ̀tèbí* 'animal' results in *[bɔ̀tɔ́ɔ̀tèbí]* 'roll-up an animal'. In this case although the /ɛ/ vowel assimilates completely, its tone is not altered. sɔ̀tɛ́ + òsé → [sɔ̀tóòsé] 'catch earthenware' is another example.

7.2.2 Tone deletion

Tone deletion occurs when a high vowel glides or is deleted in Gua. If the next TBU has the same tone it is not clear whether the tone fuses with the neighboring tone or if it deletes totally. The examples in (7) below involve two vowels with the same tone where the high vowel either deletes or is changed to a glide.

(7)	a.	sɔ̀kwí ífì	→	[sɔ̀kwífì]	'cease a rope!'
	b.	kòfí sɔ́kwì àdɛ́	→	[kòfí sɔ́kwjàdɛ́]	'Kofi ceased a cutlass'
	c.	kòfí sóbì ìsɛ́	→	[kòfí sóbìsɛ́]	'Kofi pulled a grass'

If the two tones are different, tone deletion is observed. Examples are cited in (8) below. The high vowel may occur before or after the non-high vowel; its tone may be low or high. In any of these cases, the non-high vowel retains its tone and the tone of the glided vowel deletes.

(8)	a.	àɲɛ̃́	ìdʑójì	H L	→	[àɲɛ̃́jdʑójì]	H	'a man's rope!'
	b.	sòbí	òní	H L	→	[sòbjònĩ́]	L	'pull a fish!'

c.	sɔ̀	ísɛ̂	L H	→	[sɔ̀jsɛ̂]	L	‘buy grass!’
d.	bùtú	ɜ̀bòbí	H L	→	[bùtwɜ̀bòbí]	L	‘cover a bird!’

7.2.3 Downstep

Downstep is a common tonal pattern in many Kwa languages: (e.g Akan (Dolphyne 1988/2006), Nkami (Asante 2016), Lɛtɛ (Akrofi Ansah 2009). Downstep is a tone lowering phenomenon such that a high tone is lowered following another high tone in an utterance, and subsequent tones are realized with reference to the lowered pitch. This is often attributed to the presence of a (floating) low tone between the high tones. Stewart (1965) makes a distinction between automatic downstep, which is not necessarily attributable to a low tone, and non-automatic downstep, which is due to the presence of a low tone. In Gua, nouns that have HF tones trigger non-automatic downstep on following high tones. The examples in (8) illustrate non-automatic downstep from the sequence HF HH, which is realized as HH ꜜHH (the arrow ꜜ indicates the following tone is lowered.

(8)	a.	ɜ́nĩ̂ tĩ́mĩ́ bólì tʊ́	→	ɜ́nĩ́ ꜜtĩ́mĩ́ bólì tʊ́	‘A short mother broke a gourd’
	b.	ásî tɛ̃́ńté bólì tʊ́	→	ásí ꜜtɛ̃́ńté bólì tʊ́	‘A tall father broke a gourd’
	c.	ífî tɛ̃́ńté fɛ́lì	→	ífí ꜜtɛ̃́ńté fɛ́lì	‘A long rope broke/teared’

The subject tone appears as HH in this context. The L tone has dislodged and floats between the two Hs, causing downstep, as shown in (9).

```
(9)        H  L    H              H   L  ꜜH
          /   \|   |             /   \     |
         V    V    V      →     V    V     V
```

The application of non-automatic downstep is clearly observed in the images below indicated with a red circle. The yellow circle also indicates a second downstep that may have occurred because of a preceding low tone.

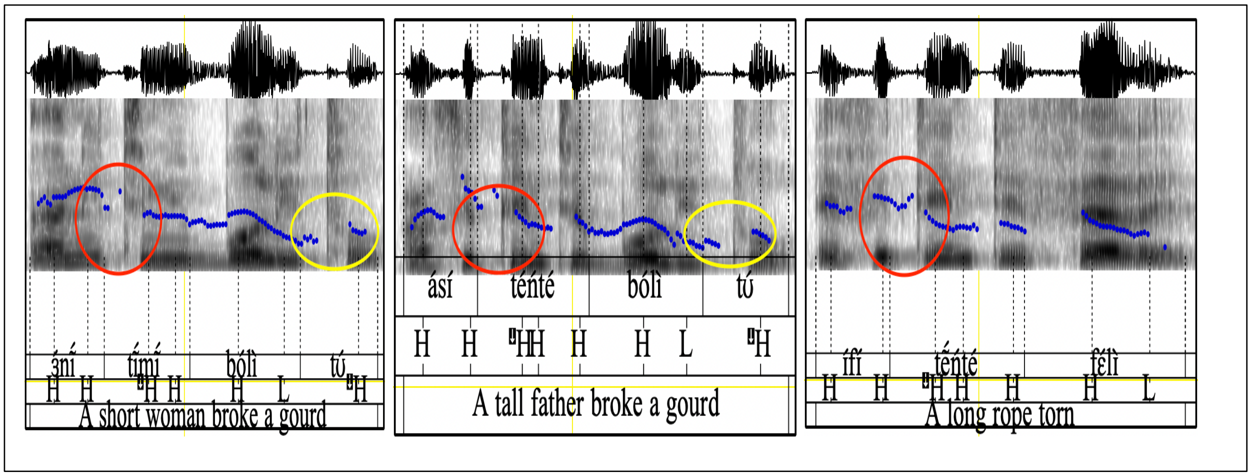


Figure 7.1: Downstep due to falling tones preceding H toned nouns

The examples in (10) below show the sequence (L)H H which does not exhibit downstep, as illustrated in the pitch tracks. The second H is realized at the same pitch as the preceding H tone.

(10)	a.	kòfí bólì kòkòsí	→	kòfí bólì kòkòsí	‘Kofi broke a coconut’
	b.	bɔ́ tɛ́ńté kɔ́ɔ̀	→	bɔ́ tɛ́ńté kɔ́ɔ̀	‘A tall red mountain’
	c.	ɜ̀lèbí tĩ́mĩ́ bólì tʊ́	→	ɜ̀lèbí tĩ́mĩ́ bólì tʊ́	‘A short boy broke a gourd’

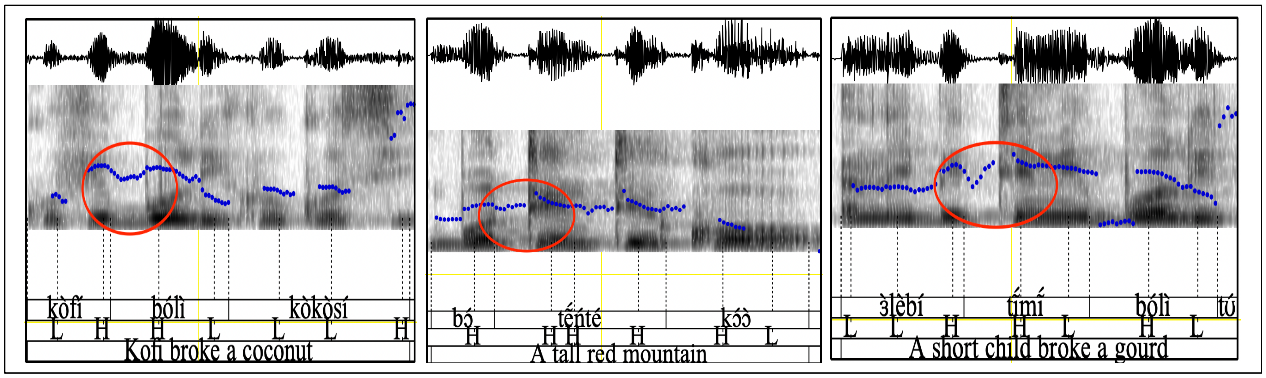


Figure 7.2: No downstep when H tones precede H toned nouns

Gua does not have nouns that end in low tones except when there are vowel sequences as in *téì* ‘food’, but it does have pronouns that end in L or H tones so we can test the effect of a L tone preceding a H tone in similar contexts. The final object *tʊ́* is also realized lower than the first H tones in the utterance, but it is not clear if this is a final lowering effect or downstep. In any case, it is not realized lower than a downstepped H tone. More research would be needed to ascertain whether multiple successive downsteps occurs. The following examples in (11) demonstrate that nouns and pronouns that end in either a falling tone or a low tone trigger downstep on a following H-toned verb.

(11)	a.	ɜ̀lèbí bólì tʊ́	→	ɜ̀lèbí bólì tʊ́	‘A boy broke a gourd’
	b.	ɔ̀kɔ́tɔ̀ bólì tʊ́	→	ɔ̀kɔ́tɔ̀ ꜜbólì tʊ́	‘A crab broke a gourd’
	c.	ásî bólì tʊ́	→	ásí ꜜbólì tʊ́	‘A father broke a gourd’
	d.	ɛ̀nĩ́ bólì tʊ́	→	ɛ̀nĩ́ bólì tʊ́	‘We broke a gourd’
	e.	ɔ́nĩ̂ bólì tʊ́	→	ɔ́ní ꜜbólì tʊ́	‘A mother broke a gourd’
	f.	ɛ́nĩ̀ bólì tʊ́	→	ɛ̀nĩ̀ ꜜbólì tʊ́	‘You.pl broke a gourd’

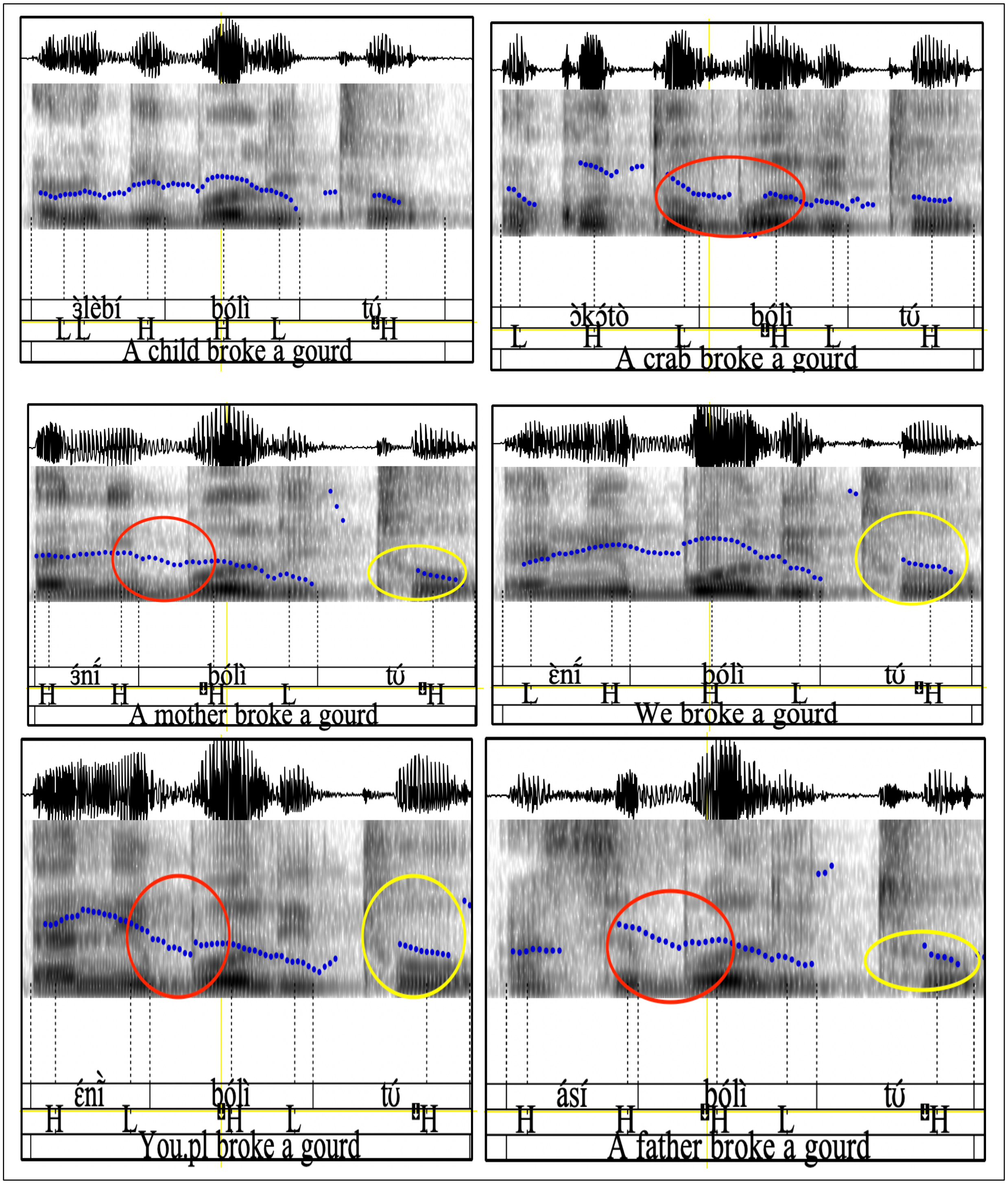


Figure 7.3: Downstep following nouns that end in L or F tone.

The images in Figure 7.3 suggest that downstep is only possible when the high tone is preceded by a Falling tone or low tone. Where there is HF tone, the L tone delinks from the subject and the subject is realized with HH tone as illustrated below. When there are sequences of two high tones with no intervening Ls, non-automatic downstep does not appear to occur as there is no lowering. If anything, the second H tone in succession is realized slightly higher than the preceding H tone.

7.3 Lexical Tone Melodies in Gua

Hyman (2017) notes that tone can do anything segments can do and more. In other words, whatever roles segments are noted to play, tone is capable of performing the same roles and functions, and even more. Tone has two main functions in tone languages: lexical and grammatical. Lexical functions distinguish basic words from others usually within the same word class while grammatical function of tone conveys morphosyntactic information or morphosyntactic constructions.

This section discusses lexical tone melodies in Gua. I will illustrate the tone patterns found on nouns, adjectives, post-positions and adverbs. There are many nouns, but other word classes like adjectives, postpositions and adverbs have very few words in Gua. However, these words are distinguished using various tonal patterns. The tonal patterns of the lexical words are discussed below.

7.3.1 Lexical tone melodies of Nouns

Nouns have different tonal patterns depending on the size. Monomoraic nouns have high tone only.

(12) a. kú 'hole'

b. sí 'sand/soil'

c. bɔ́ 'mountain'

d. lʊ́ 'hernia'

e. kpɔ̃́ 'knot/forest'

f. nɔ̃́ 'a farm'

g. kpí 'water storing equipment'

h. kpʊ́ 'sea'

i. tʊ́ 'gourd'

j. lé 'song'

k. té 'an oath'

Bimoraic bisyllabic nouns have one of two tone patterns: low-high (LH) or high-falling (HF). There are no HH or LL nouns. We analyzed HF as resulting from a HL pattern with H tone spreading. There are LH nouns in (13) while (14) has HF nouns.

(13) **LH Nouns**

a. àɲɛ̃́ 'man'

b. àtɕí 'woman'

c. àdɛ́ 'cutlass'

d. òsé 'earthenware'

(14) **HF Nouns**

a. ɜ́nî ‘mother’

b. ɜ́bî ‘snail’

c. átɕɔ̂ ‘hoe’

d. ésê ‘case/matter’

e. ífî ‘a rope’

f. íkwâ ‘neck’

g. áfî ‘an axe’

h. ísɛ̂ ‘grass’

There are also bimoraic monosyllabic nouns with vowel sequences as shown in the examples in (15). They have either LH or HL tone patterns. The HL pattern is only possible in nouns when there is no intervening consonant. This suggests the fall may be a timing issue where the drop to a lower pitch is delayed by the consonant, resulting in the fall. There is a case of plural subject pronoun *ɛ́nĩ̀* ‘you.pl’ which that has HL tone that is different from the tonal pattern with lexical nouns.

(15) a. téì ‘food’

b. k͡pàí ‘storage basket for smoked fish’

c. gbèí ‘dog’

d. tɕã́ĩ̀ ‘meat from cattle hide’

Trimoraic nouns have different tonal patterns: LLH and HLH, HLL patterns as in (16). Trimoraic nouns are less common in Gua. In trimoraic nouns, H tone can precede L tone without creating a falling tone.

(16) a. ɜ̀lèbí 'child'

b. ɜ̀tèbí 'animal'

c. ɔ̀kɔ́tɔ̀ 'a crab'

d. bókìtì 'bucket'

e. bókèté 'a bowl for measurement'

f. kòkòsí 'coconut'

Apart from monomoraic nouns which have only H tone, the tone patterns of nouns are alternating and involve a combination of L and H. There are no bimoraic or longer words that are all L or all H. If there are sequences of identical tone, they occur only in the trimoraic forms: LLH.

7.3.2 Adjectives

Gua does not have many non-derived adjectives, but the few available ones show distinct tone melodies. There are no monomoraic adjectives. Bimoraic adjectives have two patterns: HH tone (17a-b) when bisyllabic, and H͡L when they are long vowels (18a-b), which we assume to be the result of a H-L sequence.

(17) a. tĩ́mĩ́ 'short'

b. pébí 'small'

c. k͡pámã́ 'bad'

d. ík͡pá 'It's long/far'

(18) a. tũ̂: 'black'

b. kɔ̂: 'red'

Trimoraic adjectives show similar patterns. When bisyllabic with a nasal coda, the pattern is all H, like other bisyllables. As shown in chapter five of this dissertation, this N is a coda that bears the same tone as the preceding syllable in this context. If the final syllable has a long vowel, the pattern is H$\widehat{\text{HL}}$. The lone trisyllabic trimoraic adjective is LHL.

(19) a. lɛ̃́ńlé 'difficult/hard'

b. tɛ̃́ńté 'long/tall'

c. fítâː 'white'

f. ɔ̀bínà 'fat'

In sum, unlike nouns, adjectives show a propensity for all H pattern. The exceptions are the two final longer words.

7.3.3 Postpositions

Postpositions in monomoraic forms appear as either L or H while in bimoraic and trimoraic forms, there are LH and HHL structures.

(20) a. dá 'there'

b. dɛ̀ 'inside'

c. sɔ̀ 'on/upper surface'

(21) a. àmɛ̃́ 'back or behind'

b. ɛ́sílɛ̀ 'in front'

7.3.4 Ideophones

Ideophones are words that express various sensations in the form of sounds, images, size, among others. Dingemanse (2012:654) defines ideophones as "marked words depictive of sensory imagery found in many of the world's languages. They are noted for their special sound patterns, distinct grammatical properties, and sensory meanings." Gua has bimoraic and trimoraic ideophones but not monomoraic forms. The tonal patterns in some of the available forms in Gua are illustrated below. The examples show that they are usually bisyllabic/bimoraic and have long vowels or vowel sequences, and some forms have reduplication.

(22)	a.	kpǒː	'sounds made after hitting something with an object'
	b.	kpố̀m	'sound made by hitting any surface with the palm'
	c.	gɔ̂̂ː	'a bright color of a light or any brighter object or substance'
	d.	tî̂ː	'straight'
	e.	kpǎː	'noise made when two flat objects hit one another'
	f.	brɛ̀ʊ́	'slow movement/motion'
	g.	fɔ̀̀ǹtấń-fɔ̀̀ǹtáǹ	'of weather that is not clear early in the morning/foggy weather'

7.3.5 Numerals

There are H tones in monomoraic numerals, LH, HF, HL in bimoraic numerals. As in nouns, the distincton between HF and HL is the presence of a consonant between the vowels. In the trimoraic forms, there exist LLH forms.

(23)	a.	nɪ̃́	'five'
	b.	sã́	'three'

c. tɕʷí 'eight'

d. àkʊ́ 'one'

e. ídû 'ten'

f. sɪ̂ɛ̂ 'six'

g. ɜ́kpê 'one thousand'

h. ɔ̀lɔ̀fɛ́ 'one thousand'

i. ŋ͡ḿk͡pɛ́ɲɔ̃́ 'two thousand'

7.3.6 Summary of lexical tone patterns

Lexical tone patterns utilize the available tone types in the language; low, high and falling (although falling tone is very restricted and likely to be due to H tone spreading as discussed above) in distinguishing between other words. All lexical words discussed here except some postpositions with monomoraic forms have high tone while adjectives have high-high tones in bimoraic forms. However, nouns have LH and HF tone patterns in bimoraic bisyllabic forms, and L͡H and H͡L in bimoraic monosyllabic forms, where the ⁀indicates a contour on a long vowel or vowel sequence. In trimoraic forms, all lexical classes, nouns, adjectives and postpositions have distinct tone patterns, except for LHL shared between nouns and one adjective. Among ideophones, there are no monomoraic forms, but there are bimoraic forms. The bimoraic forms have L͡H and H͡L tones on long vowels. From the table below, we observe that the trimoraic forms have almost distinct tone patterns across the three categories. F stands for a falling tone on a single monomoraic vowel and H͡L to indicate a falling tone on a bimoraic vowel sequence or long vowel. Numerals also behave like nouns where there are H in monosyllabic words, LH, HF and HL in bisyllabic words while trisyllabic numerals have LLH, HHH attested in few forms.

Table 7.1: Summary of tone patterns in lexical words

	Nouns	Adjectives	Postpositions	Numerals	Ideophones
monomoraic	H	--	L H	H	--
bimoraic – monosyllabic	H͡L L͡H	H͡L	--	HL	H͡L L͡H
bimoraic – bisyllabic	LH HF	HH	LH	LH HF	--
trimoraic - bisyllabic	--	HHH HH͡L	--	LLH HHH	
trimoraic trisyllabic	LLH HLL HLH LHL	LHL	HHL		

7.4 Grammatical Tone Function, Tone Melodies and TAM structures in Gua

As noted earlier, grammatical tones mark distinctions between grammatical categories like tense, mood, aspect, etc through different tone patterns. This section presents the tonal patterns in Gua verbs. Gua verbs do not show lexical tone – there is only grammatical tone that can be analyzed as tone melodies (systematic tone patterns) L, LH and HL which are exponents of the Tense, Aspect Mood (TAM) system. Tone melodies in Gua are found on verb roots, and verbal prefixes adopt tone that avoids a tone clash between the tone of the prefixes and the tone melodies of the verb roots. In this section, basic tone marking, grammatical tone patterns and tone patterns with the verbal prefixes are discussed. The verbal template for the tone patterns is as follows, where AM = associated motion.

(24) SUBJ(sg)-NEG-TAM- AM-root.

Throughout the remainder of this chapter, I will transcribe long vowels such as [ɛ̂ː] with double letters as [ɛ́ɛ̀] so that alternating tone patterns can be more clearly seen.

7.4.1 Habitual Aspect

In habitual constructions, all verb forms have L tone: monomoraic (25), bimoraic monosyllabic (26), bimoraic bisyllabic (27) and trimoraic (28). There are no cases of CVCVV and CVVCV verb forms, although CVNCV are possible.

Monomoraic verbs

(25) a. ɛ́nì kɛ̀ ɛ̀dɛ́
2PL.SUBJ teach/show.HAB thing
'You teach (something)'

b. ɛ́nì tè àkpɛ́ à
2PL.SUBJ weed.HAB path/road DET
'You weed along the path'

Bimoraic monosyllabic verbs

(26) a. ɛ́nì dàȉ téì
2PL.SUBJ cook.HAB food
'You cook food'

b. ɛ́nì dìì
2PL.SUBJ sleep.HAB
'You sleep'

Bimoraic bisyllabic verbs

(27) a. ɛ́nì kpɔ̀lì dá
2PL.SUBJ clean.HAB there
'You clean there'

b. ɛ́nì bòlì kókósì
2SG.SUBJ break.HAB coconut
'You break a coconut'

Trimoraic trisyllabic verbs

(28) a. ɛ́nì bùrùfè b. ɛ́nì fùrùtɕì

2PL.SUBJ urinate.HAB 2PL fly.HAB

'You urinate' 'You fly'

A list of monosyllabic and bisyllabic verbs is given below that show the patterns.

(29)

fì	'sell'	bòlì	'break'
kwè	'grind'	k͡pɔ̀lì	'clean'
wɔ̀	'pound'	sòbì	'pull'
tɕà	'dance'	kwɛ̀lɛ̀	fry'
kù	'cut/dig'	sɔ̀tɛ̀	'catch'
tɕè	'pass/pass by'	dã̀ĩ̀	'cook'
sɔ̀	'buys/collect'	dʑã̀ĩ̀	'search'
sɛ̀	'fetch'	sĩ̀ǹtĩ̀	'hit foot against stone'
dʑò	'wait'	fĩ̀ǹtĩ̀	'jump'
fɔ̀	'wash'	dɜ̃̀ǹtɕĩ̀	'turn'

7.4.2 Past Tense

Past tense marking in Gua has L tone on monomoraic verbs, HL on bimoraic verbs (both monosyllabic and bisyllabic) and HHL on trimoraic verbs. The monomoraic past forms are identical to the habitual forms. The examples in 30-33 below show the various forms of the verb based on tone pattern in the past. These are the same roots that were used to illustrate the habitual forms above. We therefore conclude that tone in verbs is grammatical. The verb forms in (30) also indicate that sequences of vowels and the long vowels are bimoraic (cf. examples 18 and 19). They have a HL tone pattern realized on them, but there is only L tone on the monomoraic verbs.

Monomoraic verbs

(30) a. ɛ́nì[33] kɛ̀ ɛ̀dɛ́
2PL.SUBJ teach/show.PST thing
'You taught (something)'

b. ɛ́nì tè àk͡pɛ́ à
2PL.SUBJ weed.PST path/road DET
'You weeded along the path'

Bimoraic monosyllabic verbs

(31) a. ɛ́nì dɑ̃́ɪ̃̀ téì
2PL.SUBJ cook.PST food
'You cooked food'

b. ɛ́nì díì
2PL.SUBJ sleep.PST
'You slept'

Bimoraic bisyllabic verbs

(32) a. ɛ́nì k͡pɔ́lì dá
2PL.SUBJ clean.PST there
'You cleaned there'

b. ɛ́nì bólì kókósí
2SG.SUBJ break.PST coconut
'You broke a coconut'

Trimoraic verbs

(33) a. ɛ́nì búrúfè
2PL.SUBJ urinate.PST
'You urinated'

b. ɛ́nì fúrútɕì
2PL fly.PST
'You flew'

---

[33] I do not indicate nasalization within the same syllable from this point in order to clearly see the tones on vowels.

The data below illustrate other verbs in the language that show the same tone pattern. It must be noted that CVNCV forms have HHL, where the second H is on the nasal. If the nasal is moraic, these are trimoraic forms and have the same tone as the CVCVCV forms.

(34)

fì	'sell'	bólì	'break'
kwè	'ground	k͡pɔ́lì	'cleaned'
wɔ̀	'pounded'	sóbì	'pulled'
tɕà	'danced'	kwɛ́lɛ̀	fried'
kù	'cut/dug'	sɔ́tɛ̀	'caught'
tɕè	'passed/passed by'	dẫĩ̀	'cooked'
sɔ̀	'bought/collected'	dʑẫĩ̀	'searched'
sɛ̀	'fetched'	sĩ́ńtĩ̀	'hit foot against stone'
dʑò	'waited'	fĩ́ńtĩ̀	'jumped'
fɔ̀	'washed'	dʒɔ̃́ɲ́tɕĩ̀	'turned'

Since the bimoraic and trimoraic forms have HL and HHL, this suggests that there is a HL tone melody realized across the verb root. However, one would have expected a HL contour on the monomoraic form, and yet this does not occur. There are no words like *dû, *bâ or *dɔ̂ with a falling tone on any monomoraic words in Gua. This suggests that there is a ban on the presence of contour tones on monomoraic words. The only contour tones that can appear on a single mora are those in bisyllabic nouns of the shape (C)VCV with the HF pattern.

Due to the identical nature of the tone on monomoraic verbs, when speakers are asked to tell the differences between the habitual construction and the past, they find it difficult to point out.

One of my consultants who attempted a distinction could only say that "there is no clear difference between them but when you utter them, we can distinguish between them and know which construction you uttered. Another way is to add the specific time in the past to show the difference". Lɛtɛ has a similar situation and Akrofi Ansah suggests that a similar strategy is adopted to account for the difference between past and present tenses in Lɛtɛ (Akrofi Ansah 2009).

7.4.3 Imperatives

Imperative forms of the verbs have a L pattern in monomoraic forms (35), but LH pattern in bimoraic forms (36-37) and LLH in the trimoraic forms (38).

Monomoraic Verbs

(35) a. tè 'weed (along a path)!' b. kù 'cut!'

c. mĩ̀ 'swallow!'

Bimoraic monosyllabic verbs

(36) a. dàĩ̀ 'cook!' b. dìì 'sleep!'

c. dʑã̀ĩ́ 'search (for it)! d. sã̀ĩ́ 'untie!'

Bimoraic bisyllabic Verbs

(37) a. bòlí 'break!' b. sòbí 'pull!'

c. kwɛ̀lɛ́ 'fry!' d. tɕùkʷí 'uproot!'

Trimoraic Verbs

(38) a. bùrùfé ‘urinate!’ b. fùrùtɕí ‘fry!’

c. kpìlàtɕí ‘vomit!’

These data suggest that imperatives employ a LH tone melody, but that the monomoraic verbs reduce this to L. See the list below for more imperative verb forms.

(39)

fì	‘sell!’	bòlí	‘break!’
kwè	‘grind!’	k͡pɔ̀lí	‘clean!’
wɔ̀	‘pound!’	sòbí	‘pull!’
tɕà	‘dance!’	kwɛ̀lɛ́	fry!’
kù	‘cut/dig!’	sɔ̀tɛ́	‘catch!’
tɕè	‘pass/pass by!’	dã̀ĩ́	‘cook!’
sɔ̀	‘buys/collect!’	dʑã̀ĩ́	‘search!’
sɛ̀	‘fetch!’	sĩ̀ǹtĩ́	‘hit foot against stone!’
dʑò	‘wait!’	fĩ̀ǹtĩ́	‘jump!’
fɔ̀	‘wash!’	dʒ̃̀ɲ̀tɕĩ́	‘turn!’

The data presented so far indicate that a contour tone is dispreferred, but the way this is resolved in both past and imperative is as a L tone. Again, there are L tones in all forms of habitual aspect. There are however, HL and HHL in the bimoraic and trimoraic past forms respectively while bimoraic imperatives have LH and their trimoraic counterparts have LLH patterns. The table in 7.2 below presents a summary of the TAM tone patterns of unaffixed verb forms in Gua.

Table 7.2: Summary of patterns in TAM Forms without Prefixes

Stem size/ TAM	HABITUAL	PAST	IMPERATIVE
Monomoraic	L	L	L
Bimoraic	LL	HL	LH
Trimoraic	LLL	HHL	LLH

The melodies associated with each of these TAM categories can be described as L, HL and LH. The tones are associated at the right edge of the verb root and spread over the root from right to left, giving rise to HHL and LLH in the trimoraic roots. However, they are reduced to L in the monomoraic forms, and the H is unrealized. The diagrams below represent how LH and HL melodies are assigned. The moraic representation of the tone melodies in monomoraic, bimoraic and trimoraic words are given. Those in bimoraic forms illustrate how tone is assigned to sequences of vowels, long vowels and short vowels in CVCV structures.

(40)

(a) Monomoraic

```
  L  H          H   L
  |                 |
  μ                 μ
  |                 |
 k u               ku
```

(b) Bimoraic

```
   L  H          L   H          L    H
   |  |          |   |          |    |
   µ  µ          µ   µ          µ    µ
   |  |           \ /           |    |
s  i  a          d ɪː         b  o  l  i

   H  L          H   L          H    L
   |  |          |   |          |    |
   µ  µ          µ   µ          µ    µ
   |  |           \ /           |    |
s  i  a          d ɪː         b  o  l  i
```

(c) Trimoraic

```
   L    H            H    L
  / \   |           / \   |
 µ   µ  µ          µ   µ  µ
 |   |  |          |   |  |
 b u r u f e       b u r u f e
```

7.5 Tone Melody, prefix selection and TAM marking

The same tone melodies L, LH, and HL appear on verb roots in other tense, mood, aspect configurations, as well as on the prefixes that accompany them. These prefixes mark future tense as well as progressive and perfective aspects. The following sections discuss the tonal patterns of the prefixes and the roots. The melodies that are selected for the prefixes ensure that there is alternating tone, which could be a reflex of the Obligatory Contour Principle (OCP) preventing adjacent identical autosegmental tones. The prefixes may not actually have underlying tone but receive tone by virtue of needing the opposite tone from that on the root – tone polarity. This means that, there is some well-formedness correspondence between the prefixes and the roots to ensure that the OCP is respected.

7.5.1 Perfective

Perfective aspect in Gua is marked by a HL melody on the root and a prefix *ɛ́ɛ̀-* which also has the HL melody. The perfective constructions have HL patterns in bimoraic forms (42-43), HHL in the trimoraic forms (40) and H pattern in the monomoraic forms (44). In the past forms without the prefixes, the monomoraic forms which had HL tone pattern reduced to L, but in the forms with the prefixes, the tone reduction becomes H (41).

Monomoraic verbs

(41) a. ɛ́nì ɛ́ɛ̀-kɛ́ ɛ́dɛ̂
2PL.SUBJ PERF-come.PERF thing
'You have taught (something)'

b. ɛ́nì éè-té àk͡pɛ́ à
2PL.SUBJ PERF-weed.PERF path/road DET
'You have weeded along the path'

Bimoraic monosyllabic verbs

(42) a. ɛ́nì ɛ́ɛ̀-dɑ̃̂ĩ̀
2PL.SUBJ PERF-cook.PERF
'You have cooked (food)'

b. ɛ́nì éè-díì
2PL.SUBJ PERF-sleep.PERF
'You have slept'

Bimoraic bisyllabic verbs

(43) a. ɛ́nì ɛ́ɛ̀-kpɔ́lì dá
2PL.SUBJ PERF-clean.PERF there
'You have cleaned there'

b. ɛ́nì éè-bólì kòkòsí
2PL.SUBJ PERF-break.PERF coconut
'You have broken a coconut'

Trimoraic verbs

(44) a. ɛ́nì éè-búrúfè
2PL.SUBJ PERF-urinate.PERF
'You have urinated'

b. ɛ́nì éè-fúrúʨì
2PL PERF-fly.PERF
'You have flown'

7.5.2 Progressive

Progressive aspect is marked by L melody on the root and a prefix *ɛ̀ɛ́-* which has LH melody. The monomoraic forms have L (45), bimoraic forms have LL pattern (46-47), and LLL in the trimoraic forms (48).

Monomoraic verbs

(45) a. ɛ́nì ɛ̀ɛ́-kɛ̀ ɛ̀dɛ̀
3PL.SUBJ PROG-come.PROG thing
'You are teaching (something)'

b. ɛ́nì èé-tè àk͡pɛ́ à
2PL.SUBJ PROG-weed.PROG path DET
'You are weeding along the path'

Bimoraic monosyllabic verbs

(46) a. ɛ́nì ɛ̀ɛ́-dã̀ĩ̀
2PL.SUBJ PROG-cook.PROG
'You are cooking (food)'

b. ɛ́nì èè-dìì
2PL.SUBJ PROG-sleep.PROG
'You are sleeping'

Bimoraic bisyllabic verbs

(47) a. ɛ́nì ɛ̀ɛ́-kpɔ̀lì dá
2PL.SUBJ PROG-clean.PROG there
'You are cleaning there'

b. ɛ́nì èé-bòlì kòkòsí
2PL.SUBJ PROG-break.PROG coconut
'You are breaking a coconut'

Trimoraic verbs

(48) a. ɛ́nì èé-bùrùfè b. ɛ́nì èé-fùrùtɕì

2PL.SUBJ PROG-urinate.PROG 2PL PROG-fly.PROG

'You are urinating' 'You are flying'

7.5.3 Future Tense

The future tense has HL melody on the root and the prefix bɛ̀- is L. The pattern on the monomoraic forms have H (49), the bimoraic roots have HL (50-51), and HHL on the trimoraic forms (52).

Monomoraic verbs

(49) a. ɛ́nì bɛ̀-kɛ́ ɛ̀dɛ̀ b. ɛ́nì bè-té àk͡pɛ́ à

2PL.SUBJ FUT-come.FUT thing 2PL.SUBJ FUT-weed.FUT path/road DET

'You are teaching (something)' 'You will weed along the path'

Bimoraic monosyllabic verbs

(50) a. ɛ́nì bɛ̀-dɑ̃́ɪ̃̀ b. ɛ́nì bè-díì

2PL.SUBJ FUT-cook.FUT 2PL.SUBJ FUT-sleep.FUT

'You will cook (food)' 'You will sleep'

Bimoraic bisyllabic verbs

(51) a. ɛ́nì bɛ̀-kpɔ́lì dá b. ɛ́nì bè-bólì kòkòsí

2PL.SUBJ FUT-clean.FUT there 2PL.SUBJ FUT-break.FUT coconut

'You will clean there' 'You will break a coconut'

Trimoraic verbs

(52) a. ɛ́nì bè-búrúfè b. ɛ́nì bè-fúrútɕì

2PL.SUBJ FUT-urinate.FUT 2PL FUT-fly.FUT

'You will urinate' 'You will fly'

The tone of the prefix is LH if the root is low-toned, but it is HL or L if the root has the HL pattern. This means that there is always a change of tone across the prefix-root boundary, either L-H or H-L. I claim that such an alternating pattern is not a coincidence but suggests that the OCP is playing a role in the choice of prefix tone. Rather than the prefixes having underlying tone, I propose that the prefixes select a tone melody that ensures no identical tones clash across the prefix-root boundary, and furthermore that selection of the tone is from the available melodies: L, HL or LH. LH is assigned to progressive ɛɛ- as the root melody is L, ensuring alternating tone. HL is assigned to perfective ɛɛ- as the root melody is HL. Why is L not selected? Why not ɛ̀ɛ̀-k͡pɔ́lì? It seems that the only time the same tone is found on long vowels within words is when a TAM grammatical tone is assigned to short CVV roots. It seems that the preference in Gua may be for a contour on a long vowel/sequences of vowels, but it will be realized as LL if the TAM grammatical tone forces it to be. The future also has a HL melody, but its prefix is monomoraic, so it receives L tone. The tone patterns in Gua are summarized in Table 7.3 below.

Table 7.3: Summary of the TAM tone melody with their prefixes in Gua

Stem size/ TAM	HAB	PAST	IMP	PROG ὲέ-	PERF έὲ-	FUT bὲ-
Mono	L	L	L	LH-L	HL-H	L-H
Bi	LL	HL	LH	LH-LL	HL-HL	L-HL
Tri	LLL	HHL	LLH	LH-LLL	HL-HHL	L-HHL

L tone is selected in the monomoraic forms without TAM prefixes. This is the case for the HL past and the LH imperative melodies. When the prefixes occur, however, the HL tone melody of the future and the perfective is not realized as L on the monomoraic forms but as a H tone. There is no LH root melody attested with prefixed forms. If they had reduced to L, there would be a L-L sequence across the morpheme boundary, a violation of the OCP. This suggests that the tone of the prefix is selected prior to reduction of the contour: the root is assigned HL, the toneless prefix attaches – HL gets assigned to it, giving HL-HL. The contour on the monomoraic root reduces to H to avoid OCP violations. If there is no prefix, then it reduces to L.

Even though Gua reduced HL and LH melodies to L on unprefixed forms, on prefixed forms, the tone on the root cannot be L if there is an immediately preceding L tone; it is constrained by the OCP to ensure that cross-morpheme tones are dissimilar. This explains why there is H tone in the monomoraic forms in future and perfective constructions while the progressive form maintains its L tone.

7.6 Tone melody on Subjects and TAM interactions

The tone melody on the verb also has some significant effect on the choice of tone on subjects. This section considers tones on the verb and how they interact with the type of tone on pronouns and lexical subjects. I will illustrate this with singular and plural pronouns as well as monomoraic and bimoraic lexical subjects. I will not discuss the imperative forms here because they do not require a subject.

7.6.1 Monomoraic pronoun subjects for habitual aspect and past tense

In the habitual aspect constructions, all singular pronouns which are monomoraic have H tone and the bimoraic verb stem has LL tone as illustrated in (53a-c).

(53) a. mí-bòlì kòkòsí

1SG-break.HAB coconut

'I break a coconut'

b. wú-bòlì kòkòsí

2SG-break.HAB coconut

'You break a coconut'

c. ɜ́-bòlì kòkòsí

3SG-break.HAB coconut

'He/she breaks a coconut'

In contrast, the past tense has L tone on the monomoraic pronoun[34] and the verb has HL (54a-c).

[34] The 1SG and 2SG pronouns have different forms between the two TAMs: 1SG mí vs. ǹ and 2SG wú vs. ò. see chapter 5 for discussion of subject pronoun allomorphs.

(54) a. m̀- bólì kòkòsí

1SG-break.PST coconut

'I broke a coconut'

b. ò- bólì kòkòsí

2SG-break.PST coconut

'You broke a coconut'

c. ɜ̀- bólì kòkòsí

3SG-break.PST coconut

'He/she broke a coconut'

7.6.2 Bimoraic plural pronouns for habitual aspect and past tense

Bimoraic plural pronoun subjects have LH tone in first person, HL in second person and LL in third person in habitual aspects while the verb has LL in the habitual constructions (55a-c). The tone on the plural subject pronouns in the habitual aspect is the same as that found in the past tense (56a-c), even though the tone of the verb root is HL (56a-c).

(55) a. ɛ̀ní bòlì kòkòsí

1PL break.HAB coconut

'We break a coconut'

b. ɛ̀ní bòlì kòkòsí

2PL break.HAB coconut

'You break a coconut'

c. ɛ̀mú bòlì kòkòsí

3SG break.HAB coconut

'They break a coconut'

(56) a. ɛ̀ní bólì kòkòsí

1PL break.PST coconut

'We broke a coconut'

b. ɛ́nì bólì kòkòsí

2PL break.PST coconut

'You broke a coconut'

c. ɛ̀mù bólì kòkòsí

3PL break.PST coconut

'They broke a coconut'

The patterns above show that unlike the monomoraic singular pronoun subjects which show differences in the subject between habitual aspect and past tense, their bimoraic plural counterparts do not show such differences. The plural pronouns are identical in both the habitual aspect and the past tense. We previously established from vowel harmony, that the plural pronouns are independent words. This wordhood status may be what makes them immune to tone alternations.

7.6.3 Monomoraic and bimoraic singular subject in habitual aspect and past tense

Monomoraic lexical nouns have H tone in both habitual aspect and past tense. The monomoraic lexical noun in (57a) has H tone for the habitual aspect and the same tone pattern for the monomoraic subject in the past (57b) as well. Monomoraic lexical subjects do not show tone alternations like monomoraic singular pronouns.

(57) a. tʊ́ wàtɕì[35]

gourd break.HAB

'A gourd breaks'

b. tʊ́ wátɕì

gourd break.PST

'A gourd broke'

Like their bimoraic plural pronoun subject counterparts, bimoraic lexical subjects do not show tone differences in habitual aspect and past tense forms either. Examples (58a-b) show subjects with LH tone for habitual aspect and past tense respectively. Examples in (59a-b) show HL patterns for habitual aspect and past tense respectively.

(58) a. kòfí bòlì tʊ́

kofi break.HAB gourd

'Kofi breaks a gourd'

[35] Here is another form of breaking something open (usually into two parts/halves) that is different from coconut.

b. kòfí   bólì   tʊ́

kofi   break.PST gourd’

‘Kofi broke a gourd’

(59) a. kwámì   bòlì   tʊ́

kwame   break.HAB gourd

‘Kwame braeks a gourd’

b. kwámì   bólì   tʊ́

kwame   break.PST gourd

‘Kwame broke a gourd’

The data so far shows that there is tone alternation on the monomoraic singular pronoun subjects, but not other subjects. A HL past verb triggers a low-toned prefix, but a L habitual verb triggers a H toned prefix. However, with monomoraic and bimoraic lexical subjects as well as bimoraic plural pronouns, there is no such distinction. The patterns suggest that the alternation does not relate to the size of the subject; rather the singular pronouns alternate their tone pattern because they are prefixes on the verb and therefore interact with the rest of the verb tonally. An alternate account for the tone patterns is that the short set of allomorphs has L tone while the longer set of allomorphs has H tone. But this is not the right generalization as we will see below in other examples.

7.6.4 Monomoraic singular pronouns with prefixed verbs

The same tone pattern on the subjects are deployed when they occur before verbal prefixes. Future tense has the future marker bɛ̀ with L tone, perfective aspect has an ɛ́ɛ̀ marker with HL falling tone and progressive aspect has an ɛ̀ɛ́ marker with LH rising tone. The future prefix begins with L tone, and the tone of the monomoraic singular pronoun is H, as predicted by the alternating pattern requirement. Examples in (60a-c) illustrate the tone pattern on the monomoraic singular subject with future stem. The singular subject pronoun has H tone.

(60) a. ḿ- mè-bólì tʊ́

1SG FUT-break.FUT gourd

'I will break a gourd'

b. wú- bè-bólì tʊ́

2SG FUT-break.FUT gourd

'You will break a gourd'

c. ɜ́- bè-bólì tʊ́

3SG FUT-break.FUT gourd

'He/she will break a gourd'

The 1SG pronoun in the future is not mí as occurs with the habitual, but a single ḿ with H tone. It causes the following /b/ to assimilate completely, as discussed in chapter 5. The other pronouns resemble those that appear with the habitual.

In perfective and progressive aspects, several phonological processes affect the form of the pronoun and its ability to bear tone. The vowel of the singular pronouns does not appear - it deletes, fuses or becomes a glide as the TAM prefix is vowel-initial. Assuming that the pronoun is underlyingly -ATR, the high vowel of the first person singular pronoun /mɪ/ becomes [mj] before the front vowel prefix ɛɛ- or ee-. In the second person singular pronoun, the vowel of the pronoun (assumed to be /ʊ/) combines with the prefix /ɛɛ/ to become [ɔɔ], or [oo] under vowel harmony. It cannot become a glide [w] as the onset is already [w]. The third person singular pronoun /a/ fuses with the prefix, and there is no change to the prefix vowel other than standard vowel harmony. The tone of the prefix is consistently HL in each of these cases for perfective aspect (61a-c) and LH for the progressive aspect (62a-c).

(61) a. mj-éè-bólì tʊ́

1SG-PERF-break.PERF gourd

'I have broken a gourd'

b. wóò-bólì tʊ́

2SG.PERF-break.PERF gourd

'You have broken a gourd'

c. ɜ́ɜ̀- bólì tʊ́

3SG.PERF-break.PERF gourd

'He/she has broken a gourd'

(62) a. mj-èé-bòlì tʊ́

1SG-PROG-break.PROG gourd

'I am breaking a gourd'

b. wòó-bòlì tʊ́

2SG.PROG-break.PROG gourd

'You are breaking a gourd'

c. ɜ̀ɜ́-bòlì tʊ́

3SG.PROG-break.PROG gourd

'He/she is breaking a gourd'

Therefore, there is no independent tone pattern that appears on the singular pronouns in the perfective and progressive forms. Only the tone pattern of the verbal prefixes appears, either HL or LH. I argued in chapter 5 that the form of the prefixes for perfective and progressive is the long form due to the glide formation with 1SG. If the tone of these subject allomorphs is H-toned, as it is in other forms, then a á-àá sequence would have to be reduced as three tones are not sanctioned on two moras; conversely, if the tone of the subject allomorphs is L-toned, then a à-àá sequence would also have to be reduced, and would predictably become LH as two L tones reduce to one. Therefore, it is not possible to determine what the tone of the subject prefixes is in these forms, but they are the CV forms.

7.6.5 Bimoraic plural pronoun subjects with prefixed verbs

Bimoraic singular pronouns have the full form with their tonal patterns in future tense, but the final vowel of the perfective and progressive aspects become a glide and losses its tone due to hiatus resolution as discussed in chapter six. However, they are maintained in these examples for simplicity's sake. Therefore, the full form of the prefixes with their tone patterns are realized in the stem. Examples in (63a-c) show the pattern in future tenses, those in (64a-c) are perfective forms, and examples in (65a-c) illustrate the progressive forms.

(63) a. ɛ̀ní   bè-bólì   tɔ́

1PL FUT-break.FUT gourd

'We will break a gourd'

b. ɛ́nì   bè- bólì   tɔ́

2PL FUT-break.FUT gourd

'You will break a gourd'

c. ɛ̀mù   bè-bólì   tɔ́

3PL   FUT-break.FUT gourd

'They will break a gourd'

(64) a. ɛ̀nj   éè-bólì   tɔ́

1PL PERF-break.PERF gourd

'We have broken a gourd'

b. ɛ́nj   éè-bólì   tɔ́

2PL PERF-break.PERF gourd

'You have broken a gourd'

c. ɛ̀m^{w} éè-bólì   tɔ́

3PL   PERF-break.PERF gourd

'They have broken a gourd'

(65) a. ɛ̀nj   èé- bòlì   tɔ́

1PL PROG-break.PROG gourd

'We are breaking a gourd'

b. ɛ́nj   èé-bòlì   tɔ́

2PL PROG-break.PROG gourd

'You are breaking a gourd'

c. ɛ̀mw èé-bòlì tʊ́

3PL PROG-break.PROG gourd

'They are breaking a gourd'

7.6.6 Lexical subjects with prefixed verbs

Lexical subjects also do not change their tone pattern irrespective of their size and the TAM form the construction marks unless hiatus is resolved between them and TAM prefixes. There is H tone in monomoraic lexical subjects while the bimoraic lexical subjects could have LH, HL, or H-falling. Examples in (66a-c) illustrate the monomoraic lexical noun in future tense, perfective and progressive aspects respectively.

(66) a. tú bè- bólì

gourd FUT-break.FUT

'A gourd will break'

b. tw éè- bólì

gourd PERF-break.PERF

'A gourd has fallen on the ground'

c. tw èé-bólì

gourd PROG-break.PROG

'A gourd is breaking'

The bimoraic counterparts of the lexical subjects are in (67) and (68). They do not change their tone patterns except when there is hiatus resolution which causes the final vowels to lose their tones. They have the same tone pattern on the subject across all the TAM forms. The examples in

(67a-b) show future tense forms, (68a-b) indicate perfective forms and (69a-b) show the progressive aspect forms with bimoraic lexical subjects.

(67) a. kòfí bè-hé tù sílɛ̀

kofi FUT-fall.FUT throw land/soil

'Kofi will fall on the ground'

b. kwámì bè- bólì tʊ́

kwame FUT-break.FUT gourd

'Kwame will break a gourd'

(68) a. kòfí éè-bólì tʊ́

kofi PERF-break.PERF gourd

'Kofi has broken a gourd'

b. kwámì éè-bólì tʊ́

kwame PERF-break gourd

'Kwame has broken a gourd'

(69) a. kòfí èé-bòlì tʊ́

kofi PROG-break.PROG gourd

'Kofi is breaking a gourd'

b. kwámì èé-bòlì tʊ́

kwame PROG-break.PROG gourd

'Kwame is breaking a gourd'

When the verb stem begins with a L the prefixes are H and when it starts with a H tone, the prefix tones end in L. The singular pronoun is H before the future prefix, but there is no independent vowel to bear tone before the perfective and progressive aspects, so subject tone cannot be accurately determined. It could be that the selection of subject allomorphs is governed by tone on the verbs stem, since low-toned short allomorphs occur before H and high-toned CV allomorphs occur before L. However, the selection of the CV forms with the perfective HL prefix suggests that is not the case. When there are monomoraic and bimoraic lexical subjects as well as bimoraic plural pronouns, there is no change in the tone of the subject except when hiatus is resolved which makes the high vowels become glides and lose their tones.

7.6.7 Interim summary of findings for lexical and grammatical tones in Gua

The tone patterns presented so far shows that verbs have only grammatical tone in Gua. Gua has tone patterns that can be analyzed as tone melodies L, HL and LH that are systematically selected by verb roots based on the TAM forms they mark in verbal structures. The spreading of the initial tone of the melody depends on the size of the root. Again, the same L, LH and HL melodies appear on TAM prefixes. In addition, Gua adopts an adherence to the OCP between prefixes and stems. The tone of prefixes shows a polarity effect in that they are always opposite to the following verb root tone. This holds for TAM prefixes and for subject prefixes that precede them. While the TAM prefixes do not alter their tones, as they occur with fixed tone root melodies, the subject prefixes are attached to all TAM forms and so can vary their tone depending on the tone that follows. Finally, low tones appear on monomoraic verbs without prefixes no matter the TAM melody, but a H tone can appear instead on prefixed forms to avoid an OCP violation.

7.7 Additional prefixes in TAM Constructions

Section 7.6 shows that Gua has prefixes whose selection is governed by dissimilation/OCP restrictions. Plural subject pronouns and lexical nouns are not affected by tone dissimilation restrictions as they constitute separate words. This section discusses the gerund prefix, negative prefix, and the associated motion prefixes that occur before the TAM stem. We will see that the gerund and the associated motion prefixes conform to the OCP-induced alternating tone polarity effect. This is not the case for the negative prefix, which is consistently high no matter what tone follows.

7.7.1 Gerund Form of the Verb and the nominalizer ɔ̀-/ò-

There is a gerund form of the verb that consists of a L-toned prefix and a HL tone pattern on the verb root. The examples in (70) below show how the gerund form attaches to verbs of attested sizes in the language.

(70) a. ò-kpó 'closing'

b. ò-sı̃́ 'accompanying'

c. ɔ̀-sɔ̃́ 'burning'

d. ò-kpítè 'cleaning'

e. ò-sóbì 'pulling'

f. ɔ̀-kpɔ́lì 'cleansing'

g. ò-búrúfè 'urinating'

h. ɔ̀-fı̃́ńtı̃̀ 'jumping'

The tone melody on the root is HL, making it homophonous with 2nd person singular past tense constructions in Gua, which have an ɔ̀- or ò- prefix, too.

7.7.2 Affirmative and Negative Constructions in Gua

There is a H-toned negative prefix, bɛ́-, and it conditions a distinct tone melody on the root. The description will show examples for both the affirmative and negative constructions, in order to show the contrast. The affirmative imperative mood has a LH tone melody. However, the negative imperative has a prefix bɛ́-, and the root has the tone melody LL.

	Imperative		**Negative Imperative**	
(71)	a. k͡pɔ̀lí	'clean!'	bɛ́-k͡pɔ̀lì	'don't clean!'
	b. bòlí	'break (a coconut)!'	bé-bòlì	'don't break!'
	c. kʷɛ̀lɛ́	'fry!'	bɛ́-kʷɛ̀lɛ̀	'don't fry!'
	d. sòbí	'pull!'	bé-sòbì	'don't pull!'

In present/habitual constructions, there is a negative prefix bɛ́ just like in the imperatives, and the root is also L toned. Monomoraic subject prefixes are L toned. The 1SG ḿ- combines with the /b/ of the negative prefix, resulting in [mɛ́]. The affirmative is LL and the negative is also LL. Consider example (72) for illustration.

	Present/Habitual			**Negative of present/habitual**		
(72)	a. mí + bɔ̀tɛ̀	→	míbɔ̀tɛ̀	m̀- + bɛ́- + bɔ̀tɛ̀	→	mɛ́bɔ̀tɛ̀
	1SG roll up		'I roll up'	1SG NEG roll		'I do not roll up'

b. wʊ́ + bɔ̀tɛ̀ → wʊ́bɔ̀tɛ̀ ɔ̀- + bɛ́- + bɔ̀tɛ̀ → ɔ̀bɛ́bɔ̀tɛ̀

2SG roll up 'You roll up' 2SG NEG roll 'You do not roll up'

c. á- + bɔ̀tɛ̀ → ábɔ̀tɛ̀ à- + bɛ́- + bɔ̀tɛ̀ → àbɛ́bɔ̀tɛ̀

3SG roll up 'S/he rolls up' 3SG NEG roll 'S/he does not roll up'

With past tense constructions, the singular subject pronoun has a low tone preceding the negative prefix bɛ́-. The tone on the verb remains HL just as the case in the affirmative construction. Furthermore, the negative marker does not take the opposite tone of the TAM tone melody, but is consistently H-toned, creating a H-H sequence across the prefix-root boundary. There is also the introduction/insertion of a completive nasal consonant [N] marker in the past negative construction that has the same high tone as the negative prefix, as is typical of word-internal nasal codas. In the affirmative constructions, all the pronouns bear low tone because they precede a high-toned syllable, and the same pattern is found in the negative as the negative marker is high-toned. Consider example (73).

Past Tense **Negative Past Tense**

(73) a. m̀- + bɔ́tɛ̀ → m̀bɔ́tɛ̀ m̀- + bɛ́-Ń- + bɔ́tɛ̀ → mɛ́ḿbɔ́tɛ̀

1SG roll up 'I rolled up' 1SG NEG-COMPL roll.PST 'I did not roll (up)'

b. ɔ́- + bɔ́tɛ̀ → ɔ̀bɔ́tɛ̀ ɔ̀- + bɛ́-Ń- + bɔ́tɛ̀ → ɔ̀bɛ́ḿbɔ́tɛ̀

2SG roll up 'You rolled up' 2SG NEG -COMPL roll.PST 'You did not roll (up)'

c. á- + bɔ́tɛ̀ → àbɔ́tɛ̀ à- + bɛ́-Ń- + bɔ́tɛ̀ → àbɛ́ḿbɔ́tɛ̀

3SG roll up 'S/he rolled up' 3SG NEG-COMPL roll.PST 'S/he did not roll (up)'

So far, we have observed that there is interaction between the singular pronoun prefixes and negative prefix. What appears to be happening is that unlike the subject prefixes that selects opposite tones of the ones the verb roots contain, the negative marker keeps its high tone. Note that the choice of the subject allomorphs partially correlates with tone, but not always. So the m̀/ɔ̀/à forms are L-toned and occur with NEG bɛ́- and PAST, which is HL. The mí/wʊ́/á forms are H-toned and occur with FUT bɛ̀- PRES/HAB LL and PROG ɛ̀ɛ́, which are all L-initial. However, they also occur with PERF which is ɛ́ɛ̀, so HL. Due to the fusion/deletion/glide formation, it's hard to see, but the mjɛ́ɛ̀- suggests an original vowel from mí-. With the negative constructions, the bilabial stop of the negative marker deletes or fuses with the pronoun allomorph leaving a single bilabial nasal. The table below shows the tone patterns in the affirmative and the negative constructions. In all cases, the negative marker has H tone irrespective of what tone follows it. The negative marker has a fixed high tone that does not change.

Table 7.4: Affirmative and Negative Tone Patterns in TAM Forms without TAM Prefixes

TAM\Affix	Person	Affirmative + Tone	Negative + Tone
Present/Habitual	1st	mí-bɔ̀tɛ̀ H LL	mɛ́-bɔ̀tɛ̀ H-LL
	2nd	wʊ́-bɔ̀tɛ̀ H LL	ɔ̀-bɛ́-bɔ̀tɛ̀ L-H-LL
	3rd	á-bɔ́tɛ̀ H LL	à-bɛ́-bɔ̀tɛ̀ L-H-LL
Past	1st	m̀-bɔ́tɛ̀ L-HL	mɛ́-ḿ-bɔ́tɛ̀ H(H)-HL
	2nd	ɔ̀-bɔ́tɛ̀ L-HL	ɔ̀-bɛ́-ḿ-bɔ́tɛ̀ L-H(H)-HL
	3rd	à-bɔ́tɛ̀ L-HL	à-bɛ́-ḿ-bɔ́tɛ̀ L-H(H)-HL

In progressive forms, the negative marker bɛ́- with high tone is again introduced but the vowel ɛ́ and its tone is deleted before the progressive prefix. In this case, the long vowels that remain have the LH tone pattern of the progressive marker. Consider the examples in (74) that illustrates these facts. The interactions only affect the tones in the prefixes; those in the root are not affected, and they remain LL in the verb stem. The failure of the H tone of the NEG to appear in the surface form means that the subject prefixes are H toned, opposite to the low tone that follows in the PROG.

	Progressive Aspect	Negative Progressive Aspect
(74)	a. mjɛ̀ɛ́-bɔ̀tɛ̀	mɛ̀ɛ́-bɔ̀tɛ̀
	1SG.PROG roll.PROG	1SG.NEG.PROG roll.PROG
	'I am rolling up'	'I am not rolling up'

b. wɔ̀ɔ́-bɔ̀tɛ̀	ɔ́-bɛ̀ɛ́-bɔ̀tɛ̀
2SG.PROG roll.PROG	2SG NEG.PROG roll.PROG
‘You are rolling up’	‘You are not rolling up’
c. àá-bɔ̀tɛ̀	á-bɛ̀ɛ́-bɔ̀tɛ̀
3SG.PROG roll.PROG	3SG NEG PROG roll.PROG
‘S/he is rolling up’	‘S/he is not rolling up’

In the negative perfective constructions, the negative marker bɛ́- is introduced but the perfective marker does not appear. These are actually homophonous with the past forms. Consider the examples in (75) below. Two important things we observe here are that all the singular pronouns that appear have low tones preceding the H tone negative marker, but the HL tone of the verb remains although there is a tone clash between the negative prefix and the verb stem. As noted above, the tone of the negative is immune to alternation as discussed before.

	Perfective Aspect	**Negative erfective Aspect**
(75)	a. mjɛ́ɛ̀-bɔ́tɛ̀	mɛ́-bɔ́tɛ̀
	1SG.PERF roll-up.PERF	1SG.NEG roll.PERF
	‘I have rolled up’	‘I have not rolled up’
	b. wɔ́ɔ̀-bɔ́tɛ̀	ɔ̀-bɛ́-bɔ́tɛ̀
	2SG.PERF roll-up. PERF	2SG-NEG roll.PERF
	‘You have rolled (up)’	‘You have not rolled up’
	c. áà-bɔ́tɛ̀	à-bɛ́-bɔ́tɛ̀
	3SG.PERF roll-up.PERF	3SG-NEG roll.PERF
	‘S/he has rolled (up)’	‘S/he has not rolled up’

The future tense has the future marker bɛ̀- prefix with low tone. In the negative constructions, all the singular pronouns have L tones preceding the H-toned negative marker, whereas in the affirmative they are H toned preceding the L-toned future marker. The future marker loses /b/ following the negative marker. This is illustrated in the examples in (76). Unlike the perfective negative constructions, there is no tone clash between the prefixes and the verb stem.

	Future Tense	**Negative Future Tense**
(76)	a. ḿ-mɛ̀-bɔ́tɛ̀	mɛ́ɛ̀-bɔ́tɛ̀
	1SG-FUT roll-up. FUT	1SG.NEG.FUT roll-up.FUT
	'I will roll up'	'I will not roll up'
	b. wʊ́-bɛ̀-bɔ́tɛ̀	ɔ̀-bɛ́ɛ̀-bɔ́tɛ̀
	2SG-FUT roll-up.FUT	2SG NEG.FUT roll.FUT
	'You will roll up'	'You will not roll up'
	c. á-bɛ̀-bɔ́tɛ̀	à-bɛ́ɛ̀-bɔ́tɛ̀
	3SG-FUT roll-up.FUT	3SG NEG.FUT roll-up.FUT
	'S/he will roll (up)'	'S/he does not roll up'

There are significant tone interactions between negative prefixes, TAM and subject pronouns. The table in 7.5 below summarizes the tone interactions between the prefixes and the verb stem. We observe that there is no tone clash except in constructions that involve the negative marker where there is tone clash between the H tone of the negative marker and the HL tone of the bilabial verb stem.

Table 7.5: Tone Patterns in affirmative and negative constructions with subject prefixes

TAM\Affix	Person	Affirmative + Tone	Negative + Tone
Present/Habitual	1st	mí bɔ̀tɛ̀ H LL	mɛ́bɔ̀tɛ̀ 0-H-LL
	2nd	wʊ́ bɔ̀tɛ̀ H LL	ɔ̀bɛ́bɔ̀tɛ̀ L-H-LL
	3rd	àbɔ́tɛ̀ L HL	àbɛ́bɔ̀tɛ̀ L-H-HL
Past	1st	m̀bɔ́tɛ̀ L-HL	mɛ́ḿbɔ́tɛ̀ 0-H(H)-HL
	2nd	ɔ̀bɔ́tɛ̀ L-HL	ɔ̀bɛ́ḿbɔ́tɛ̀ L-H(H)-HL
	3rd	àbɔ́tɛ̀ L-HL	àbɛ́ḿbɔ́tɛ̀ L-H(H)-HL
Progressive	1st	mjɛ̀ɛ́bɔ̀tɛ̀ 0-LH-LL	mɛ̀ɛ́bɔ̀tɛ̀ 0-LH-LL
	2nd	wɔ̀ɔ́bɔ̀tɛ̀ 0-LH-LL	ɔ́bɛ̀ɛ́bɔ̀tɛ̀ H-LH-LL
	3rd	àábɔ̀tɛ̀ 0-LH-LL	ábɛ̀ɛ́bɔ̀tɛ̀ H-LH-LL
Perfective	1st	mjɛ́ɛ̀bɔ́tɛ̀ 0-HL-HL	mɛ́bɔ́tɛ̀ 0-H-HL
	2nd	wɔ́ɔ̀bɔ́tɛ̀ 0-HL-HL	ɔ̀bɛ́bɔ́tɛ̀ L-H-HL
	3rd	áàbɔ́tɛ̀ 0-HL-HL	àbɛ́bɔ́tɛ̀ L-H-HL
Future	1st	ḿmɛ̀bɔ́tɛ̀ H-L-HL	mɛ́ɛ̀bɔ́tɛ̀ 0-HL-HL
	2nd	wʊ́bɛ̀bɔ́tɛ̀ H-L-HL	ɔ̀bɛ́ɛ̀bɔ́tɛ̀ L-HL-HL
	3rd	ábɛ̀bɔ́tɛ̀ H-L-HL	àbɛ́ɛ̀bɔ́tɛ̀ L-HL-HL

Crucially, while there are tone interactions between the singular subject pronouns and the verb stem by ensuring that dissimilation is applied and OCP respected in the affirmative constructions, the negative marker is consistently H toned, so its presence also causes the subject prefixes to also become low-toned. When it doesn't appear, as in the progressive, then they are high-toned.

7.7.3 Associated Motion Prefixes

Gua also has associated motion prefixes which indicates the closeness of the object to the interlocutor. When the action described is towards the participants in the interaction, the venitive prefix bɛ̀- with low tone is introduced. However, when the action is away from the participant, then the itive prefix wɔ̀- is used, also with a low tone. The two associated motion forms are prefixes that are derived from verbs we-wɔ and bɛ-bɔ, where the first part is optional, but they are prefixes here.

In imperative constructions, there is no need for a subject so the verb has only the prefix wɔ̀- or bɛ̀- as shown in example (77). The prefixes have L tone, while the imperative has HL. Without the associated motion prefix, imperatives have LH tone. This could mean that the prefixes have fixed L tone and the HL tone melody on the root is chosen for tone polarity reasons instead of the normal LH. It preempts or overwrites the standard melody.

Associated Motion Imperative

(77)	a. bɛ̀-bɔ́tɛ̀	'come (here) and clean!'	wɔ̀-bɔ́tɛ̀	'go (there) and clean!'
	b. bè-sóbì	'come (here) and pull!'	wò-sóbì	'go (there) and pull!'
	c. bɛ̀-fítɛ̀	'come (here) and dry (it)!'	wɔ̀-fítɛ̀	'go (there) and dry (it)

In the habitual aspect construction, the longer bɛ-bɛ or we-wɔ- associated motion prefixes are found, as in the examples in (78). The *wè* form that is introduced is different from the *dʑè* 'go' verb in Gua. As with the imperative forms, the tone on the root is HL whereas habitual usually has LL tone on the root. The verb stem conforms to the alternating H-L-HL polarity pattern.

(78)	a. kòfí bɛ̀-bɛ̀-bɔ́tɛ̀	'kofi comes to roll up'	kòfí wé[36]-wɔ̀-bɔ́tɛ̀ 'Kofi goes to roll up'
	b. kòfí bè-bè-sóbì	'Kofi comes to pull'	kòfí wé-wò-sóbì 'Kofi goes to pull'
	c. kòfí bɛ̀-bɛ̀-fítɛ̀	'Kofi comes to dry'	kòfí wé-wɔ̀-fítɛ̀ 'Kofi goes to dry'

In the past tense, there is HL tone on the verb roots and the nasal completive marker. The associated motion prefix is L, so the completive marker is also L.

(79)	a. kòfí bɛ̀m̀-bɔ́tɛ̀	'Kofi came to roll up'	kòfí wɔ̀m̀-bɔ́tɛ̀ 'Kofi went to roll up'
	b. kòfí bèǹ-sóbì	'Kofi came to pull'	kòfí wòǹ-sóbì 'Kofi went to pull'
	c. kòfí bɛ̀ɱ̀-fítɛ̀	'Kofi came to dry it'	kòfí wɔ̀ɱ̀-fítɛ̀ 'Kofi went to dry it'

The future marker is added preceding the associated motion prefixes as follows:

(80)	a. kòfí bɛ̀-bɛ́-bɛ̀-bɔ́tɛ̀	'Kofi will come to roll up'
	b. kòfí bè-bé-bè-sóbì	'Kofi will come to pull'
	c. kòfí bɛ̀-bɛ́-bɛ̀-fítɛ̀	'Kofi will come to dry'
	d. kòfí bè-wé-wɔ̀-bɔ́tɛ̀	'Kofi will go to roll up'
	e. kòfí bè-wé-wò-sóbì	'Kofi will go to pull'
	f. kòfí bè-wé-wɔ̀-fítɛ̀	'Kofi will go to dry'

[36] This is your one example of a +ATR prefix then. And note that the regressive nature of the vowel harmony is upheld.

Apart from the lexical nouns, singular subject prefixes also occur before the verb stem. I illustrate the behavior of the subject prefixes using only the third person singular subject prefix. The examples in (81) show that, where wé- is introduced in the itive constructions, the tone in the singular subject prefix becomes low but when it is absent or before the venitive marker bɛ̀- with low tone, the tone becomes high. I show this in the itive construction.

(81) a. wò-sóbì 'go and pull'
b. ɜ́-wò-sóbì 'S/he is going to pull it.'
c. ɜ̀-wé-wò-sóbì 'S/he goes to pull it.'
d. ɜ́-bè-wé-wò-sóbì 'S/he will go to pull it.'
e. ɜ́-wòǹ-sóbì 'S/he went to pull it.'

The associated motion constructions involve low-toned prefixes that can be preceded by another H toned prefix in some constructions. They consistently have HL on the verb root. This may be a case of the prefix having fixed L tone, and selecting a specific tone melody in accordance with the OCP rather than the standard TAM tone melody assigned to verbs with no associated motion prefixes. Although they utilize the completive marker in the past tense constructions, this time, it bears low tone due to the requirement that the nasal coda matches the tone of the preceding vowel. It also another confirmation that the singular subject prefixes alternate their tone depending on the following tone.

Gua has subject prefixes, negative prefixes, associated motion prefixes and gerund prefixes. As the tone pattern on the prefixes show, the subject prefixes alternate their tones to show opposite tones from the tone on the verb stem. The gerund and associated motion forms have L tones only, and they do not alternate their tones. But the verb root they occur with always starts with high tone, which does suggest tone polarity. In contrast, the negative prefix always shows high tone irrespective of the tone on the verb stem. The subject pronouns, on the other hand, alternate their tones based on the tone of the verb stems they are attached to. The tones are selected in such a way that the OCP is respected.

7.8 Conclusion

This chapter considers tonal structures in Gua and shows that the language uses tone to mark lexical and grammatical structures. Apart from the basic tones L, H, and HF (in the case of nouns), all monomoraic nouns and adjectives bear H tone while their bimoraic and trimoraic counterparts have different patterns. Lexical tone melodies presented also reveal that ideophones uses the same tonemes for their tonal arrangement.

The language also has grammatical tone on verbs which are best analyzed as tone melodies. These melodies are carefully selected in a way that tone clash between the tones on verb stems and those that occur on subject prefixes and TAM prefixes are avoided. Gua has other prefixes and unlike the subject prefixes that change their tones to avoid tone clash, the negative, associated motion and the gerund prefixes do not change their tones. Rather, while the negative marker bɛ́- which bears a high tone can occur with any toneme that starts the stem, the associated motion and the gerund prefixes bear low tones, but cooccur with roots that start with a high tone.

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CHAPTER EIGHT

CONCLUSION

8.0 Introduction

This chapter provides a summary of findings in the entire dissertation, and contributions and implications for typological and theoretical linguistics from each chapter. Section 8.1 is a summary of the main findings and their implications, section 8.2 makes recommendations for future research and a conclusion is given in section 8.3.

8.1 Summary of findings and their implications for linguistic typology and theory

The dissertation focuses on the properties of the sound system of Gua. This includes the segmental inventory, tone, and phonological processes such as vowel harmony, hiatus resolution, consonant assimilation and nasalization.

The general introduction of the dissertation is presented in chapter 1. In chapter 1, the sociolinguistic survey conducted in Boso showed that Gua is losing speakers due to a lack of transmission of the language from some adults to the younger generation; Akan is taking over most of the domains of language use in the community. A worrying trend was that of younger adults using more Akan in the home than Gua, compared to the oldest generation who use Gua only. This survey established Gua's threatened status and motivated this dissertation as a major springboard for the future development of the language.

Chapter 2 presented Gua's large vowel inventory with vowel length distinctions, nasal vowels and vowel sequences. Gua has a typical Kwa vowel system of nine phonemic oral vowels and seven phonemic nasal vowels. A symmetrical ten vowel surface system is achieved with addition of the allophonic vowels [ɜ] and [ẽ, õ, ɜ̃]. The lack of /ẽ õ/ is a common pattern in West African vowel systems, but descriptions do not always address the presence of allophonic vowels.

Gua groups vowels into two sets based on the advancement (+ATR) or retraction of the tongue root (-ATR), and this distinction is demonstrated with acoustic measurements and articulatory data. As with some other West African languages, [+ATR] vowels show lower F1 than [-ATR], leading to the 'flip' in the vowel space where [ɪ] and [ʊ] are situated lower than [e] and [o] as they have higher F1 values. In terms of syllable structure, Gua has open CV syllables, but does allow nasal codas in word internal syllables.

Chapter 3 presents the basic patterns of word-internal ATR vowel harmony. Gua shows a robust regressive directionality pattern of ATR harmony within words and roots. Prefixes undergo harmony and only +ATR suffixes trigger harmony. Harmony also operates within compounds. The distribution of the vowels, including the allophonic vowel [ɜ], provides evidence for root-internal harmony. Other Guang languages like Nkami (Asante 2016, Akanlig-Pare & Asante 2016), Lɛtɛ (Akrofi Ansah 2009), Nkonya (Asante 2009) are also reported to have regressive ATR harmony within words, so this is a feature of some Guang languages, but not all (i.e. Nawuri has bidirectional harmony (Casali 2002). Gua is added to the small group of languages across the world that are reported to have regressive ATR directionality. The ATR pattern in Gua is particularly clear as it also operates within roots.

In Chapter 4 a detailed description of cross-word harmony demonstrates that the process is sensitive to both prosodic phrasal units as well as syntactic structure. Cross-word vowel harmony is non-iterative, affecting only the final vowel of the word, and it operates within prosodic domains of two or three words. Syntactic influence is noted in sentences with five or more words where the size of the subject influences the pattern of prosodic phrasing. The cross-word effects of the harmony process is the first case of prosodic binarity sensitivity in a vowel harmony system; previous analyses have shown prosodic binarity effects for tone, stress and duration. Moreover, while ternary phrasing is often disfavored in other languages, it is acceptable in Gua. The current study therefore adds a unique case to literature on cross-word harmony (Downing & Krämer 2021) and the syntax-prosody interface (Bennett & Elfner 2019).

In chapter 5, the sound properties of consonants are explored. Voice-onset-time measurements show a two-way voiced vs. unaspirated contrast for stops, including labio-velar stops. Labio-velar stops have not been included in the VOT typology survey of Chodroff et al (2019), where only eight African languages are featured, and three with labio-velar stops. With respect to consonantal phonological processes, nasal consonants are involved in complex interactions within the prefix domain of verbs in Gua. Nasal place assimilation, nasal assimilation and stop deletion are all observed. Prefixes both trigger and undergo these phonological changes, but the initial root consonant does not change and only induces nasal place assimilation. This suggests a distinct prefix domain in Gua verbs.

Two processes are introduced in chapter 6 that affect vowel realization: nasalization and vowel hiatus. The chapter shows how nasal and nasalized vowels are fully participatory in ATR vowel harmony; the nasalized allophones [ẽ õ ɜ̃] arise via nasalization and/or ATR vowel harmony. Gua vowels shows full participation, but this shows that descriptions of this type should be conducted for other languages to understand the range of participation of nasal vowels. The second section discussed the resolution of vowel hiatus (Casali 1997/2011) across morpheme and word boundaries, showing all combinations of sequences of oral vowels. The vowel hiatus resolution patterns interact with cross-word ATR harmony, leading to opacity on the surface. It is argued that ATR harmony applies before the application of vowel hiatus, emphasizing that cross-word harmony is a phonological process that can be ordered with respect to other rules.

Tone and tone processes are discussed in Chapter 7. Gua is a two-tone language with downstep triggered by either a floating or a non-floating L tone. In verbs, tone is grammatical. Tense, aspect and mood (TAM) correlate with one of three tone melodies (L, LH and HL) that extend across the root from right to left. Monomoraic roots cannot host a contour tone, and how a LH or HL tone melody reduces depends on the presence of a prefix. In addition, verbal prefixes show tone polarity effects. Subject markers alternate tone based on the tone of the following tone-bearing unit. TAM prefixes display opposite tone to the following tone-bearing unit. Nevertheless, negative and associated motion prefixes show fixed tone irrespective of the tone that follows.

8.2 Recommendations for future research

The dissertation has highlighted various phonological phenomena including vowel harmony, nasality, hiatus resolution, consonant assimilation, and tone processes. These processes interact with both morphology and syntax. Since the focus of the dissertation was to provide a detailed description of the phonetic and phonological patterns of the language, theoretical considerations have been raised only where relevant to provide stronger description. Some aspects of the phonology-phonetics interface relating to nasality in the language still remain to be explored, including acoustic and aerodynamic studies. There is also room for formal theoretical analysis of the tone interactions and the consonant behavior of prefixes.

The dissertation is a useful exploration to help with orthography work on the language. This process has begun with some initial discussions in the Boso community and preparations are underway. This will continue to ensure that the development agenda for the language is sustained.

Finally, the bigger project of writing a grammar is a future plan. Adequately describing the morphosyntax and discourse structure of Gua is still needed. The data already collected from conversations, stories and other elements of language usage will help in this regard. As shown in this dissertation, Gua has much to contribute to linguistics.

8.3 Conclusion

The dissertation has highlighted important phonological patterns from Gua that contribute to the study of the world's languages. It has touched on various phenomena such as vowel harmony, nasality, hiatus resolution, consonant processes and interactions, and tone melody and tone processes. These processes contribute greatly to linguistic typological knowledge.

The dissertation is also a testimony that more native speakers should gain linguistic training to provide detailed descriptions of their own languages. I hope the dissertation will contribute to Gua being more valued within the Boso community and to its maintenance and revitalization.

References

Abakah, Emmanuel N. 2004. The segmental and tone melodies of Akan. PhD Dissertation, Norwegian University of Science and Technology, Trondheim.

Abramson, Arthur S. and Douglas H. Whalen. 2017. Voice Onset Time (VOT) at 50: Theoretical and practical issues in measuring voicing distinctions. *Journal of Phonetics* 63, 75-86.

Abramson, Arthur S. 1995. Laryngeal Timing in Karen Obstruents. In F. Bell-Berti and L.J. Raphael (eds.), *Producing Speech: Contemporary Issues*, 155-165. New York: AIP Press.

Abramson, Arthur S. 1977. Laryngeal timing in consonant distinctions. *Phonetica* 34.4, 295-303.

Akanlig-Pare, George and Rogers Krobea Asante. 2016. Vowel Harmony in Nkami. *Journal of West African Languages* 43(1), 21-44.

Akinlabi, Akinbiyi. 1997. Kalaḅarị vowel harmony. The Linguistics Review 14, 97-138.

Akinlabi, Akinbiyi. 1994. Alignment constraints in ATR harmony. *Studies in the Linguistic Sciences* 24/1-2, 1-18.

Akrofi Ansah, Mercy. 2009. Aspects of Lɛtɛ (Larteh) Grammar. PhD Dissertation, University of Manchester.

Allen, Blake, Douglas Pulleyblank and Ọládiípò. Ajíbóyè. 2013. Articulatory mapping of Yoruba vowels: An ultrasound study. *Phonology* 30, 183-210.

Ampene, Kwasi. 2003. *History of the Guang-Speaking People of Ghana. (The Undisputed Aborigines of Ghana).* Philadelphia: StarSpirit Press.

Andersen, Toben. 1995. Morphological stratification in Dinka: On the alternations of voice quality, vowel length and tone in the morphology of transitive verbal roots in a monosyllabic language. *Studies in African Linguistics* 23(1), 1-64.

Andrzejewski, Bogumił W. 1955. The Problem of Vowel Representation in the Isaaq Dialect of Somali. *Bulletin of the School of Oriental and African Studies* 17, 567–580.

Archangeli, Diana and Douglas Pulleyblank. 2002. Kinande vowel harmony: domains, grounded conditions and one-sided alignment. *Phonology* 19, 139-188.

Archangeli, Diana and Douglas Pulleyblank. 1994. *Grounded phonology* (Vol. 25). Cambridge, MA: The MIT Press.

Archangeli, Diana and Douglas Pulleyblank. 1989. Yoruba vowel harmony. *Linguistic inquiry*, 20(2), 173-217.

Anttila, Arto, Matthew Adams and Michael Speriosu. 2010. The role of prosody in the English dative alternation. *Language and Cognitive Processes*, 25(7-9), 946-981.

Asante, Rogers Krobea. 2009. *Topics in Nkonya Phonology*. MPhil Thesis, University of Ghana, Legon.

Asante, Rogers Krobea. 2016. Nkami language: Description and analysis. PhD dissertation, Tongji University, Shanghai.

Bakovic, Eric. 2003. Vowel harmony and stem identity. *Lingua(GEM)* 2.2, *Phonology: theory and analysis*, 77-132.

Bakovic, Eric. 2000. *Harmony, dominance and control*. PhD dissertation, Rutgers University.

Bamgbose, Ayo. 1966. *A Grammar of Yoruba*. Cambridge: Cambridge University Press.

Beckman, Jill N. 1997. Positional faithfulness, positional neutralisation and Shona vowel harmony. *Phonology*, 1-46.

Bennett, Ryan and Emily Elfner (2019). The syntax-prosody interface. Annual Review of Linguistics 5: 151-171.

Bickmore, Lee. 2015. Tones gone crazy: The adventures of the melodic tone in Bantu. Plenary lecture given at the 46th Annual Conference on African Linguistics, University of Oregon.

Bickmore, Lee. 1990. Branching nodes and prosodic categories. In Sharon Inkelas and Draga Zec (eds.), *The Phonology-Syntax Connection*. Chicago: University of Chicago Press, 1-17.

Bing, Janet. 1987. Phonologically conditioned agreement: Evidence from Krahn. In David Odden (ed.), *Current approaches to African linguistics* 4. 53-60. Berlin: De Gruyter Mouton.

Blench, Roger. and Dendo, M. 2007. Recovering data on Mpra [= Mpre] a possible language isolate in North-Central Ghana. *Draft Manuscript March*, *10*, 2007. http://www.ddl.ish-lyon.cnrs.fr/projets/clhass/PageWeb/ressources/Isolats/Mpra%20%20Blench%202007.pdf. Accessed on June 21, 2021 at 10:16am.

Blevins, Juliette. 1996. The syllable in phonological theory. In John A. Goldsmith (ed.) *The Handbook of Phonological Theory*, Oxford: Oxford University Press, 206-44.

Bobuafor, Mercy. 2013. *A grammar of Tafi*. PhD Dissertation, Leiden University, Netherlands.

Boyd, Virginia L. 2015. The phonological systems of the Mbam languages of Cameroon with a focus on vowels and vowel harmony. PhD Dissertation, Leiden University, Netherlands.

Cahill, Michael. 2007. *Aspects of the morphology and phonology of Kɔnni*. Dallas: SIL International.

Campbell, Eric W. 2014. Aspects of the phonology and morphology of Zenzontepec Chatino, a Zapotecan language of Oaxaca, Mexico. PhD dissertation. University of Texas, Austin.

Casali, Roderic F. 2012. [+ATR] dominance in Akan. *Journal of West African Languages* 39.1, 33–59.

Casali, Roderic F. 2011. Hiatus resolution. In Marc van Oostendorp, Colin J. Ewen, Elizabeth Hume and Keren Rice (eds.). *The Blackwell Companion to Phonology*, vol. 3, 1434-1460. Malden, MA and Oxford: Wiley-Blackwell.

Casali, Roderic F. 2008. ATR harmony in African languages. *Language and Linguistics Compass*, 2(3), 496-549.

Casali, Roderic F. 2003. Nawuri ATR harmony in typological perspective. *Journal of West African Languages* 29(1), 3-43.

Casali, Roderic F. 1996. Resolving Hiatus. Ph.D. Dissertation, UCLA.

Casali, Roderic F. 1997. Vowel elision in hiatus contexts: which vowel goes? *Language* 73, 493-533.

Cho, Taehong, Douglas H. Whalen and Gerard Docherty. 2019. Voice onset time and beyond: Exploring laryngeal contrast in 19 languages. *Journal of Phonetics* 72, 52-65.

Cho, Taehong and Peter Ladefoged. 1999. Variation and universals in VOT: evidence from 18 languages. *Journal of Phonetics*, 27(2), 207-229.

Chodroff, Eleanor, Alessandra Golden and Colin Wilson. 2019. Covariation of stop voice onset time across languages. Evidence for a universal constraint on phonetic realization. *Journal of the Acoustical Society of America* 145(1), 106–115.

Christaller, Johann Gottlieb. 1875. A grammar of the Asante and Fante language. Basle: Evangelical Missionary Society.

Clements, G. Nick and Annie Rialland. 2006. Africa as a phonological area. In Bernd Heine and Derek Nurse, eds., *Africa as a Linguistic Area*. Cambridge: Cambridge University Press.

Clements, G. Nick. 2000. Phonology. In Bernd Heine and Derek Nurse (eds.), *African Languages: An Introduction*. Cambridge University Press, 123-160.

Clements, G. Nick. 1981. Akan vowel harmony: a nonlinear analysis. *Harvard Studies in Phonology* 2, 108-77. Bloomington: Indiana University Linguistics Club.

Connell, Bruce. and D. Robert Ladd. 1990. Aspects of pitch realisation in Yoruba. *Phonology* 7(1), 1-29.

Corbett, Greville. 1991. *Gender*. Cambridge: Cambridge University Press.

Cruz, Emiliana. 2011. Phonology, tone and the functions of tone in San Juan Quiahije Chatino. PhD Dissertation. University of Texas at Austin.

Dakubu, Mary Esther Kropp. 1988. Guang. In Mary Esther Kropp Dakubu (ed.) *The Languages of Ghana*. London Kegan Paul International.

Dimmendaal, Gerrit J. 1983. *The Turkana Language*, Foris, Dordrecht.

Dingemanse, M. (2012). Advances in the cross-linguistic study of ideophones. *Language and Linguistics compass*, *6*(10), 654-672.

Diop, Abdul A. M. 1998. *Aspects of Pulaar non-linear phonology*. PhD Dissertation, University of Illinois at Urbana-Champaign.

Dolphyne, Florence. 2006. *The Akan (Twi-Fante) language: its sound systems and tonal structure*. Accra: Ghana Universities Press. (2nd edition).

Downing, Laura J. 2018. Is Vowel Harmony canonically (P)Word Bound? An Africanist perspective on vowel harmony domains. Paper presented at the GLOW 41 Phonology Workshop on Long Distance Segmental Phenomena, held in Budapest on April 10-14, 2018.

Downing, Laura J. 2005. On the ambiguous segmental status of nasals in homorganic NC sequences. In Marc van Oostendorp and Jeroen van de Weijer (eds.), *The internal organization of phonological segments*, New York: Mouton de Gruyter, 183–216.

Dye, Amanda. 2015. *Vowel Harmony and Coarticulation in Wolof and Pulaar: An Ultrasound Study* (Doctoral dissertation, New York University).

Eberhard, David M., Gary F. Simons, and Charles D. Fening (eds.). 2021. *Ethnologue: Languages of the World. Twenty-second edition.* Dallas, Texas: SIL International. Online version: http://www.ethnologue.com.

Efere, Emmanuel Efereala. 2001. The pitch system of the Bumo dialect of Izon. In Suzanne Gessner, Sunyoung Oh and Kayono Shiobara (eds), *Current research on African languages and linguistics*, 115-259. University of British Columbia Working Papers in Linguistics 4.

Francis, A. L., and Nusbaum, H. C. 2002. Selective attention and the acquisition of new phonetic categories. *Journal of Experimental Psychology: Human perception and performance*, *28*(2), 349.

Fulop, Sean A., Ethelbert Kari, and Peter Ladefoged. 1998. An acoustic study of the tongue root contrast in Degema vowels. *Phonetica* 55.1-2 (1998): 80-98.

Genzel, Susanne (2013). Lexical and post-lexical tones in Akan. PhD thesis, University of Potsdam.

Ghini, Mirco. 1993. Phi-formation in Italian: a new proposal. *Toronto Working. Papers in Linguistics* 12, 41–77.

Goldsmith, John. 1976. Autosegmental phonology. PhD Dissertation, MIT.

Gordon, Matthew. 2016. *Phonological Typology*. Oxford University Press.

Hajek, John. 2011. Nasal Vowels in West Africa. In: Dryer, Matthew S. and Haspelmath, Martin (eds.) The World Atlas of Language Structures Online. Munich: Max Planck Digital Library, feature 10B. Available online at http://wals.info/feature/10B. Accessed on 04-20-2021

Haspelmath, M. (2015). The serial verb construction: Comparative concept and cross-linguistic generalizations. draft.

Hammarström, Harald, Robert Forkel and Martin Haspelmath. 2019. Glottolog 4.0. Jena: Max Planck Institute for the Science of Human History.

Hantgan, Abie., and Davis, Stuart. 2012. Bondu-so vowel harmony: a descriptive analysis with theoretical implications. *Studies in African Linguistics*, 41(2), 2-26.

Harry, Otelemate. 2004. *Aspects of the Tonal System of Kalabari-Ijo*. Stanford, CSLI Publications.

Harry, Otelemate G., and Larry M. Hyman. 2014. Phrasal construction tonology: The case of Kalabari. *Studies in Language. International Journal sponsored by the Foundation "Foundations of Language"* 38.4 (2014): 649-689.

Heath, Jeffrey. 2008. *A Grammar of Jamsay.* Berlin: Mouton De Gruyter.

Hess, Susan. 1992. Assimilatory effects in a vowel harmony system: an acoustic analysis of advanced tongue root in Akan. JPh 20. 475–492.

Hyman, Larry M., and Knut J. Olawsky. 2004. Dagbani verb tonology. In *Trends in African Linguistics 4*, 97-108. Africa World Press, Inc.

Hyman, Larry. 2002. Is there a right-to-left bias in harmony? Ms. Paper presented at the 9th International Phonology Meeting, Vienna.

Hyman, L.M., 1972. Nasals and nasalization in Kwa. *Studies in African linguistics*, *3*(2), pp.167-205.

Itô, Junko and Armin Mester. 2007. Prosodic adjunction in Japanese compounds. *Formal Approaches to Japanese Linguistics* 4,97-111. *MIT Working Papers in Linguistics* 55.

Jacobson, R. (1962). *Selected Writings 1: Phonological Studies*. Second expanded edition, Mouton, The Hague

Jenewari, C. E. W. 1978. Kalaḅarị orthography (2nd edn.). Ibadan and Port Harcourt. Rivers Readers Project.

Jenewari, C. E. W. 1989. Ijoid. In Bendor-Samuel, J. (ed.), The Niger-Congo Languages, 105–118. Lanham: University Press of America.

Jones, Peggy. 1987. Collected field reports on the phonology of Dilo. Accra: Institute of African Studies, University of Ghana.

Ka, Omar. 1994. Wolof phonology and morphology. University Press of America, Lanham, MD.

Kaplan, Aaron. 2008. Noniterativity is an emergent property of grammar. PhD dissertation, University of California, Santa Cruz.

Kari, Ethelbert E. 2007. Vowel Harmony in Degema, Nigeria. *African Study Monographs 28(2)*, 87–97.

Kaye, Jonathan. 1982. Harmony processes in Vata. In Projet sur les langues Kru, 60–151. UQAM.

Kidda, Mairo E. 1985. *Tangale Phonology: A Descriptive Analysis (Nigeria)* (Doctoral dissertation, University of Illinois at Urbana-Champaign).

Kilpatrick, Eileen. 1985. Bongo phonology. Occasional Papers in the Study of Sudanese Languages 4, 1-62.

Kimper, Wendell. 2011. Domain specificity and Vata ATR spreading. In *University of Pennsylvania Working Papers in Linguistics* 17(1), Proceedings of the 34th Annual Penn Linguistics Colloquium.

Kirkham, Sam & Claire Nance 2017. An acoustic-articulatory study of bilingual vowel production: Advanced tongue root vowels in Twi and tense/lax vowels in Ghanaian English. Journal of Phonetics 62: 65-81.

Kisseberth, Charles W. 1994. On domains. In Jennifer Cole and Charles Kisseberth (eds.), Perspectives in Phonology. Stanford: CSLI, 133-166.

Kügler, Frank. 2015. Phonological phrasing and ATR vowel harmony in Akan. Phonology 32 177-204

Kutsch Lojenga, Constance. 1986. Vowel harmony in Alur: On the crossroads of two systems. Proceedings of the Third Nilo-Saharan Linguistics Colloquium (NiloSaharan 6): 131–141.

Leben, William R. 1973. Suprasegmental phonology. Doctoral dissertation, MIT.

Lefebvre, Claire and Brousseau, An-Marie. 2011. 16. The so-called verb-doubling phenomena. In *A Grammar of Fongbe* (pp. 503-530). De Gruyter Mouton.

Lewis, M. Paul, Gary F Simons, and Charles D Fennig, eds. (2013), Ethnologue: Languages of the World. 17th Ed. Dallas: SIL Interna tional. Online version: http://www.ethnologue.com.

Linebaugh, Garry. 2015. Directionality in advanced tongue root harmony. In V. A. De Lucas,A. G. Senosiáin, D. Izquierdo Alegría, F. Jiménez Berrio, and M. Casado Velarde (eds.) Lenguas, lenguaje y lingü.stica. Contribuciones desde la Lingü.stica General. Pamplona, Spain: Servicio de Publicaciones de la Universidad de Navarra.

Lisker, Leigh and Abramson, Arthur S. 1964. A cross-language study of voicing in initial stops: Acoustical measurements. *Word*, *20*(3), 384-422.

Maddieson Ian., Flavier, Sébastien, Marsico, Egidio, Coupé, Christophe, Pellegrino, François. 2020. LAPSyD: Lyon-Albuquerque Phonological Systems Databases, Version 1.0. http://www.lapsyd.ddl.ish-lyon.cnrs.fr/lapsyd/

Maddieson, Ian. 2013. Tone. In: Dryer, Matthew S. & Haspelmath, Martin (eds.) The World Atlas of Language Structures Online. Leipzig: Max Planck Institute for Evolutionary Anthropology. (Available online at http://wals.info/chapter/13, Accessed on 2021-07-26.)

Maddieson, Ian. 2007. "Areal distribution of nasalized vowels". Proceedings of ICPhS ID 1676 Saarbrücken, 6-10 August 2007. 1381-1384.

Maddieson, Ian. 1984. Patterns of Sounds. Cambridge: CUP.

Mahanta, Shakuntala. 2007. Directionality and locality in vowel harmony; with special reference to vowel harmony in Assamese. PhD Dissertation. Published by LOT.

Marchese, Lynell. 1988. Noun classes and agreement systems in Kru: A historical approach. Agreement in Natural Language: Approaches, Theories, Descriptions.

Marchese, Lynell. 1979. Tense aspect and the development of auxiliaries in the Kru language family, UCLA dissertation.

Marlo, Michael R., Leonard Chacha Mwita and Mary Paster. 2014. Kuria tone melodies. *Africana Linguistica* 20. 277-294.

McCord, Michael S. 1989. Acoustical and Autosegmental Analyses of the Mayogo Vowel System. MA Thesis. University of Texas at Arlington.

McCollum, Adam G. and Essegbey, James. 2020. Initial prominence and progressive vowel harmony in Tutrugbu. *Phonological Data and Analysis*, *2*(3), pp.1-37.

McIntosh, Justin Daniel. 2015. Aspects of phonology and morphology of Teotepec eastern Chatino. PhD dissertation. University of Texas, Austin.

McKendry, Inga. 2013. Tonal association, prominence and prosodic structure in South-Eastern Nochixtlán Mixtec.

McPherson, Laura, and Jeffrey Heath. 2016. Phrasal grammatical tone in the Dogon languages. *Natural Language and Linguistic Theory* 34, no. 2: 593-639.

McPherson, Laura. 2014. Replacive grammatical tone in the Dogon languages. PhD Dissertation. University of California Los Angeles.

Morrison, Michelle. 2009. Homorganic NC sequences in Kibena: Pre-nasalized consonants, consonant clusters, or something else?. *Rice Working Papers in Linguistics*, *1*.

Mutaka, Ngessimo. 1995. Vowel harmony in Kinande. *Journal of West African Languages* 25, 41–55.

Myers, Samantha, Michael Obiri-Yeboah, Kenneth de Jong and Kelly Berkson (to appear). Tongue root contrasts in Gua: evidence from articulatory imaging. *Indiana Working Papers on Speech Sound Articulation*.

Nespor, Marina and Vogel, Irene. 1986. Prosodic Phonology. Dordrecht: Foris 70

Noonan, Michael. 1992. A grammar of Lango. Walter de Gruyter.

Noske, Manuela. 2000. [ATR] Harmony in Turkana: A Case of Faith Suffix >> Faith Root. *Natural Language and Linguistic Theory*, *18*(4), pp.771-812.

Netelenbos, Nicole, Li, Fangfang and Rosen, Nicole. 2016. Stop consonant production of French immersion students in Western Canada: A study of voice onset time. *International Journal of Bilingualism*, *20*(3), 346-357.

Nilsson, Morgan and Laura Downing. 2019. Somali vowel qualities and vowel harmony domains. Paper presented at NACAL 47, LACITO, Paris.

Niang, Mamadou O. 1997. Pulaar–English English–Pulaar Standard Dictionary. New York: Hippocrene.

Obeng, Samuel Gyasi. 1995. Vowel harmony in Gwa Nmle. Afrikanistische Arbeitspapiere 41, 143-152.

Obiri-Yeboah, Michael and Sharon Rose. 2021. Vowel harmony and phonological phrasing in Gua. *Natural Language and Linguistic Theory*, 1-35. https://doi.org/10.1007/s11049-021-09509-y

Obiri-Yeboah, Michael. 2020. *Tone Melody and TMA Marking in Gua. In F. Ahoua & B. Elugbe (eds.) Language typology and language documentation in West Africa: proceedings of the 27th West African Linguistics Congress (WALS). Paris: L'Harmattan.*

Obiri-Yeboah, Michael. 2013. *Aspects of Gua Phonology.* MA Thesis. University of Ghana, Legon.

Odden, David, and Lee Bickmore. 2014. Melodic tone in Bantu: overview. *Africana Linguistica* 20.1: 3-14

Odden, David. 1995. Phonology at the phrasal level in Bantu. In Francis X. Katamba (ed.), *Bantu Phonology and Morphology*. Munich: Lincom Europa, 40-68.

Ofori, Kwaku. 2014. A grammar of Anum. PhD Dissertation. University of Education, Winneba.

Okello, Betty J. 1975. *Some phonological and morphological processes in Lango*. Indiana University.

Osam, Emmanuel K. A. 1994. *Aspects of Akan grammar: A functional perspective* PhD Dissertation. University of Oregon.

Otero, Manuel A. 2015. [+ATR] Dominant Vowel Harmony Except When It's Not? Evidence from Ethiopian Komo. In Ruth Kramer and Elizabeth C. Zsiga (eds) *Selected Proceedings of the 44th Annual Conference on African Linguistics,* Cascadilla Proceedings Project Somerville, MA

Painter, Colin. 1967. The Distribution of Guan in Ghana and a statistical pretesting on twenty-five idiolects. *Journal of West African Languages* Vol. 4. Pp25-78

Painter, Colin. 1967b. *Fourteen Papers on Gwa and fifty-two texts in Gwa*. Institute of African Studies, University of Ghana.

Painter, Colin. 1971. Vowel harmony in Anum. Phonetica 23:239-248.

Palancar, Enrique, and Jean-Léo Léonard (eds.). 2016. *Tone and Inflection: New facts under new perspectives.* Berlin: De Gruyter Mouton.

Paradis, Carole. 1996. The inadequacy of filters and faithfulness in loanword adaptation. In: Jacques Durand and Bernard Laks (eds.), Current trends in phonology: Models and methods. Salford: ESRI.

Paradis, Carole. 1992. Lexical Phonology and Morphology: The Nominal classes in Fula. New York, London: Garland.

Paster, Mary. 2010. The verbal morphology and phonology of Asante Twi. *Studies in African Linguistics*, *39*(1), 78-99.

Pater, Joe. 1999. Austronesian nasal substitution and other NC effects. *The prosody-morphology interface*, 310-343.

Peacock, Wesley. 2007. The phonology of Nkonya. Collected Language Notes No. 27 Institute of African Studies, University of Ghana Legon

Prieto, Pilar. (2011). The intonational phonology of Catalan. In Jun, S.-A. (Ed.), Prosodic typology 2: The phonology of intonation and phrasing. Oxford, UK: Oxford University Press.

Pulleyblank, Douglas. 1988. Vocalic underspecification in Yoruba. *Linguistic inquiry*, *19*(2), 233-270.

Ribeiro, Eduardo. 2002. Directionality in Vowel Harmony: The Case of Karajá (Macro-Je). Berkeley Linguistics Society 28, 475-485.

Riehl, Anastasia. K. 2009. The Phonology and Phonetics of Nasal Obstruents Sequences. PhD Dissertation. Cornell University.

Ringen, Catherine O. 1979. Vowel harmony in Igbo and Diola-Fogny. *Studies in African Linguistics*, *10*(3), 247.

Roberts, David. 2016. Word Tone and Tonal Overwriting in Kabiye Nouns. *Journal of African Languages and Linguistics* 37 (1): 131-60.

Rolle, Nicholas, Florian Lionnet and Matthew Faytak. 2019. Areal patterns in the vowel systems of the Macro-Sudan Belt.

Rolle, Nicholas. 2013. Nasal Vowel Patterns in West Africa. *UC Berkeley Phonology Lab Annual Report (9)9*

Rose, Sharon. 2018. ATR Vowel Harmony: new patterns and diagnostics. In *Proceedings of the Annual Meetings on Phonology* (Vol. 5).

Rosenthall, Samuel. (1997). The Distribution of Prevocalic Vowels," Natural Language and Linguistic Theory, 15, 139-180.

Rosenthall, Samuel. 1994. Vowel/glide alternation in a theory of constraint interaction. PhD Dissertation. UMass.

Ruhlen, Merritt. 1978. “Nasal Vowels”. In Greenberg, J. (Ed.), Universals of Human language. Vol II: Phonology. Stanford: Stanford University Press. 203-241.

Sandalo, Filomena and Hubert Truckenbrodt 2002. Some Notes on Phonological Phrasing in Brazilian Portuguese. *MIT Working Papers in Linguistics* 42, 285-310

Sande, Hannah. 2020. Morphologically conditioned phonology with two triggers. *Phonology*, *37*(3), pp.453-493.

Sande, Hannah. 2019. Phonologically determined nominal concord as post-syntactic: Evidence from Guébie. *Journal of Linguistics*, *55*(4), pp.831-878.

Sande, Hannah. 2015. The nominal system of Guébie (Kru) in typological perspective.

Schröder, Helga and Schröder, Martin. (1987). Vowel harmony in Toposa.

Selkirk, Elizabeth. 2011. The Syntax-Phonology Interface. In J. Goldsmith, J. Riggle, and A. Yu (eds.), *The Handbook of Phonological Theory,* 2nd edition. Oxford: Blackwell.

Silverman, Daniel. 1997. Tone sandhi in Comaltepec Chinantec. *Language*, 473-492.

Smolensky, Paul. 2006. Optimality in phonology II: Harmonic completeness, local constraint conjunction, and feature-domain markedness. In The Harmonic Mind: From Neural Computation to Optimality-Theoretic Grammar, Volume II, eds. Paul Smolensky, Geraldine Legendre and (eds.), 27-160: MIT Press.

Snider, Keith L. 1990. Studies in Guang phonology. PhD Dissertation. University of Leiden. The Netherlands.

Stewart, John. 1983. Akan vowel harmony: the word structure conditions and the floating vowels. *Studies in African Linguistics* 14.2:111-139.

Stewart, John M. 1965. The Typology of the Twi Tone System. Preprint from the Bulletin of the Institute of African Studies (Legon), 1, 1–27.. 1971. *Niger-Congo: Kwa." In Current Trends in Linguistics*, *7*, 179-212.

Sullivant, John R. 2015. *The phonology and inflectional morphology of Cháʔknyá, Tataltepec de Valdés Chatino, a Zapotecan language* (Doctoral dissertation).

Swenson, Janel. 2015. ATR quality in the Luo vowel system. Canadian Institute of Linguistics EWP 1, 101-145.

Styler, Will. 2021. Praat Scripts. https://github.com/stylerw/styler_praat_scripts Accessed: January 18, 2021 at 11:10am PST

Tideman, Lauren. 2019. *Vowel Phenomena of Guang Languages.* PhD Dissertation, Trinity Western University.

Tompkins, Barbara, Hatfield, Deborah H. and Kluge, Angela. 2002. Sociolinguistic Survey of the Gua Language Community. SIL International

Trommer, Jochen. 2011. Phonological aspects of Western Nilotic mutation morphology. Habilitation. Leipzig University.

UNESCO FAQ on endangered languages. http://www.unesco.org/new/en/culture/themes/endangered-languages/faq-on-endangered-languages/ [Accessed on: May 06, 2021 at 4:30pm PST].

van der Hulst, Harry. 2016. Vowel harmony. *Oxford Research Encyclopedia of Linguistics*.

van der Hulst, Harry and Jereon van de Weijer. 1995. Vowel Harmony. In John Gold-smith (ed.), The Handbook of Phonological Theory. Basil Blackwell, Oxford, 495-534.

Villard, Stéphanie. (2015). *The phonology and morphology of Zacatepec Eastern Chatino.* PhD Dissertation.

Williamson, Kay. 1973. “More on nasals and nasalization in Kwa”. Studies in African Linguistics, 4(2): 115-138.

Woock, Edith and Michael Noonan. 1979. Vowel Harmony in Lango. Papers from the Fifteenth Regional Meeting Chicago Linguistic Society, 20-29.

Yip, Moira J. 2002. Tone. Cambridge: Cambridge University Press.

Zimmermann, Eva. 2016. The power of a single representation: morphological tone and allomorphy. *Morphology* 26(3-4):269-294.